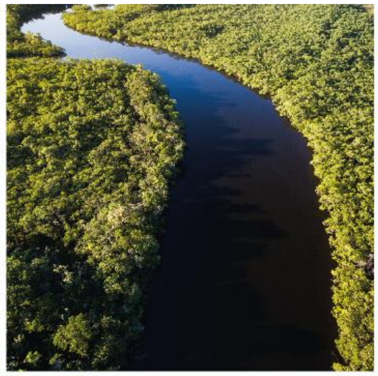



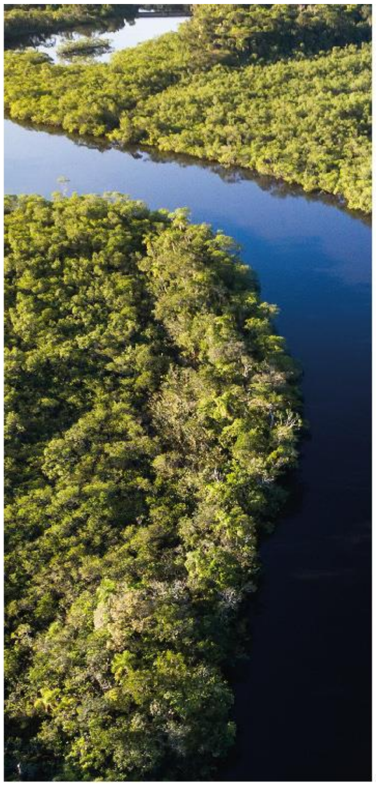

UNLOCKING PRIVATE CAPITAL BY VALUING BIOECONOMY PRODUCTS AND SERVICES WITH CLIMATE MITIGATION AND ADAPTATION RESULTS IN THE AMAZON

A feasibility study covering Brazil, Colombia, Ecuador, Guyana, Peru and Suriname

Commissioned by:
Interamerican Development Bank
Washington DC, USA

IDB

August 2021



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General Editor:

Nature Services,
Fernandez Concha 675,
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Recommended citation:

Hajek, F., Killeen, T.J., Ludena, C. et al, 2021.
Unlocking private capital by valuing bioeconomy products and services with climate mitigation and adaptation results in the Amazon: A feasibility study for Brazil, Colombia, Ecuador, Guyana, Peru and Suriname. Nature Services, Lima.

Design:

Gabriel Herrera

Lima, August 2021

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The authors would like to thank Jan Fehse, Gonzalo Varillas and Lily Rodriguez, for contributions.

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EXECUTIVE SUMMARY

The Amazon region includes forest, peatland and aquatic ecosystems of global climatic importance and great biological and cultural diversity. However, climate change-induced increases in temperature, changes in precipitation, more severe and sustained droughts, as well as other extreme hydro meteorological events, are increasing the vulnerability of Amazon ecosystems to degradation and loss of ecological functions[1]. These impacts are compounded by other dynamics associated to unsustainable agricultural practices and wildfires, all of which increase the Amazon´s greenhouse gas emissions. It is projected that if more than 20-25% of the Amazon's original forest cover is lost, we could reach a "tipping point" under which current dense forest could permanently transition into savannah-like-ecosystems. This would result in irreversible Amazon forest dieback, rapidly accelerating climatic changes worldwide, as the region becomes a net source of carbon emissions instead of a sink[2].

To date, over 115 million hectares of the Amazon have been converted to agriculture and other land uses, an estimated 30-40% of which are currently degraded pastures. In the last decades, agricultural deforestation pressures on the Amazon have intensified, causing the loss of at least 10% of its vegetation cover, whilst a much larger area is being degraded by licit and illicit extractive activities. This transition has accelerated with the implementation of governmental policies and infrastructure development programs, as well as the consolidation of national and international agricultural commodity markets.

Led by Brazil, the region is now a global agricultural powerhouse. However, business models that avoid deforestation and land degradation, delivering climate benefits and net gains in natural capital, are still far from achieving their full potential. For example, aquaculture with native species holds great promise, as fish is a relatively high-value product with rapidly growing national and international markets, and a much smaller land footprint than beef. However, aquaculture requires substantial upfront investment and specific skills to manage reproduction, nutrition and water quality, not currently within reach of many Amazon inhabitants and businesses. Other climate positive business models are already more consolidated, as is the case with irrigated açaí agriculture. This native crop is already generating more than a billion dollars in annual revenue in Brazil alone, capturing ecosystem carbon, enhancing food security, and providing tens of thousands of local jobs.

In light of the above, the objective of this feasibility study is to scope bioeconomy potential and finance demand in the shared Amazon landscapes of Brazil, Colombia, Ecuador, Guyana, Peru and Suriname in order to help determine the climate mitigation and adaptation benefits that could be delivered by the Amazon Bioeconomy Fund Program being presented to the Green Climate Fund. The feasibility study provides an overview of the policy, climate change, economic, and socio-ecological context of the six target countries, coupled with evidence of the impacts of climate change and climate-induced risks

[1] These climate-induced changes are expected to cause a rise in evapotranspiration, which is a key component of the surface water and energy balance of the ecosystems in the basin. Recent observations show that during the dry season, degraded forests in the Amazon are 6.5°C warmer, pump one-third less water; absorb one-third less carbon, and show a considerably higher fire risk than intact forests.

[2] Deforestation, through changes in the albedo and surface roughness, causes climate feedback loops that reduce precipitation and increase temperatures and hence reduce evapotranspiration and rainfall recycling.

associated with those changes, documenting existing opportunities to finance the initial steps of a transition towards a tree-based bioeconomy for the region. The study was conducted by sectorial and country experts who carried out a broad literature review. Interventions in agriculture, agroforestry, aquaculture, forestry, nature tourism and ecosystem services value chains were scoped and sized, including the climate adaptation and mitigation benefits that address the identified land-use and climate change-induced risks[3].

The study was guided by three key questions: 1) What bioeconomy value chain interventions can deliver climate and natural capital benefits in the six target countries of the Fund? , 2) What is the potential private sector financial demand and what are the key constraints to addressing this demand?, and 3) What is the optimal portfolio structure for the Fund to achieve transformational change in reducing emissions, increasing ecosystems resilience and increasing human wellbeing in the Amazon? A summary of the main findings of the study is presented in the following paragraphs.

In order to prevent further deforestation, degradation, generalized ecosystem services losses, and a potentially catastrophic ´tipping point´ in environmental conditions in the region, production systems should more closely resemble Amazon ecosystems, from a structural, functional and productive standpoint. Towards this aim, the Fund should encourage a regional economic transition from extensive cattle ranching and annual monocultures like soy and maize, towards integrated production systems based on the perennial agriculture, agroforestry, aquaculture, forestry and ecosystem services value chains presented in this report.

By screening and evaluating a set of key value chains, current bioeconomy finance demand is estimated in the order of US$1,901 million[4]. Attending this financial demand would support and improve the economic profitability of more than 143,000 businesses, of which 95.2% are vulnerable smallholder producers and micro-enterprises. Overall, it is estimated that US$792 million should be invested in smallholder producers, US$606 million in medium sized enterprises, cooperatives and productive associations, and US$503 million in large enterprises. Though smaller in number, the investments in the medium and large bio-businesses are a key part of the impact strategy of the program. These businesses are anchor companies in the aggregation, transformation and export nodes of the prioritized value chains, and are the conduit through which smallholders can reach national and international markets, and through which extension programs, quality checks and environmental standards can be channelled.

There are many barriers preventing finance reaching productive bio-businesses in the Amazon. These can be separated into demand-side barriers and supply-side barriers. Demand-side barriers to expanded bioeconomy investment among producers of all sizes include (a) Poverty of many potential beneficiaries reduces ability to access available financing, (b) Provision of technical assistance linked to financing is generally unavailable, and (c) Outdated systems and administrative procedures can be

[3] This feasibility study was complemented with a separate study by consultancy UNIQUE Forestry and Landuse (https://www.unique-landuse.de/) to financially model the prioritized value chains, structure the investments for each intervention, and quantitatively estimate climate benefits using the FAO EX-ACT tool (http://www.fao.org/in-action/epic/ex-act-tool/overview/en) .

[4] This estimate should be considered a minimum, as the portfolio of value chains evaluated is indicative and not exhaustive.

barriers to achieving finance. Financial institutions in the countries under study report the following barriers to expanding bioeconomy investments at present: (a) Great distances and related costs due to poor infrastructure (roads, telecom, connectivity) which increase transaction costs, (b) Significant risks in terms of illegality, informality, reputational risk and social license, (c) Insufficient technical assistance for businesses to become finance ready, (d) Limited knowledge of the Amazon amongst financial and non-financial actors which results in mismatch between financing terms, products, and demand, (e) Small number and size of businesses in many regions, (f) Reliance on complex certifications limits demand/supply, and (g) Current prioritization of COVID-19 recovery rather than bioeconomy financial innovation

Given the Pan Amazon context, the current nature of supply of financing and the types of investment opportunities identified, it is key that the Fund carefully screen opportunities for investment, and also ensure that the Inter-American Development Bank and its partners put in place best practices for ensuring successful bioeconomy investments, including: (a) Invest in financing deals as part of multi-actor partnerships with co-investors, (b) Seek projects that are context-driven and based on good climate data and analysis, (c) Select projects that include built-in, local expertise and demonstrate buy-in from local communities and indigenous peoples, and (d) Ensure investments align with bioeconomy criteria, using quantified metrics.

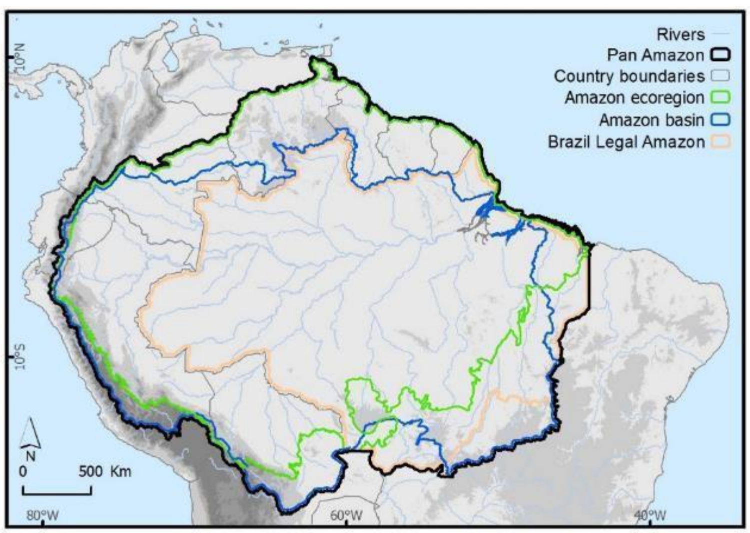
The Fund needs to be a transformational catalyst that overcomes a general lack of investment in bio-businesses and encourages the transition towards a tree-based economy with positive climate mitigation and adaptation outcomes in the region. These businesses need to create enough value to compete successfully with ´business-as-usual´ activities ranging from agricultural commodity monocultures, large scale slash-and-burn clearing for livestock, and illegal, unsustainable logging. Sustainable intensification business models are more effective at generating higher revenues on a per hectare basis, and in supporting climate adaptation through creating employment opportunities, while extensive ecosystem conservation business models are more effective at delivering emission reductions and enhancing ecosystem resilience (mitigation and adaptation impacts respectively). The Fund should therefore support a diverse portfolio of sustainable land-use intensification and extensive ecosystem conservation bio-businesses. This tree-based-economy should have the Amazon’s natural capital as its basis, and climate science, technology, and human capital systems as the strategic value multipliers. Targeted financial support at scale is now needed to help natural capital-based industries compete in national and international markets and realize the full climate and human wellbeing benefits of the Amazon’s biodiversity.

1.0 INTRODUCTION

1.1 The Amazon

The Amazon forest is spread over eight countries (Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela) and one overseas department (French Guiana) and is the largest tropical forest on earth. The term Pan Amazon has been developed to describe this shared region, acquiring political and administrative context through the Amazon Cooperation Treaty (ACT), to which the eight countries are signatories[5]. The Pan Amazon region is inhabited by a total population of roughly 34 million people, of which approximately 1.5 million (4%) are indigenous people[6]. The Pan Amazon, as depicted in Figure 1, includes both the Amazon biome/ecoregions (green) and the Amazon Basin (blue), and also incorporates areas reflected in Brazilian legislation governing fiscal and regulatory policy referred to as the Legal Amazon (pink). It is important to note that this inclusive geographic definition of the Amazon, also referred to in the literature as the extended Amazon, includes Andean ecosystems in Bolivia, Peru, Ecuador and Colombia, a significant portion of the Orinoco basin in Venezuela, the entire Guiana Shield region, as well as Chaco and Cerrado forest areas bordering the Amazon rainforest to the south in Bolivia and Brazil. In total, it covers approximately 839 million hectares.

Figure 1: The Pan Amazon and its relation to Amazon geographies



Source: Amazon Cooperation Treaty Organization, RAISG

The Amazon holds more than 40% of the rainforest remaining on Earth, storing approximately 90-140 billion metric tons of carbon, hence playing a considerable role in the global climate. However, the Amazon's environmental integrity and resilience is being reduced by multiple drivers and may be

[5] Nunes, Paulo Henrique Faria, 2018. A institucionalização da Pan-Amazônia. Curitiba.

[6] Organización del Tratado de Cooperación Amazónica - OTCA. (2018). *Análisis diagnóstico transfronterizo regional de la Cuenca Amazónica ADT*. Brasilia: OTCA. Red Amazónica de Información Socioambiental Georreferenciada - RAISG. (2018). Pan Amazonía. Evolución anual de la cobertura y uso de la tierra (1985-2018).

approaching a tipping point.[7] Deforestation rates are persistently trending higher in Bolivia, Colombia, Ecuador, and Peru over the last decades; while in Brazil, after concerted public-private cooperation led to a sharp decline in 2008-2012, they are now rising again.

Ecosystems are experiencing changes in their dynamics as a result of climate change-induced increases in temperature, changes in precipitation, and extreme hydro meteorological events. These climate-induced changes are expected to cause a rise in evapotranspiration, which is a key component of the surface water and energy balance of the ecosystems in the basin. These impacts are compounded by other dynamics associated to land-use change, including deforestation (small and large-scale), forest and land degradation, unsustainable agricultural practices and wildfires that increase the amount of carbon dioxide and other greenhouse gases being emitted into the atmosphere. These changes in Amazon ecosystems and the climate change-induced changes in temperature, precipitation and extreme hydro-meteorological events affect the productive systems and the people and businesses (micro, small, medium and large) that interact and depend on them. Climate change is expected to impact even further these systems. In particular, according to IPCC Special Report on Climate Change and Land (2019):

1) There is an urgent need to increase the volume of climate financing and bridge the gap between global adaptation needs and available funds, especially in relation to agriculture (FAO 2010). The land sector offers the potential to balance the synergies between mitigation and adaptation – although context and unavailability of data sets makes cost comparisons between mitigation and adaptation difficult (UNFCCC 2018b) - page 711.
2) There is significant regional heterogeneity in risks: tropical regions, including […] Central and South America are particularly vulnerable to decreases in crop yield with high confidence - page 675
3) Agricultural expansion has driven profound landscape transformations in the region, particularly between the 1970s and early 2000s, contributing to increased deforestation rates and associated GHG emissions. High rates of native vegetation conversion were found in Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay and Peru threatening ecologically important biomes, such as the Amazon, the savannas (Cerrado, Chaco and Llanos), the Atlantic Rainforest, the Caatinga, and the Yungas. The Amazon biome is a particularly sensitive biome as it provides crucial ecosystem services including biodiversity, hydrological processes (through evapotranspiration, cloud formation, and precipitation), and biogeochemical cycles (including carbon) - page 481
4) Smallholder farming systems have been recognized as highly vulnerable to climate change because they are highly dependent on agriculture and livestock for their livelihood (high confidence). Farmers observed high frequency and severity of drought; excessive precipitation; drying of rivers, dams and wells; and changes in timing and pattern of seasons as evidence of climate change, and indicated that prolonged wet, hot, and dry weather conditions resulted in crop damage, death of livestock, soil erosion, bush fires, poor plant germination, pests, lower incomes, and deterioration of infrastructure - Page 459.
5) Overall, historical data and projections show that South America is one of the regions of the world with the highest potential to increase crop and livestock production in the coming decades in a sustainable manner (Cohn et al. 2014), increasing food supply to more densely populated regions in Asia, Middle East and Europe. However, a great and coordinated effort is required from governments, industry, traders, scientists and the international community to improve planning, monitoring and innovation to guarantee sustainable intensification of its agricultural

[7] Lovejoy, T., Nobre, C. 2019. Amazon tipping point: Last chance for action. ScienceAdvances.

systems, contribution to GHG mitigation, and conservation of the surrounding environment (Negra et al. 2014; Curtis et al. 2018 and Lambin et al. 2018) - Page 482

6) Agroforestry systems with perennial crops, such as coffee and cacao, may be more important carbon sinks than those that combine trees with annual crops. Brandt et al. (2018) showed that farms in semi-arid regions (300–600 mm precipitation) were increasing in tree cover due to natural regeneration and that the increased application of agroforestry systems were supporting production and reducing GHG emissions - Page 485.

Two important contrasting features characterize the region: having the biggest tropical forest of the planet on the one side, and possessing the largest potential for agricultural expansion and development during the next decades on the other. (IPCC WGII AR5, page 1504, 2014). Land-use change remains a key driver of environmental degradation for the region that exacerbates the negative impacts from climate change. The high levels of deforestation observed in most of the countries in the region have been widely discussed in the literature as a deliberate development strategy based on the expansion of agriculture to satisfy the growing world demand for food, energy, and minerals. Land is facing increasing pressure from competing uses, among them cattle ranching, food and bioenergy production. The enhanced competition for land increases the risks of land-use changes, which may lead to negative environmental and socioeconomic impacts. (IPCC WGII AR5, pages 1513-1514, 2014).

Climate-change induced warming of the Amazon, with more severe and sustained droughts, will make the forest and agricultural ecosystems more vulnerable to degradation and loss of ecological functions. Recent observations show that during the dry season, degraded forests in the Amazon are 6.5°C warmer, pump one-third less water, absorb one-third less carbon, and show a considerably higher fire risk than intact forests.

In the last decades, the Amazon region has suffered with greater intensity a series of pressures that have caused the loss of at least 10% of its vegetation cover. Deforestation causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness, and that reduce evapotranspiration and rainfall recycling. It is projected that if more than 20-25% of the Amazon's original forest cover is lost - the “tipping point”, current dense forest could permanently transition into savannah-like-ecosystems, resulting in the dieback of the Amazon forest, and rapidly accelerating climatic changes worldwide, as the Amazon becomes a net source of carbon emissions instead of a sink.

1.2 Study background, objectives and bioeconomy definitions

The Inter-American Development Bank (IDB) is in the process of structuring a program to finance investments that enhance the bioeconomy in the Amazon region, for which the proposal *The Amazon Bioeconomy Fund: Unlocking private capital by valuing bioeconomy products and services with climate mitigation and adaptation results in the Amazon* is being presented to the Green Climate Fund. The proposal covers the Amazon regions of Brazil, Colombia, Ecuador, Guyana, Peru and Suriname. These six countries are signatories of the Amazon Cooperation Treaty and, more recently, the Leticia Pact.[8] The Leticia Pact is a clear manifestation of the will of these nations to work together towards the conservation, sustainable use and resilience of the Amazon. The proposed program's goal is to reduce GHG emissions and increase the adaptive capacity of targeted value chains in the Amazon region by enabling the conditions to increase the flow of funds to bio-businesses in the bioeconomy of the Amazon.

The objective of this feasibility study is to help determine the climate mitigation and adaptation benefits that the aforementioned *Amazon Bioeconomy Fund* could deliver, and provide the necessary technical and economic data for the full proposal and financial model of the Program. To this end, the feasibility study is guided by the following three questions: a) Which are key bioeconomy value chains interventions that can deliver natural capital and climate benefits in the seven target countries of the Amazon Bioeconomy Fund ?, b) What is the potential private sector financial demand that the Fund could attend in order to support products and services with climate mitigation and adaptation benefits in these value chains ?, and c) What is the intervention portfolio structure for the Fund to achieve transformational change in reducing emissions, increasing human wellbeing and ecosystems resilience in the Amazon ?

According to the Economic Commission for Latin America and the Caribbean (Comisión Económica para América Latina y el Caribe-CEPAL), the bioeconomy is "an economy based on the consumption and production of goods and services derived from the direct use and sustainable transformation of biological resources and biomass waste generated in the transformation, production and consumption processes, taking advantage of the knowledge of biological systems, processes and principles, and traditional and modern technologies applicable to the knowledge, emulation and transformation of biological resources, systems, processes and principles." Thus, the bioeconomy uses natural wealth in a sustainable way and encourages practices that allow to mimic certain biological processes to reduce environmental impacts, repair damage or use resources more efficiently.[9]

Several Latin American countries are beginning to integrate the bioeconomy into their development plans and actions, proposing their own definitions to delineate their field of action. In Colombia, the bioeconomy "is a strategy that efficiently and sustainably manages renewable biological resources and residual biomass to generate new products, processes and value-added services based on knowledge" (National Planning Department, 2017). For Costa Rica, the objective is to consolidate a "sustainable production of high added value in all its regions and emerging bio-cities, based on the fair and equitable use of biodiversity, the circular use of biomass and the biotechnological progress of the country as a society of knowledge." (Ministry of Science, Technology and Telecommunications, 2020). In Ecuador, the Ministry of Environment and Water (MAE 2019) proposes a series of key action areas to work towards the bioeconomy: (1) sustainable use of biodiversity resources, (2) eco-intensification to improve the performance of agricultural activities, (3) biotechnology applications, (4) biorefineries and bioproducts, (5) improvement of agro-food value chains, and (6) maintenance of ecosystem services.

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[8] Signed September 6, 2019 – reproduced in Appendix 1.

[9] Rodríguez, A., Mondaini, A., and Hitschfeld, M. (2017). *Bioeconomía en América Latina y el Caribe: contexto global y regional y perspectivas.* Santiago de Chile: CEPAL.

For the purposes of this study, the bioeconomy refers to any economic activity based on the use of natural renewable biological resources, to obtain food, materials, and energy in a sustainable way without compromising their availability for future generations. It comprises activities related to the invention, development, production, and use of biological products and processes. In the Amazon the bioeconomy aims to be climate and nature-positive, encouraging sustainable land-use practices that lead to reduced emissions, higher carbon stocks, net gains in natural capital, and increased climate resilience of vulnerable populations and ecosystems.[10]

1.3 Geographic scope of study

The geographic scope of this study is the proposed program area, namely the Pan Amazon portions of the six participating countries (Brazil, Colombia, Ecuador, Guyana, Peru and Suriname).[11] Across all countries, the study covers over 728 million hectares, as detailed in Table 1 and shown in Figure 2. By including landscapes that border the Amazon biome, namely Andean landscapes in the Amazon basin of Peru, Ecuador and Colombia, and Cerrado landscapes in Brazil, the study looks at economic and social drivers of climate change and bioeconomy value chains, originating both within and on the borders of the Amazon biome. The sources of all data used in the geographical analysis throughout the study can be found in Appendix 12.

Table 1: Geographic scope of study

Country	Extent (million hectares)	Extent (%)
Brazil	530.6	72.8%
Colombia	50.8	7.0%
Ecuador	13.3	1.8%
Guyana	21.2	2.9%
Peru	98.0	13.5%
Suriname	14.7	2.0%
Total	728.6	100.0%

Source: Study team, based on RAISG 2020 GIS files

[10] This is a draft working definition, resulting from internal discussions by the IDB team and independent consultants.

[11] Venezuela and the overseas department of French Guiana are not included in the geographic scope, even though they are part of the Pan Amazon, as they are not signatories to the Leticia Pact.

Figure 2: Geographic scope of study

Source: Study team, based on RAISG 2020 GIS files

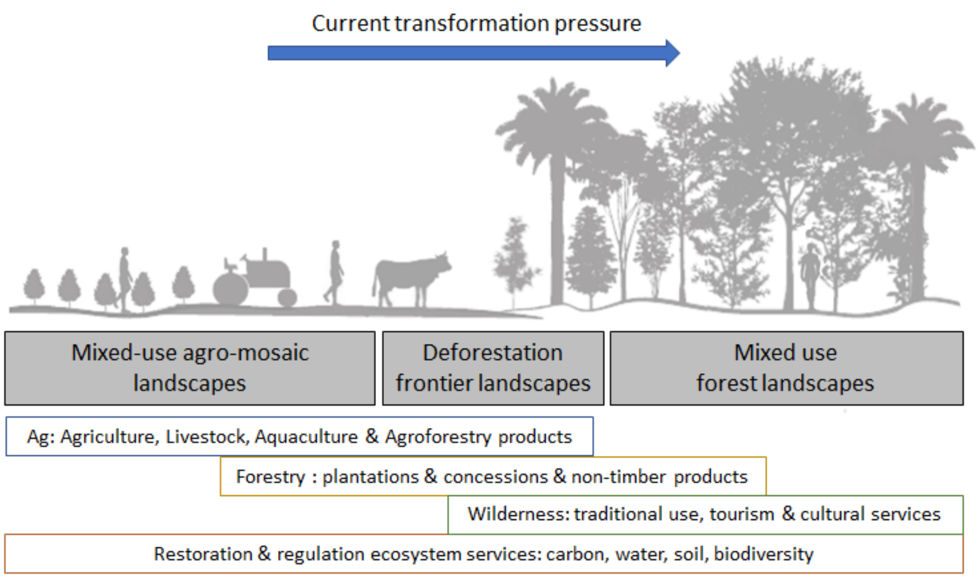
1.4 Transformation rationale and paradigm shift

In order to evaluate a broad sample of economically significant value chains with the scale to address the climate mitigation and adaptation ambition of the Program, we have adopted a landscape lens and grouped economic sectors and chains according to the land use they occupy. Different businesses and value chains, because of their intrinsic characteristics, concentrate in determined landscapes and land use types. Agriculture, and aquaculture businesses, for example, make intensive use of land and cluster in agricultural landscapes which normally have energy provision and good, or at least reasonable, infrastructure connections[12]. Certain activities in this sector make more extensive use of land and, to a great extent, rely on the availability of low cost land, like cattle ranching and bulk-commodity crops. In the Amazon these are often found on the deforestation frontier, where most of the land use change

[12] Agricultural actors need to get their perishable products to markets under the right conditions and on a regular basis

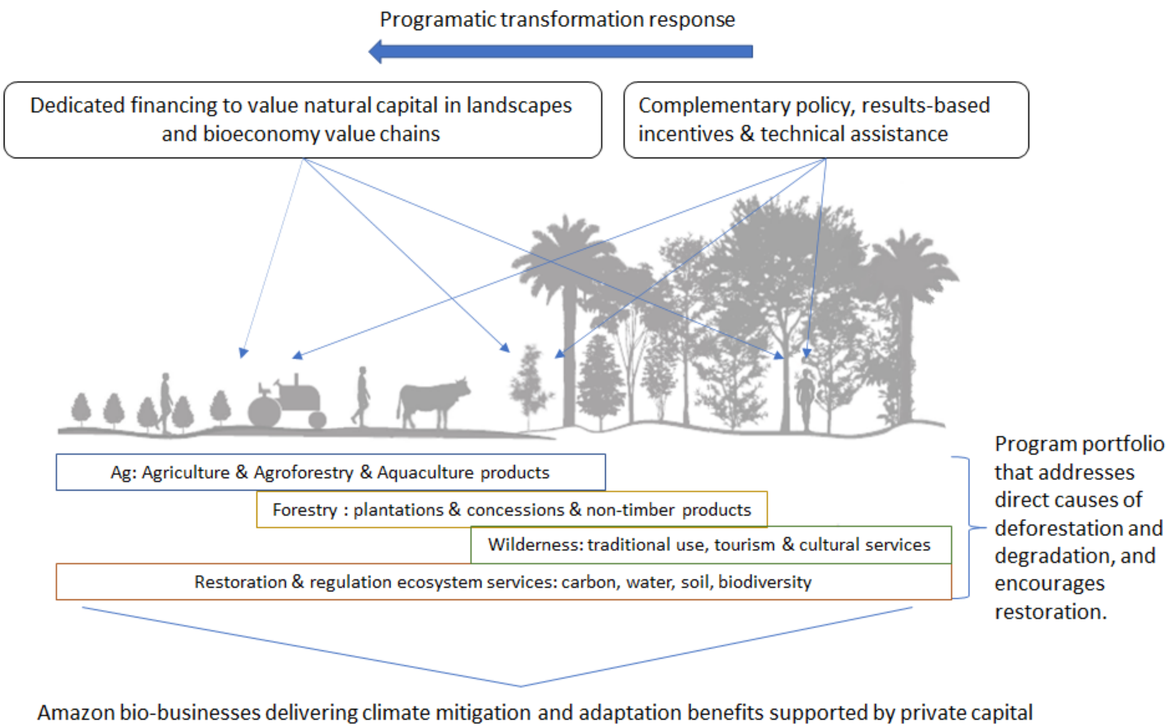
from forest to agriculture is currently happening. Other activities, rely on forests themselves, as is the case of timber and non-timber forestry. Wood, nuts, oils still have to be transported to local and international markets, but their less perishable nature, as well as the extensive land-use characteristics of the businesses themselves, means that infrastructure and human population densities are usually lower. Finally, there are economic activities that depend on the full diversity of the forest to be viable. These include traditional indigenous use and nature tourism. Ecosystem services and habitat restoration focused businesses work across landscapes, as all landscapes provide ecosystem services, and all landscapes can benefit from specific restoration interventions. This distribution of different economic activities and the land use transformation currently underway are depicted for illustrative reasons in Figure 3.

Figure 3: Landscape transition and related sectors of the economy



We use this landscape narrative to group the sectors and sub-sectors of the bioeconomy and develop a spatially explicit framework through which existing and new value chains can be classified within the Program, namely: (1) Ag: Agriculture, Livestock, Agroforestry and Aquaculture; (2) Forestry: plantations, concessions, and non-timber forest products (NTFPs including foods, fibers, genetic resources and other natural ingredients from natural forests); (3) Wilderness: traditional indigenous use, nature tourism and cultural services; and (5) Ecosystem services and habitat restoration. All value chains should be able to access dedicated concessional financing, and benefit from a conducive policy environment, technical assistance and incentives to value natural capital, as depicted in Figure 4.

Figure 4: Objectives and transformation response sought by the Amazon Bioeconomy Fund

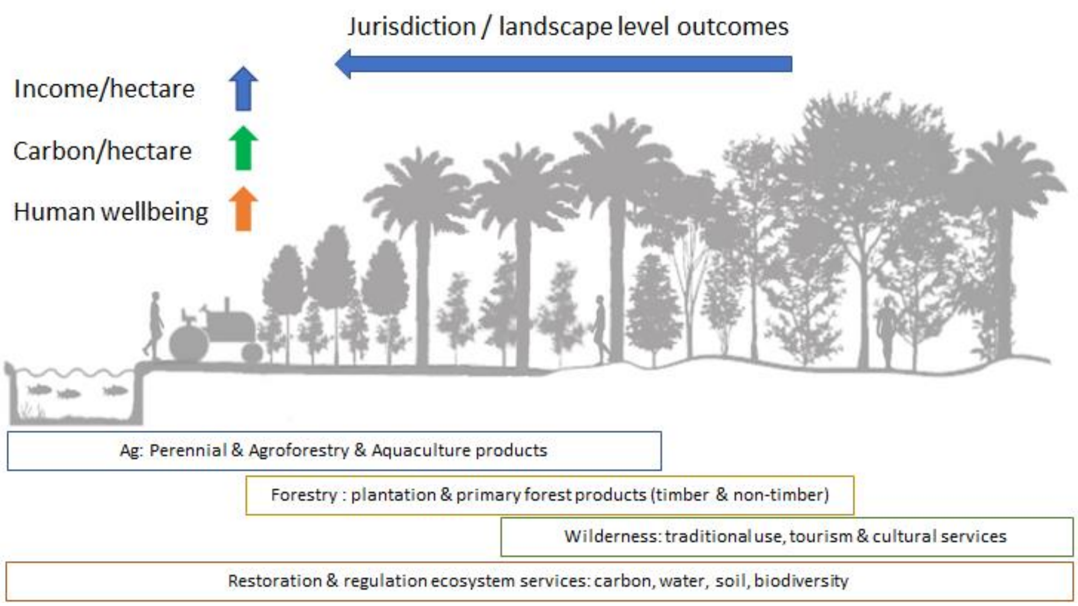


Like this, the ´*network of interconnected value chains, including agricultural, forestry, fishing and aquaculture activities, the food, beverage, pulp and paper industries*´ that comprise the Amazon bioeconomy should begin to transition from deforestation-causing to restoration-inducing, from linear extraction to circular regeneration, from marginal economics to economically competitive.

Towards this end, Program activities need to be designed in a way that they can be integrated into national systems, so that changes are ingrained and continue to evolve after Program completion. In particular, National Development Banks and private financial institutions which are foreseen to act as implementing entities of the Program should have extensive knowledge of the local markets, dedicated teams knowledgeable of climate change mitigation and adaptation, and a vision to catalyze the Program's impact through the use of their multiple delivery channels, hence also increasing the pool of potential supply of co-financing.

In this way, the valuing of natural capital via a set of financial solutions, technical support and incentives –to borrowers and lenders alike– will increase the commercial profitability of bio-business models, so that they can outcompete conventional Amazon business models that are destroying natural capital and contributing to the climate crisis. Once they have seen it can be profitable (i.e., adequate risk-adjusted returns and risk management possibilities), more private investors will choose to invest in bio-businesses to reduce sustainability risk and boost portfolio resilience. Like this, momentum will be created for the adoption of sustainable practices and technologies in private-led businesses that create dignified employment opportunities and increase profitability, while capturing ecosystem carbon and increasing ecosystem resilience, contributing like this to regional level climate change mitigation and adaptation, as depicted in Figure 5.

Figure 5: Paradigm shift and Amazon Bioeconomy Fund outcomes



1.5 Study approach and methodology

Sectorial and country experts carried out a broad literature review focused on the policy, economic, socio-ecological and business context of the Pan Amazon. This was complemented by a value chain analysis[13] and a Pan Amazon geospatial analysis, segmented for all sic beneficiary countries, in order to understand the bioeconomy in practice and inform a numerical overview of the socio-economic and environmental consequences of human development in the region, as well as create a template for spatial comparison amongst countries and bioeconomy sectors and value chains. Current bioeconomy activity was evaluated by first looking at national GDP data and then identifying priority sectors and applying value chain analysis as the basis to understand the functioning of individual businesses and estimate their financial requirements. Basic business and economic data was compiled as an Excel workbook that accompanies this report. Primary data from direct interviews with private sector and multilateral donors was also used to ensure contemporary relevance.

13 https://www.marketlinks.org/good-practice-center/value-chain-wiki/32-value-chain-analysis.

The study aims to be comprehensive by including the most significant value chain investment opportunities across bioeconomy sectors, as well as robust by focusing on existing economic activity and trends for which public and/or peer reviewed data is available. Due to the breadth of the bioeconomy and the geographical region in question, this feasibility study is not exhaustive, rather it is indicative of the significant investment opportunities that exist. Value chains that have a direct impact on ecosystems and land cover have been prioritized, as ecosystems are the fundamental renewable natural capital assets on which climate change exerts pressure and on which the bioeconomy depends. Further value chains and investment opportunities will surely materialize once the Program is under implementation. Another noteworthy consideration is that this study is not predictive of new bioeconomy sectors, as a detailed review of bioeconomy innovation directions and initiatives has not been carried out. This has been flagged for the technical assistance component of the Program.

We recognize that total economic value[14] goes beyond the economic values quantified in this report, and acknowledge that jurisdictional / integrated landscape management approaches (which are beyond the remit of this study) are a novel, emerging policy and practice process for stewarding total economic value in the medium and long term in the Pan Amazon. [15]

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[14] Total Economic Value = Direct Use Value + Indirect Use value + Option Value + Bequest Value + Existence Value. From: IUCN, The Nature Conservancy, The World Bank, 2004. How much is an ecosystem worth? Assessing the economic value of conservation.

[15] Nepstad, D., 2018. Jurisdictional sustainability: a primer for practitioners. EII. *Jurisdictional / landscape level sustainability and conservation of natural capital can be achieved when there is a shared definition of success among key sectors, when the political and economic power of those who want jurisdictional sustainability is sufficient to drive change, and when there is a viable strategy and plan for supporting the transition. Jurisdictional sustainability becomes durable when enabling conditions for maintaining it are locked into public policies, business models and formal land designations. It becomes self-reinforcing when it confers broadly perceived benefits, such as increases in access to markets and finance, job creation, food security, poverty alleviation, more abundant natural resources, and a healthier, more resilient environment.*

2.0 ECONOMIC, POLICY AND SOCIO-ECOLOGICAL CONTEXT

2.1 Economic development, policy and natural capital in the Pan Amazon

The economy of nations is traditionally evaluated by their gross domestic product (GDP), a metric that measures total economic output. The GDP of the Pan Amazon was approximately US$270 billion in 2017 (Figure 6) The contribution to national GDP from the jurisdictions located within the Pan Amazon range from a high of 100% (Guyana and Suriname) to a significant percentage in Brazil (8%), Peru (13%), and Ecuador (10%) to a small contribution in Colombia (2%).

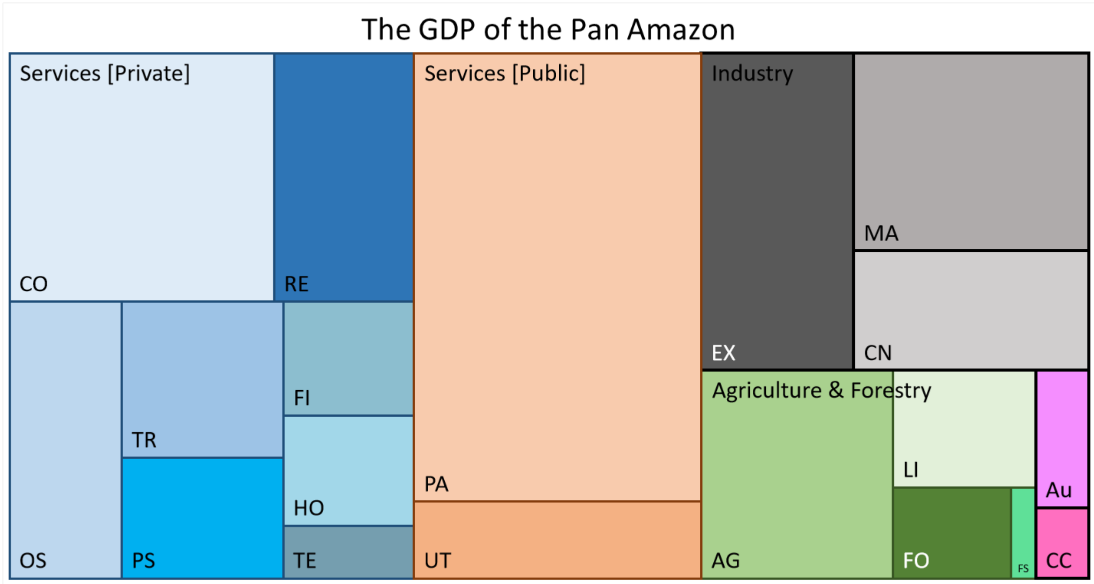
The GDP metric has five major limitations when evaluating the economic health of a society, all of which are germane to the Amazon: (1) it provides no information on inequality; (2) it underestimates the contribution of the informal sector; (3) it makes no attempt to measure the economic value of subsistence activities; (4) it does not distinguish between sustainable activities, such as the harvest of renewable resources, and non-sustainable business models, such as the exploitation of non-renewable resources; (5) it fails to account for negative outcomes that create a long-term economic liability, such as the loss of a key ecosystem services.[16] Regardless of these limitations, or perhaps because they are so obvious, it is useful to evaluate the structure of the Amazonian economy from the perspective of GDP.

The most salient attribute of the sectorial GDP data is the small contribution of the forest sector to the regional economy (< 2%); this surprisingly small number is juxtaposed to the intrinsic value[17] of the Amazon's forest and its vast pool of renewable natural resources. The most obvious explanation for this low number is the failure of GDP to capture values from subsistence and informal rural economies, and the ecosystem services the Amazon delivers to the global economy, particularly climate change mitigation and hydrologic regulation.

[16] Khan Academy (9 June 2020) The limitations of GDP, AP Macroeconomics

[17] Investors use the term *intrinsic value* to describe the potential value of an asset based on an objective evaluation that considers the long-term potential return; it is used in juxtaposition to the term *market value*, which reflects current earnings generated by the asset. Conservationists and environmental economists use the term to describe a point of view that resists efforts to ascribe a monetary value to nature, arguing that it has value in and of itself. Both usages are valid for the Amazon.

Figure 6: The GDP of the Pan Amazon stratified by sector and subsector. Agriculture and Forestry: Agriculture (AG), Fisheries and Aquaculture (FI), Forestry (FO), Livestock (LI); Industry: Extractives (EX), Manufacturing (MA), Construction (CN); Services [Private Sector]: Real Estate (RE), Commerce (CO), Transportation (TR), Hospitality (HO), Telecommunications (TE), Finance (FI), Professional Services (PS), Other services (OS); Services [Public sector]: Public Administration (PA), Utilities (UT). Illicit Activities: Coca/Cocaine (CC), Artisanal Gold (Au).[18]



Approximately 10% of the previously deforested land in Brazil and Bolivia has been settled by small farmers; although limited in area, these farmlands are home to about 70% of rural families and are an important source of basic foodstuffs, such as manioc, rice, beans and variety of tropical fruits.[19] In Peru and Ecuador, the predominance of smallholders is much greater, representing about 98% of all landholdings and occupying more than 90% of agricultural landscapes. The production model pursued by the majority of smallholders on frontier landscapes is based on slash-and-burn technology, which is used to establish and maintain a forest-fallow production system. Most farmers invest in perennial production systems over time as they diversify their crops and plantations, but they expand cultivation at the expense of remnant forests within their properties. The full value of their production is not incorporated into GDP, which causes the official statistics to underestimate their contribution to the regional economy, as well as the economic forces that drive deforestation by smallholders.

A significant factor in the under appreciation of forest and agriculture production is the methodological framework designed to avoid double accounting when compiling the GDP metric. Unlike the underreporting caused by the informal economy or subsistence farmers, this is not a flaw

[18] This value was compiled by the study team from reports published by national statistical agencies that stratify information by sub-national jurisdiction and sub sector. The GDP metric reported here is based on 'current value' and compared among countries using mean annual exchange rates in 2017.

[19] IBGE - Instituto Brasileiro de Geografia e Estatistica (2010 CENSO Agropecuario 2017, Tabela 6780 - Número de establecimentos agropecuários, por tipologia, origem da orientação técnica recebida, grupos de atividade econômica e grupos de área total (Vide Notas), https://sidra.ibge.gov.br/tabela/6780; CEDLA Centro de Estudios para el Desarrollo Laboral y Agrario (8 June 2020) Algunas características de las unidades productivas agropecuarias a cargo de mujeres, https://cedla.org/publicaciones/prya/algunas-caracteristicas-de-las-unidades-productivas-agropecuarias-a-cargo-de-mujeres/.

but an attribute of the GDP bookkeeping methodology. The value of the production for any sector is measured only once and, in the case of agriculture, those data are captured at the *farmgate*, a term used to describe the price paid to the producer. All subsequent transactions added value to the commodity and are accrued to a supply chain participant; for example, the increased value of dressed beef and soy oil are accrued to the manufacturing sector, while the cost of hauling grains to export terminals is allocated to the transportation sector. A comparison of the total gross value of farm production in Mato Grosso with the value-added metric used to compile sectorial GDP reveals that 45% of the total proceeds are allocated to service providers or manufacturers in the agricultural commodity supply chain.[20] The same assumptions hold true for timber, NTFP, wild-caught fish (WCF), and aquaculture-produced fish (APF). Consequently, these producer cascades up and down the supply chain means that successful land-based bioeconomy business models will likewise reverberate across other sectors of the economy.

The contribution of the construction industry to regional GDP is large across all jurisdictions, ranking just behind agriculture as a component of the conventional economy (Figure 6). Large-scale construction projects in Amazonian jurisdictions have been criticized for their environmental and social impacts; nonetheless, they enjoy the support of elected officials from successive governments at the national, regional, and local levels. There is an inherent synergy between expenditures in construction and the value of real estate, because property values increase following improvements in public infrastructure. The declared value of real estate transactions, however, are underreported by buyers and sellers in order to evade taxes, a practice more prevalent on frontier landscapes, where contracts are executed without the intermediation of banks.[21] Real estate markets are further distorted by the highly lucrative activity of land grabbing and, in the Andean republics, money laundering linked to illicit drugs.

The extractive industries in Pan Amazonian jurisdictions are important for the national economies of Colombia, Ecuador, Peru, Guyana, and Suriname (Figure 6). All mineral resources in the Pan Amazon are the property of individual states, which exploit them via state-owned enterprises or joint venture with corporations specialized in mining or the production of hydrocarbons. Revenues accrue to a region's GDP, even though they do not flow through the local economy; instead, they are deposited directly into the national treasury. This bookkeeping procedure distorts the value of the GDP per capita, which is often [mis-]reported as a measure of human well-being. Governments return mineral rents to producing regions as royalties, which are included within GDP values reported for public administration. Royalties vary between jurisdictions and across commodities: Peru has the most generous revenue sharing mechanism, while Brazil has the most frugal but transfers more resources

[20] IBGE, Instituto Brasileiro de Geografia e Estatistica, Sistema de Contas Regionais – SCR. https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/2021-np-contas-regionais-do-brasil/9054-contas-regionais-do-brasil.html?=&t=resultados.

[21] In Bolivia, transactions are actually formalized with two sets of parallel documents: one with the real value, which is kept private, and one with a "cadastral" value, which is reported to the authorities. In spite of an obvious fraud, courts will accept the real value version in litigation.

via the general budgetary system. Like agriculture, the extractive industries generate benefits to regions via the service sector, which vary depending upon the mineral commodity.[22]

The mining sector has an illegal component that is one of the most lucrative activities in the Pan Amazon. Artisanal and small-scale gold mining generated an estimated seven billion dollars in 2017, of which about half was exported via channels invisible to authorities. Most small-scale miners use placer mining technologies that destroy floodplains, while polluting watersheds with mercury. The most seriously impacted basins are the tributaries to Madeira (Madre de Dios, Perú and Beni, Bolivia) and Tapajós (Brazil), the Caroni river in Venezuela, the Essequibo in Guyana and the Courantyne on the border between Suriname and French Guiana. Ironically, the environmental liabilities being created by this blatantly illegal activity will create a business opportunity for the bioeconomy. Sooner or later, society will [must] remediate the contamination caused by illegal miners and the most cost-effective solutions are most likely to be some form of habitat restoration that removes or stabilizes toxic chemicals (mercury), but restores the ecosystem services provided by the floodplain habitats destroyed by the industry.

Another illegal activity not captured by GDP is the coca-cocaine supply chain that originates in Bolivia, Colombia, and Peru. The quasi-legal (or tolerated) cultivation of coca is associated with illegal laboratories that process coca leaf into cocaine. The coca-cocaine supply chain generates about US$1.5 billion annually within Amazonian jurisdictions, an amount multiplied several times over as money is laundered in the commerce, construction, and real estate sectors. Coca cultivation is an important source of deforestation in the Andean foothills, where it occurs even in protected areas and indigenous territories. Governments and bilateral agencies have spent tens of billions of dollars promoting alternative development on these landscapes for more than 35 years. These initiatives have mostly failed and provide a cautionary tale for the challenges that face promoters of a new bioeconomy. The business models of the new bioeconomy will dominate the landscape (including coca-cocaine frontiers) if they are more lucrative than the conventional models they seek to replace. In the case of coca-cocaine (and illegal gold mining), they will only displace illegal activities if they are accompanied with a strong effort to impose law and order.

Only Manaus has a strong manufacturing sector, an anomalous situation maintained by subsidies and tariff barriers. The other large cities (Belem, Santa Cruz, Cuiabá, Santarem, Porto Velho) are economically diverse, but their manufacturing and service companies rely directly or indirectly on revenues from the extractive industry or the agricultural and livestock sectors and, to a much lesser extent, the forest economy. The dependence of mid-sized cities (10,000 to 100,000 residents) on the rural economy is even more pronounced, because they are the economic gateway for private sector services to farms, ranches, and rural communities. The predominance of the service sector is not uncommon among nations, because it is a basket of many different economic activities. The growth of the service sector is also the consequence of the ongoing urbanization of Amazonian society. More than 50% of the region's inhabitants reside in cities with populations greater than 100,000, and the

[22] In Ecuador, value added GDP was 50% of the gross oil production, while in Pará value added GDP was 40% of gross production; since production costs are fixed, these percentages vary depending on the price of these global commodities. Source: Instituto Brasileiro de Geografia e Estatistica (IBGE) and Dirección Nacional de Síntesis Macroeconómica, Banco Central de Ecuador.

overwhelming majority work in the service sector. Many private sector services are environmentally benign and could be easily accommodated within a green economy, including telecommunications, information management, health care, hospitality, and finance. The bioeconomy will scale only if it offers economic opportunity to the majority of Amazonian inhabitants residing in both large and small urban centers. Their participation is important in order to foster political support for alternative production models; more importantly, these are the entrepreneurs who are most likely to pursue new business opportunities.

Government expenditures are relatively large in Brazil and are the leading sector in Acre, Amapá, Rondônia, and Roraima, which reflects that nation's willingness to subsidize its frontier jurisdictions via revenue transfers from federal to state and local budgets. Brazil's large federal contribution contrasts with that of the nations of the Andes and Guianas, where small public budgets in Amazonian jurisdictions are a legacy of their centralized governance systems. Public budgets provide one of the easiest avenues for channeling financial resources to shift the Amazonian economy away from non-sustainable production paradigms, which is why the jurisdictional approach for organizing the payment-for-ecosystem services is gaining popularity among policy analysts.[23]

The challenge will be to translate an increase in state expenditures into a modification of behavior by private sector actors. Brazil pursued a version of this strategy from 2004 to 2018, when it successfully reduced deforestation within its Amazonian states by 80%; however, that effort also contributed to a political backlash by landowners opposed to the regulatory measures imposed by the state that restricted their freedom to manage their landholdings. Business models based in a revitalized bioeconomy have the potential to change this conflict-prone dynamic between regulators and landholders, but only if they can out-compete the non-sustainable production models that are the foundation of the conventional economy.

The bioeconomy must compete with the conventional economy by offering better economic returns to the inhabitants of the Pan Amazon over the short term. Unfortunately, people make economic decisions based on factors constrained by the conventional (real) economy and not hypothetical opportunities incorporated into models that reflect (hard-to-measure) externalities, no matter how true they may be in the context of the global economy. The challenge facing initiatives to promote the bioeconomy is to support business models that can compete with conventional business models. It is not sufficient that they be profitable, however; they must be more profitable than conventional systems, because most investors, especially in emerging markets, will select the option that maximizes their return on investment.

[23] The Governors' Climate and Forests (GCF) Task Force has organized a framework to reduce emissions from deforestation and forest degradation (REDD+) and promote realistic pathways for sustainable rural development. Founded in 2008 by governors from Brazil, Indonesia, and the United States, the GCF Task Force has grown to over 38 states and provinces in ten countries that contain more than 1/3 of the world's tropical forests including all of the legal Brazilian Amazon and 85 percent of the Peruvian Amazon. Source: https://www.gcftf.org/.

2.2 Land use planning and land rights

The Pan Amazon nations have instituted numerous policy initiatives to reform rural land markets to encourage sustainable development; however, most still have legal mechanisms for transferring public land to private individuals that explicitly allow—or even require—deforestation. Local and regional governments, with the support of multilateral development agencies, build roads in wilderness landscapes, where it is implicitly understood that land speculation will invariably lead to deforestation. These policies enjoy the support of the economic interests of construction companies, landholders, and agribusinesses, as well as the electoral power of landless peasants seeking a pathway out of poverty.

The Pan Amazon nations have used land-use planning methodologies to identify landscapes that should be set aside for protection or zoned for some type of economic activity, including forest management, livestock, perennial crops, and intensive agriculture. There are two basic approaches*:* *Zonificación agro-ecológica* (ZAE) and *Zonificación ecológica económica* (ZEE).[24] The ZAE method uses climate and soil data to differentiate land-use categories, while the ZEE approach essentially uses the ZAE output as a baseline but incorporates social and economic criteria to arrive at a land-use plan that, theoretically, will be accepted and used by society. A ZEE includes a consultation process that engages all stakeholder groups, including indigenous and traditional communities, academics, and civil society, as well as migrants and agroindustry.[25] The effectiveness of these studies and their implementation as land use policy is mixed. Settlement, colonization, and deforestation have occurred and continue to occur via processes influenced largely by social and market forces. Nonetheless, the ZEE process has supported the establishment and management of protected area systems and institutionalized the claims and rights of indigenous communities and other vulnerable groups. Governments, NGOs, and multilateral institutions continue to invest in these approaches as a path towards truly sustainable development.

Land-use zoning is most relevant on frontier landscapes undergoing land-use change. In some instances, these recommendations have provided sound information and supported expanding agricultural production systems. However, highway infrastructure and the cost of land are more important factors when predicting future expansion of the agricultural sector. Greater detail of how the land use planning-economic development trajectories are unfolding in each country of the Program can be seen in Appendix 2.

Approximately 460 million hectares (63%) of the Program area have now been set aside as either protected natural areas (approximately 169 million hectares - 23%), public forests to be managed as standing natural forests (approximately 204 million hectares - 28%) or indigenous territories

[24] This methodology had its roots in the USDA system known as Land Capability Classification (LCC), which in Latin America was promoted as *Capacidad de Uso Mayor de la Tierra,* by USAID and the Instituto Interamericano de Cooperación para la Agricultura (IICA).

[25] Bolivia: Plan de Uso del Suelo (PLUS); Brazil: *Zoneamento Eecológico e Econômico* (ZEE*);* Colombia: *Plan de Ordenamiento Territorial* (POT); Ecuador; *Planes de Desarrollo Ordenamiento Territorial* (PDOT); Guyana: National Land Use Plan (NLUP); Peru: *Zonificación Ecológica Económica (ZEE);* Suriname: *Land use Plan* (LUP); Venezuela: *Plan Nacional de Ordenación del Territorio* (PNOT).

(approximately 186 million hectares- 26%)[26]. Totals and percentages do not add up due to overlapping rights amongst these three categories. An overview of land rights in the six countries of the program, as well as the degree of overlapping rights, can be seen in Table 2 and Figure 7. The need to support sustainable production systems that keep the forest standing is important in these recognized forest landscapes, and even more so in forest landscapes under agricultural title/ tenure or that do not yet have clear tenure. Approximately 268 million hectares are in this latter category and are on course to be managed as a mix of agricultural, livestock and economic uses by a diversity of individuals, associations, and/or corporations. Due to edge effects and ongoing climate change, the fate of these agricultural and livestock lands is fundamentally important for the long-term resilience of the Amazon. Only if tree cover is increased, both in private lands and lands with unclear tenure, will the Amazon biome survive the synergistic pressures from deforestation, fire, and climate variability. If not, the parks, indigenous territories and forest reserves that are at the core of current conservation and sustainable strategies will become isolated islands of forest in a mosaic of rapidly degrading lands.

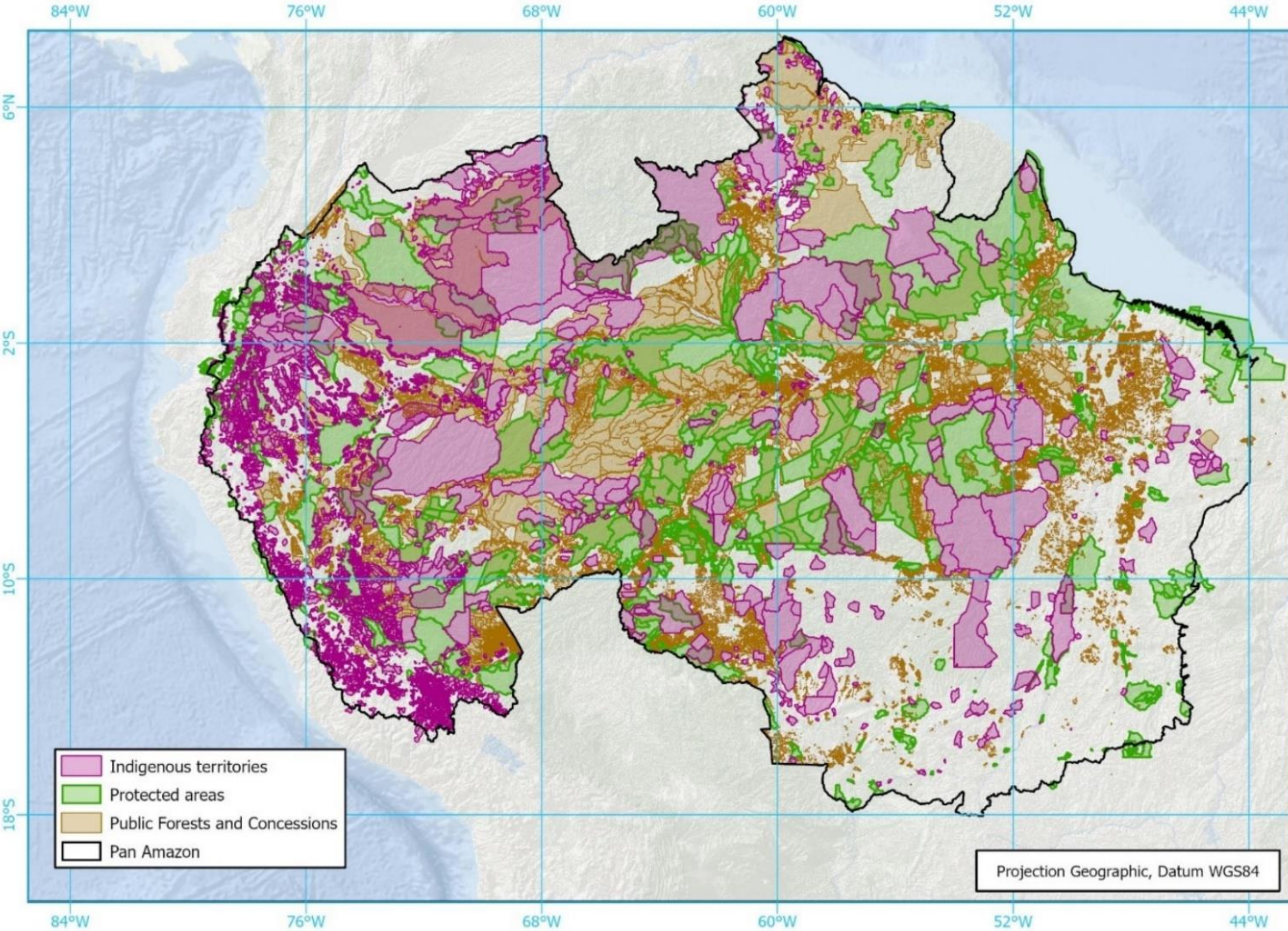
Table 2: Indigenous territories, protected areas and public forests in the program area (hectares)

Land Rights	Brazil	Colombia	Ecuador	Guyana	Peru	Suriname	Total
Indigenous Territories (IT)	104,996,255	4,792,944	5,262,917	3,053,140	27,212,172	0	145,317,428
Protected Areas (PA)	64,270,146	7,963,862	2,951,507	397,374	14,669,238	2,160,864	92,412,991
Public Forests and Concessions (PFC)	83,640,173	6,481,010	0	12,608,269	16,687,346	4,312,775	123,729,573
IT - PA overlap	10,453,504	3,204,510	2,256,759	99,335	2,877,149	0	18,891,257
IT - PFC overlap	159,818	18,860,708	0	0	3,145,425	0	22,165,951
PA - PFC overlap	57,036,438	0	0	536,099	71,455	94,743	57,738,735
Private land rights or rights not awarded	210,016,414	9,471,369	2,797,824	4,559,051	33,363,547	8,159,993	268,368,198
Total country	**530,572,748**	**50,774,403**	**13,269,007**	**21,253,268**	**98,026,332**	**14,728,375**	**728,624,133**

Source: Study team, based on RAISG 2020 GIS files

[26] It is generally assumed that indigenous lands will be managed as protected areas because indigenous communities have embraced nature conservation as a strategy to preserve their livelihoods and cultures. However, generational and cultural changes, as well as external economic pressures, are already altering this reality in some regions, and so this assumption should be periodically revisited.

Figure 7: Indigenous territories, protected areas and public forests in the program area



Source: Study team, based on RAISG 2020 GIS files

2.3 Socio-ecological context

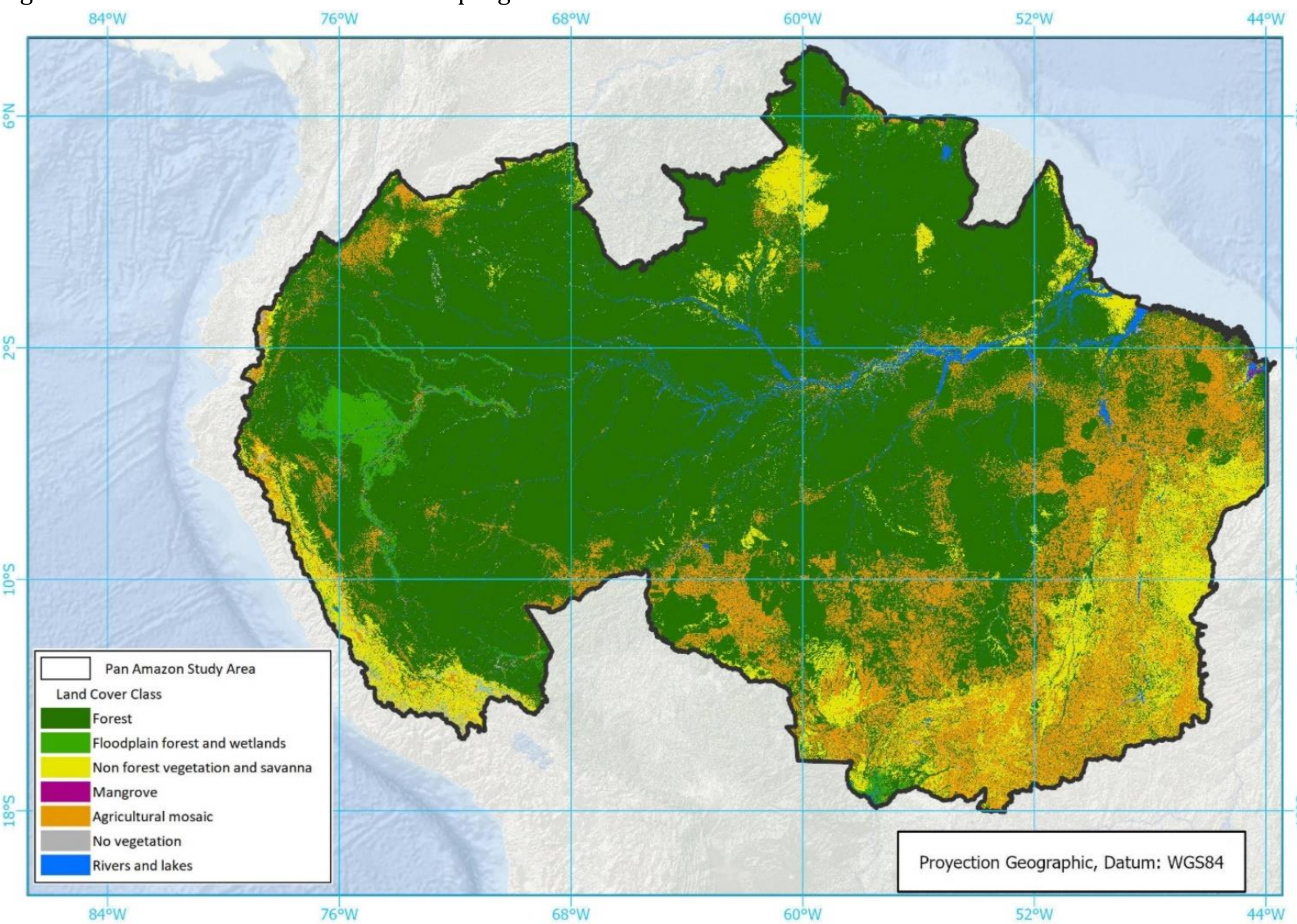
The economy of the Amazon has traditionally depended on some sort of extractive activity. Over the last 100 years, it first transitioned from traditional livelihoods based on hunting, fishing and swidden agriculture, on to the harvest of forest commodities, such as rubber and Brazil nuts, and next to frontier economies based on the extraction of timber, minerals, and agricultural commodities, resulting in the current landcover and land use realities (Figure 8). Even though significant progress has been made in land-use planning practices across Amazon countries, and over 460 million hectares have been slated for sustainable forest management and conservation (as detailed in the previous section), the transition from a forest economy to an extractive and agricultural frontier economy is still in progress across much of the region. Nearly 110 million hectares are now under agricultural use, with approximately 98.5 million hectares in Brazil alone (Table 3).

Table 3: Land cover and land use in the program area

Land Cover Class	Brazil	Colombia	Ecuador	Guyana	Peru	Suriname	Total
Forest	358,802,680	44,669,481	10700973	18,842,567	64,414,519	13,738,474	511,168,694
Floodplain forest and wetlands	968,299	15	107	481,569	11,059,176	227,966	12,737,132
Non forest vegetation and savanna	59,032,236	2,013,638	721044	1,264,234	12,266,431	166,806	75,464,389
Mangrove	734,483	0	0	16,670		39,262	790,415
Agricultural mosaic	98,454,348	3,239,646	1342316	386,901	6,138,372	246,488	109,808,071
No vegetation	857,922	325,930	367567	45,276	2,919,751	42,031	4,558,477
Lakes and rivers	11,722,780	525,693	129754	216,051	1,141,641	267,348	14,003,267
Glacier	0	0	7246	0	86,442	0	93,688
Total country	**530,572,748**	**50,774,403**	**13269007**	**21,253,268**	**98,026,332**	**14,728,375**	**728,624,133**

Source: Source: Study team, based on RAISG 2020 GIS files

Figure 8: Land cover and land use in the program area



Source: Study team, based on RAISG 2020 GIS files

The Pan Amazon integrates an enormous diversity of landscapes and ecosystems, making the region the most biodiverse on the planet. A characterization of all ecosystems is beyond the scope of this study, however, we can consider the classification of global vegetation types and ecoregions developed by WWF and TNC (2008) as a useful framework to outline the biodiversity of the region and identify those ecoregions that are suffering from land use change, deforestation and degradation, in order to detect the extent of habitat loss and monitor ecosystem persistence over time. The Pan Amazon has six distinct vegetation types and 5I distinct ecoregions. Tropical humid broadleaf forests are the predominant vegetation type, with 78% regional cover. These forests, in addition to having the largest extent, also have the greatest biodiversity, containing more species than any other vegetation type on Earth. Its forests and soils contain the largest terrestrial carbon stocks and recycle the largest amount of freshwater in the world. They are generally found in extensive patches and are characterized by low annual temperature variability and high levels of precipitation.

By overlaying the agricultural land cover information presented in Figure 8, the most affected vegetation types in terms of percent area loss can be determined. Results indicate that tropical and subtropical grasslands, savannas and shrublands in the Pan Amazon have lost 30.4% of their original extent (totaling over 36 million hectares lost), while tropical and subtropical dry broadleaf forests have lost 23.0% (totaling over 7 million hectares). However, the vegetation type with the greatest absolute extent loss is tropical moist broadleaf forests with over 69 million hectares lost, representing just over 11% cover of this vegetation type. Within these vegetation types, the most affected ecoregions are shown in Table 4.

Table 4. The eight Pan Amazon ecoregions most threatened by land use change

Ecorregion	Vegetation Type	Ecorregion extension (ha)	Agriculture extension (ha)	%
Alto Paraná Atlantic forests	Tropical & Subtropical Moist Broadleaf Forests	1.308.469	1.000.464	76%
Maranhao Babaçu forests	Tropical & Subtropical Moist Broadleaf Forests	5.982.916	3.060.849	51%
Tocantins/Pindare moist forests	Tropical & Subtropical Moist Broadleaf Forests	19.437.150	8.681.669	45%
Xingu-Tocantins-Araguaia moist forests	Tropical & Subtropical Moist Broadleaf Forests	26.830.061	9.081.997	34%
Mato Grosso seasonal forests	Tropical & Subtropical Moist Broadleaf Forests	42.185.725	14.188.029	34%
Apure-Villavicencio dry forests	Tropical and Subtropical Dry Broadleaf Forests	741.870	330.995	45%
Chiquitano dry forests	Tropical and Subtropical Dry Broadleaf Forests	19.211.490	5.914.394	31%
Cerrado	Tropical and Subtropical Grasslands, Savannas and Shrublands	95.744.834	35.695.708	37%

Among the ecoregions most affected are the Atlantic Forests of Alto Paraná, the Maranhao Babaçu Forests, the Humid Forests of Tocantins/Pindare, the Xingu-Tocantins-Araguaia Humid Forests, and the Seasonal Forests of Mato Grosso, all located in Brazil, where the loss amounts to more than 30% of their total extent. The Atlantic Forests of Alto Paraná is the most devastated with a loss of 76%. For a more detailed picture of the Amazons ecoregions refer to Appendix 3.

Why do people clear forests and other natural ecosystems? For people living on the Amazon frontier, the answer is as simple as it is obvious: doing so is essential to their livelihood. In some cases, it is to grow food to feed their family or community, for others it is to generate wealth by selling timber, cultivating crops or raising livestock. The flow of goods between rural and urban societies is as old as civilization itself, but in today's global economy the connection between the producer and the consumer is mediated by complex value chains. For the last several decades, increases in demand for food and fiber have been met by the expansion of agricultural value chains into tropical forest areas. Producers operating on these landscapes are responding to global demand; they are providing products to consumers, creating revenue for their families and investors, and providing jobs for their communities. Many are fully aware that deforestation is a global problem, yet feel that they should not bear the cost of conserving biodiversity or fighting global warming, especially when other nations have sacrificed their own natural capital and polluted the atmosphere in pursuit of economic growth. A common refrain, voiced across economic spectra, is that wealthy nations should assume the cost of forest conservation.

Non-extractive bioeconomy business models exist but are limited in scope, because they require a level of specialized knowledge and/or demand additional capital investment not available to Pan Amazon inhabitants. For example, aquaculture with native Amazonian species holds great promise for both smallholders and corporate actors. However, it requires substantial upfront investment and specific skills to manage reproduction, nutrition, and water quality.

The success of pro-forest economic activity and the decline in deforestation are essential for the long-term survival of the Amazon forest. In recent years, deforestation rates have crept upward across the region and registered historical highs in Colombia and Peru (Table 5, Figure 9). Worse still, the predicted impacts of climate change have manifested, in part due to increasing temperatures but, more ominously, by modifying precipitation regimes that threaten to tip the region—or at least its southern half—into a cataclysmic shift in ecosystem function that could lead to widespread forest dieback.[27]

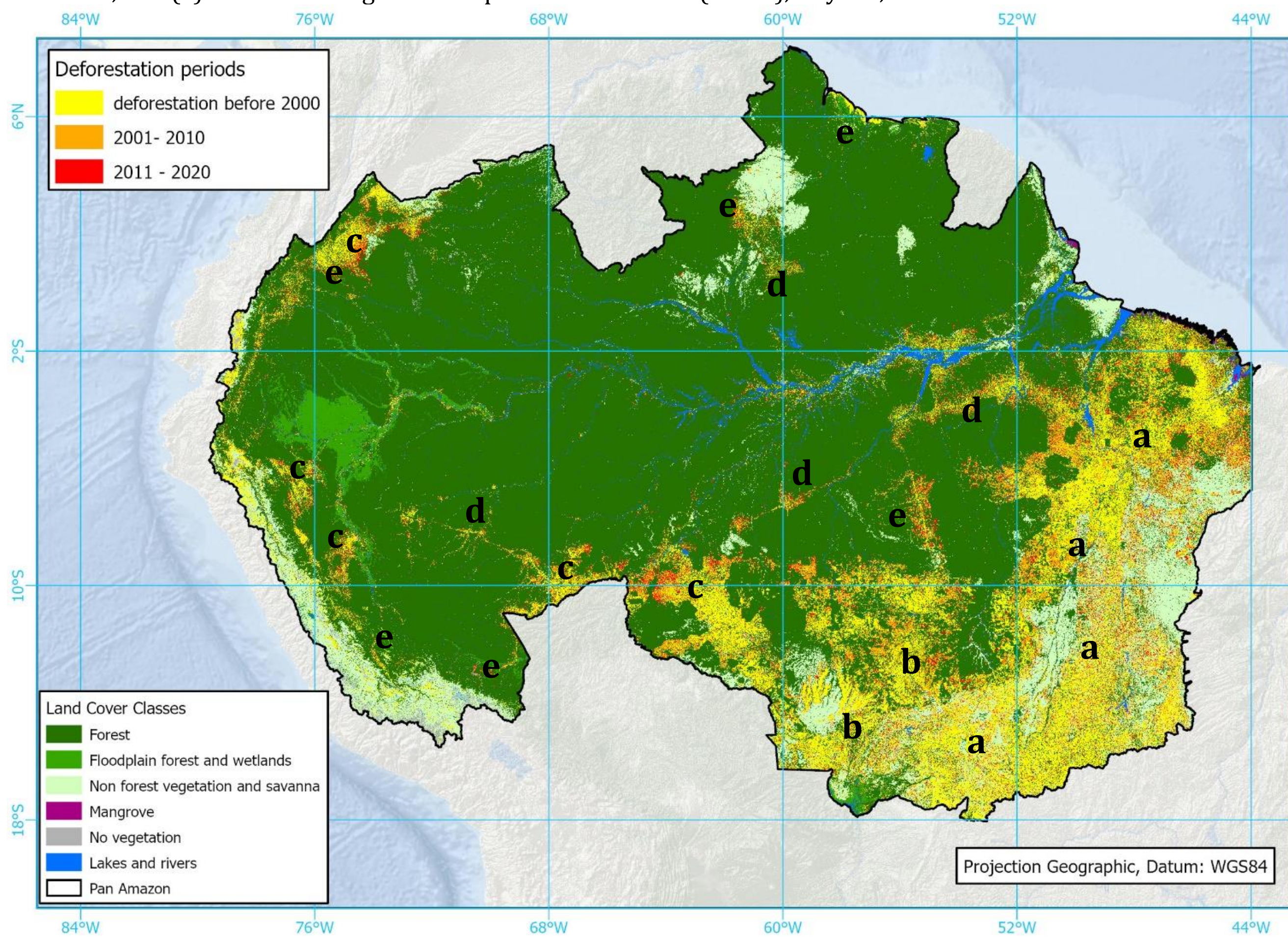
Table 5: Deforestation in the program area

	Brazil	Colombia	Ecuador	Guyana	Peru	Suriname	Total
2010	1,366,955	90,289	24,022	4,343	128,353	3,637	1,617,599
2011	1,427,349	75,316	38,383	3,878	117,179	4,312	1,666,417
2012	1,429,701	82,775	28,020	3,149	137,453	5,338	1,686,436
2013	1,599,548	100,814	34,377	3,008	139,116	4,663	1,881,526
2014	1,632,037	101,453	13,209	3,459	118,693	6,354	1,875,205
2015	1,661,936	80,652	35,224	4,168	118,582	8,073	1,908,635
2016	2,031,773	92,588	13,097	5,162	119,773	7,511	2,269,904
2017	2,216,044	154,986	42,368	5,130	138,442	4,920	2,561,890
2018	2,538,987	173,408	34,479	4,991	133,314	8,123	2,893,302
Total	**15,904,330**	**952,281**	**263,179**	**37,288**	**1,150,905**	**52,931**	**18,360,914**

Source: Study team, based on RAISG 2020 GIS files

[27] Lovejoy, Thomas E. and Carlos Nobre. 2018. 'Amazon tipping point'. Science Advances 4 (2).

Figure 9: Deforestation occurs in different ways across different landscapes in the Program area, including (a) by the loss of remnant forests in consolidated agricultural and industrial landscapes, (b) industrial farming landscape in Mato Grosso (Brazil), (c) agricultural settlement zones and forest frontiers in Rondônia and Acre (Brazil), Ucayali and Loreto (Peru) and Caquetá (Colombia), (d) agricultural frontiers adjacent to highway corridors, and (e) alluvial mining and coca production in Para (Brazil), Guyana, Peru and Colombia.



Source: Study team, based on RAISG 2020 GIS files

Many public policies still encourage deforestation. Most Amazonian countries have legal mechanisms for transferring public land to private individuals that explicitly allow—or even require—deforestation. Similarly, small-scale deforestation and the use of fire are either allowed or openly tolerated in almost all Amazonian jurisdictions. In those countries where a clear national policy framework discouraging deforestation already exists, it takes many years for that to work its way through governmental systems to the local rural level. National, regional, and local governments, with the support of development agencies, still build roads in forest and wilderness landscapes, where it is implicitly understood that land speculation will invariably lead to deforestation. These policies remain in place because they enjoy the support of the economic interests of construction companies, landholders, and agribusinesses, as well as the electoral power of landless peasants seeking a pathway out of poverty. Rhetoric supporting forest conservation is widespread, but acting to curtail deforestation is politically costly.

Culture also plays an important role. Consider the pioneer who created a successful farm over a lifetime of hard work and is understandably proud of that accomplishment. Their children and grandchildren are likely to have similar views—even if they now also hold views supporting forest conservation. Frontier societies are populated with individuals who believe conventional agriculture-led development is beneficial, a life view reinforced by educational systems and spiritual leaders. As in other frontier societies, there is cultural tolerance of tax evasion and informal payments, which hinders the use of legal mechanisms to control environmental degradation; for example, activities such as illegal logging, land grabbing, and small-scale gold mining are often referred to as “informal” rather than “illegal” activities. It is often assumed that improved governance will empower environmental advocates and slow deforestation, but initiatives to decentralize administrative processes place decisions in the hands of local politicians, who tend to favor conventional agriculture. Local elites are not necessarily opposed to the bioeconomy, but they are unaware of the potential of many sustainable production schemes. Many, if not most, are risk-adverse businesspeople who prefer to invest their limited capital resources in production systems they know and understand.

2.4 Climate context, risk and vulnerability

2.4.1 Climate risk in the Amazon Basin

Scientific evidence and information point out that climate variability and change pose a great risk[28] to the Amazon region. However, it is important to note that climate change vulnerability is not uniform across the Amazon, nor across each country. Looking at climate risk at the country level, countries in the Amazon ranked from 10th to 130th in terms of climate risk in 2019 (Table 6).[29] For example, in Colombia, the third National Communication to the UNFCCC demonstrated that despite being less exposed to hazards in comparison with other regions, the result of a high level of sensitivity and a low adaptive capacity is that many Amazonian departments are considered at high risk from climate change.[30]

Table 6: Overview or climate risk according to the 2021 GermanWatch Climate Risk Index

	CRI Rank for 2019	CRI Rank for 2000-2019	Average Fatalities 2000-2019 (rank)	Average losses per unit GDP in % 2000-2019 (rank)
Brazil	27	81	17	124
Colombia	28	38	24	87
Ecuador	121	103	67	122
French Guiana	n/a	n/a	n/a	n/a
Guyana	130	119	159	49
Peru	46	45	33	79
Suriname	130	171	163	173
Venezuela	130	145	86	162

Source: Eckstein et al. 2021

[28] Risk is defined as “The potential for consequences [= impacts] where something of value is at stake and where the outcome is uncertain (...). Risk results from the interaction of vulnerability, exposure, and hazard (...).” – GIZ and EURAC 2017, p. 13

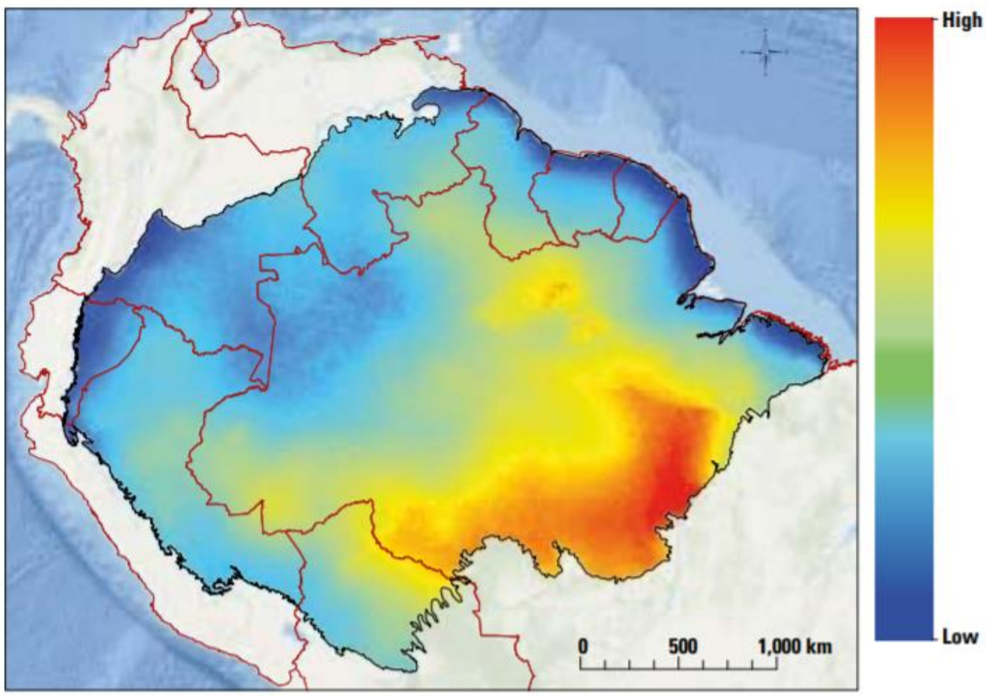
[29] Eckstein et al. 2021.

[30] IDEAM et al. 2017.

Modelling climate risk in the Amazon Basin

Different models result in different hotspots of climate risk in the Amazon basin. The eastern and southern Amazon in Brazil is particularly at risk (Rondônia, Mato Grosso, and Pará), along with northern Guyana, the north-central Peruvian Amazon (Loreto), and the bordering Amazonas state in Brazil (Figure 10).[31] Conservation International elaborated on a climate vulnerability index for the Amazon basin (considering exposure, sensitivity, and adaptive capacity under AR4).[32] This resulted in slightly different results; however, there are still areas of high climate vulnerability in northeast Brazil, and Peru, as well as highly vulnerable areas in Ecuador, Colombia, and Venezuela (Figure 11).

Figure 10: Regional Climate Change Index for the Amazon biome

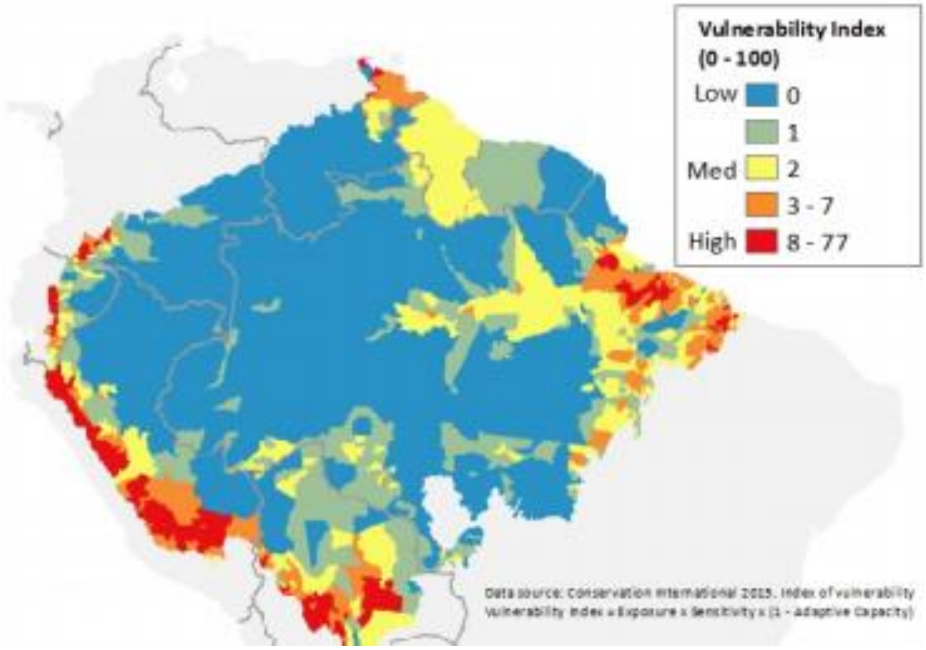


Source: Suarez et al. 2015, 9

[31] Suarez et al. 2014.

[32] (2015) AR5 sees climate risk = exposure, vulnerability (sensitivity and capacity), whereas A4 uses the term "vulnerability" instead of climate risk, which is comprised of exposure, sensitivity, adaptive capacity.

Figure 11: Climate vulnerability index in the Amazon biome



Source: Conservation International 2015 in USAID 2018, 1

The Amazon tipping point: Rainfall recycling, deforestation, and climate change

The varying levels of climate risk and vulnerability in the Amazon region indicated above are alarming not only because of climate projections but also due to the intricate and synergistic interactions with other factors (e.g., deforestation and forest degradation, land use, anthropogenic fires, biodiversity loss, and ecosystem fragmentation) that create adverse climate feedback loops (Figure 12).[33]

The findings of the last few decades support climatological models' forecasts of a warmer Amazon scenario with more severe and sustained droughts, making the forest more vulnerable to degradation and loss of its ecological functions to sequester carbon, retain carbon reserves and biodiversity, and control hydrological and biogeochemical cycles.[34] Such trends towards ecosystem degradation and loss of ecosystem function will be further exacerbated by deforestation and forest degradation (direct deforestation and forest degradation, as well as fires[35]). Deforestation is closely linked with drought in the Amazon basin, referred to as the drought-deforestation feedback loop (Figure 13).[36] The conversion of forests into non-forest land potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness, and that reduce

[33] Marengo et al. 2011.

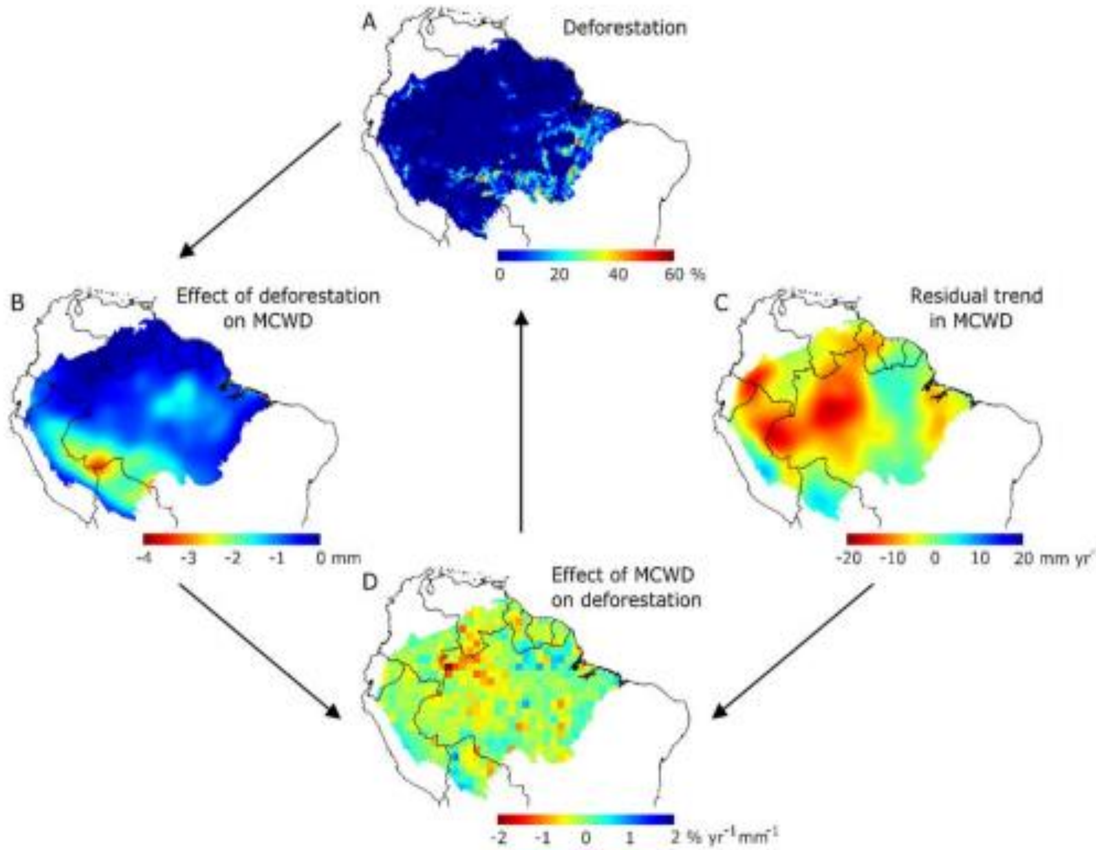
[34]Marengo and Souza 2018

[35] Wildfires, while often linked with anthropogenic activities and forest clearing, will also pose a greater risk in the future with climate change impacts projected to include increasing temperatures (e.g., De Faria et al. 2017), and increasing dry conditions in much of the basin.

[36] Staal et al. 2020.

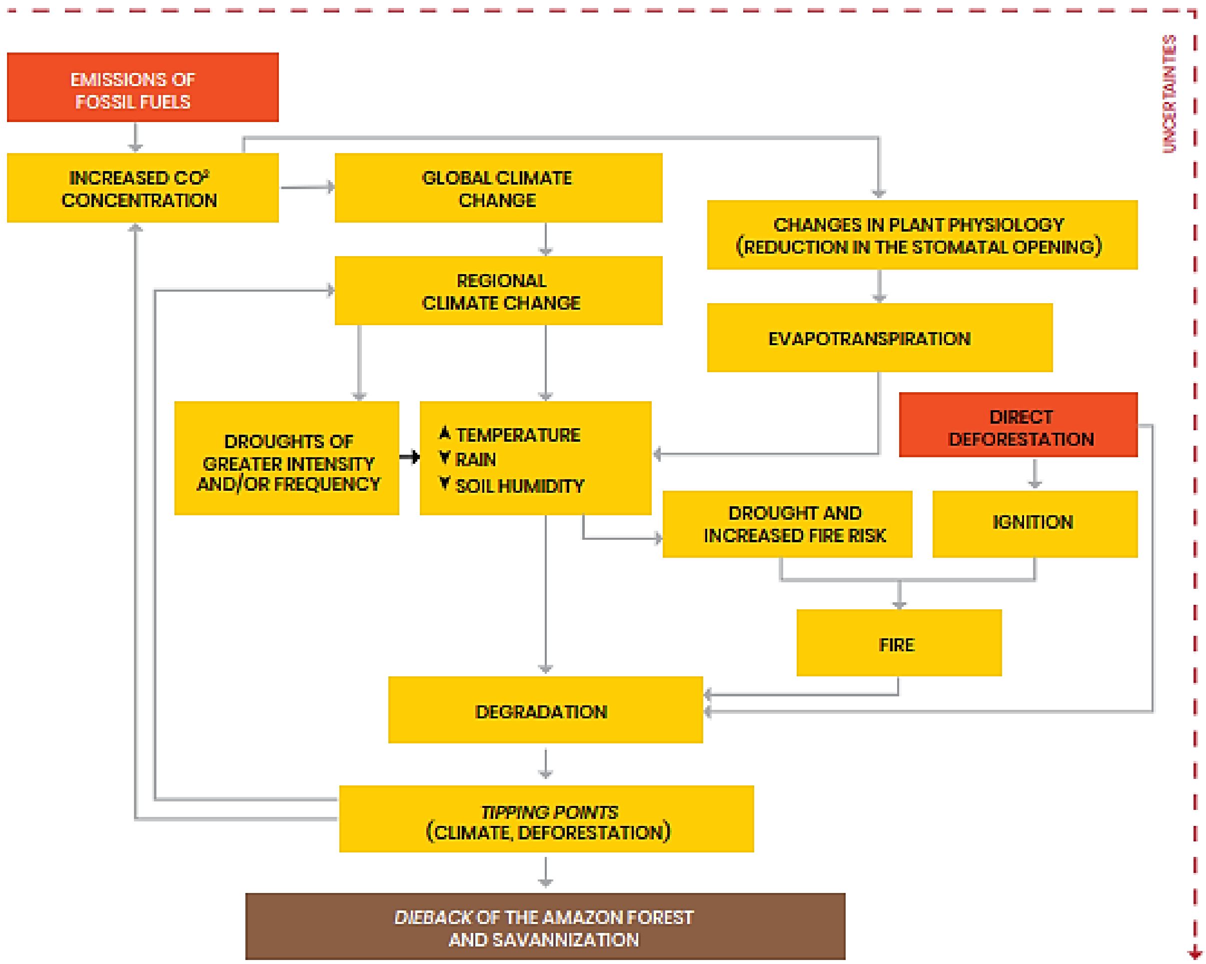
evapotranspiration and rainfall recycling. This process creates a feedback loop and a general trend toward increasingly dry conditions during the dry season and could further enable the Amazon rainforest to reach its tipping point.

Figure 12: Drought-deforestation feedback loop in the Amazon, overview of interplay of dynamics during the period from 2001 and 2014



Note: MCWD is maximum climatological water deficit
Source: Staal et al. 2020, 5

Figure 13: Overview of the Amazon tipping point and forest dieback/ savannization mechanism



Source: Marengo and Souza 2018, 21

The Amazon's tipping point implies that if temperatures increase by 4°C, or deforestation exceeds 40% of the forest area, a large-scale and irreversible transition to a savannah-like ecosystem will occur, due to a drastic reduction in rainfall recycling and drought conditions (i.e., reduced precipitation and increasing temperatures). Once the tipping point is reached, the Amazon will become a net source of carbon dioxide (CO2) emissions instead of a sink.[37] The tipping point will not only have an impact on ecosystem function and services, but will have a major impact on economies in the Amazon Basin. Countries who are projected to be the most severely impacted by this transformation are Peru, Bolivia, Brazil, and French Guyana.[38]

[37] Hubau et al. 2020

[38] Staal et al. 2020.

A dynamic interplay between direct land-use change, regional precipitation and ENSO responses to global forcing can decide the Amazon's fate.[39] Staal et al. (2020) found that deforestation contributed to 4% of observed drying since 2003, especially in the southwestern part of the Amazon.[40] They further noted that climate change currently has a stronger role than deforestation in causing drying and dieback, however the feedback loop needs to be closely monitored and addressed, as deforestation remains a major challenge in many parts of the Amazon. Other studies note while climate change poses a long-term danger to the Amazon rainforest, deforestation represents a more urgent threat due to rising temperatures and potential declines in rainfall.[41] Due to direct physical variations in temperature and rainfall, both near and far from where trees are cleared, deforestation increases ecosystem instability and releases carbon back to the atmosphere.[42] Controlling and limiting deforestation and forest degradation is seen as an efficient way to reduce climate change's impacts, which are already being observed, and to avert a devastating loss of forest ecosystem resilience and ultimately the "savannization" of Amazonian ecosystems.[43]. Thus, preventing large-scale deforestation in the tropics is considered highly beneficial on both a local and global scale.[44]

There is a need for concerted efforts across the Amazon Basin to reduce deforestation, increase forest cover, and restore degraded ecosystems to strengthen climate change mitigation, improve the resilience of local populations, livelihoods and ecosystems in the basin, support species recovery and the enhancement of biodiversity, and ultimately restore ecosystem functionality. While the Leticia Pact is a signal of commitment from Governments, there is a need to mobilize additional financial and technical assistance. Beyond this, with limited public budgets, there is a need to develop incentives to mobilize private sector finance to support these goals.

2.4.2 Overall climatology and climate-related hazards

Data availability and coverage of climate observation stations

It is important to note that information on climate risk and vulnerability in the Amazon varies by country, and even varies greatly within each country. The quality of available historical and projected climate and hydrology data sets is often compromised by the lack of data systemization and limited spatial data coverage and differentiation.[45] There is uneven coverage of climate observation stations within the Amazon region and project intervention area, with many countries having very low coverage (e.g. Colombia, Ecuador, Guyana, Peru, and Suriname; Figures 14 and 15). Brazil has comparatively better coverage, although majority of stations are located in northeast and southeastern Brazil. This uneven coverage affects the overall data availability, where there is uneven and inconsistent data collection, geographical gaps where certain areas are not covered by existing stations. Given the Amazon

[39] Lenton et al. 2008.

[40] Staal et al. 2020.

[41] Lawrence et al. 2015.

[42] Lawrence et al. 2015; Marengo and Souza 2018.

[43] Marengo and Souza 2018.

[44] Lawrence et al. 2015.

[45] Maps at the country level are included within the country profiles in the Appendices to the Feasibility Study. See https://gis.ncdc.noaa.gov/maps/ncei/cdo/monthly for more detailed information.

is a large and heterogeneous area, existing data are unable to fully capture the complex dynamics and characteristics of the region. Thus, while observed datasets, and future projections provide useful insight, they need to be interpreted with caution given clear gaps in observational climate stations.

Figure 14. Map of daily observational data points (World Meteorological Organization - WMO data)

Source: National Centers for Environmental Information, n.d. https://gis.ncdc.noaa.gov/maps/ncei/cdo/daily

Figure 15. Map of a) monthly and b) annual observational climate data from meteorological stations

a)  b) 

Source: NCEI, n.d., https://gis.ncdc.noaa.gov/maps/ncei/cdo/monthly and https://gis.ncdc.noaa.gov/maps/ncei/cdo/annual

In addition, in many countries, there are limited national-level climate risk and vulnerability studies (many are forthcoming with the development of National Adaptation Plans).
This assessment follows the AR5 approach to climate risk, where climate risk[46] is the outcome of assessing hazards (climate signals and direct physical impacts),[47] vulnerability (sensitivity and

[46] Risk is defined as "The potential for consequences [= impacts] where something of value is at stake and where the outcome is uncertain (...). Risk results from the interaction of vulnerability, exposure, and hazard" – GIZ and EURAC 2017, p. 13

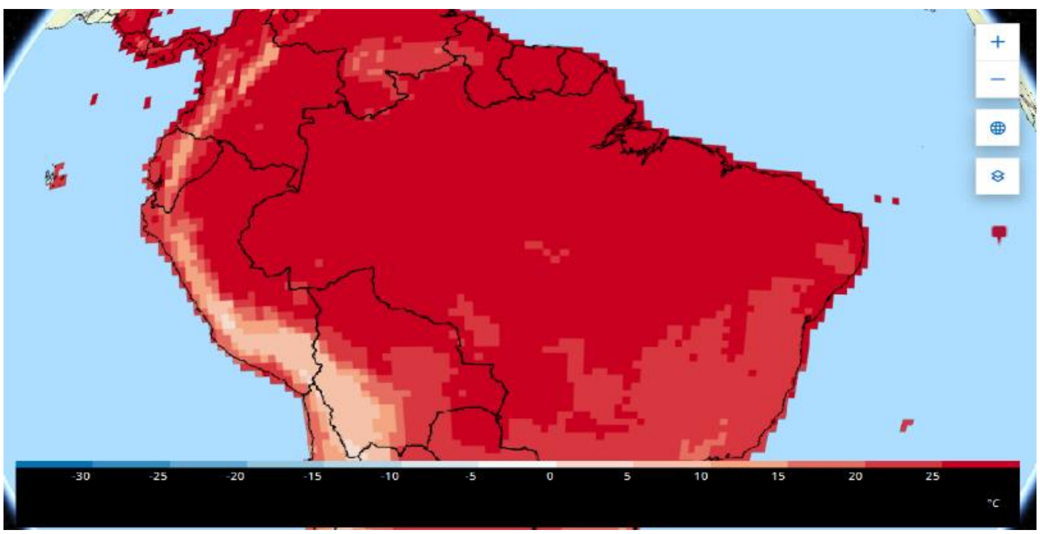
[47] Hazard is defined as "The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In [the IPCC] report, the term hazard usually refers to climate-related physical events or trends or their physical impacts." – GIZ and EURAC 2017, 13.

capacity)[48] and exposure.[49] Existing climate change studies and documents, especially related to climate change adaptation, tend to focus on more densely populated regions in the country. The distribution of hydrometeorological stations across nearly all program countries further reflects this geographic unbalance; comparatively fewer data collection and processing sources are located within the Amazon region, likely also due to issues of inaccessibility around the denser and more remote forest areas. Thus, it is important to note that information on climate risk and vulnerability varies per reference, and that additional research is needed at the biome level, as well as the country level, to strengthen information on climate risks and vulnerability, as well as suitable measures to strengthen climate resilience.

Temperature and precipitation

The presence of vast rainforests and diverse ecoregions contributes to a variety of climates across the basin. In general, the Amazon basin has a hot and humid climate (Figure 16).[50] The average temperature of the Amazon Basin during the dry seasons is 27.9°C, and 25.8°C in the rainy season (Figure 17) .[51] The rainy season is typically during the period from December to April in the northern Amazon (although still characterized by relatively high rainfall, with less pronounced changes in seasonality), whereas it may start as early as mid-October and end of March or April in the southern Amazon (Figure 17 and 19), still the main variability is at decadal and interannual time scales.[52]

Figure 16: Annual mean temperature (°C), time period 1981-2010



Source: SMHI, Climate Information, https://climateinformation.org/, 19.04.2021

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[48] Vulnerability is defined as "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.'" – GIZ and EURAC 2017, 16.

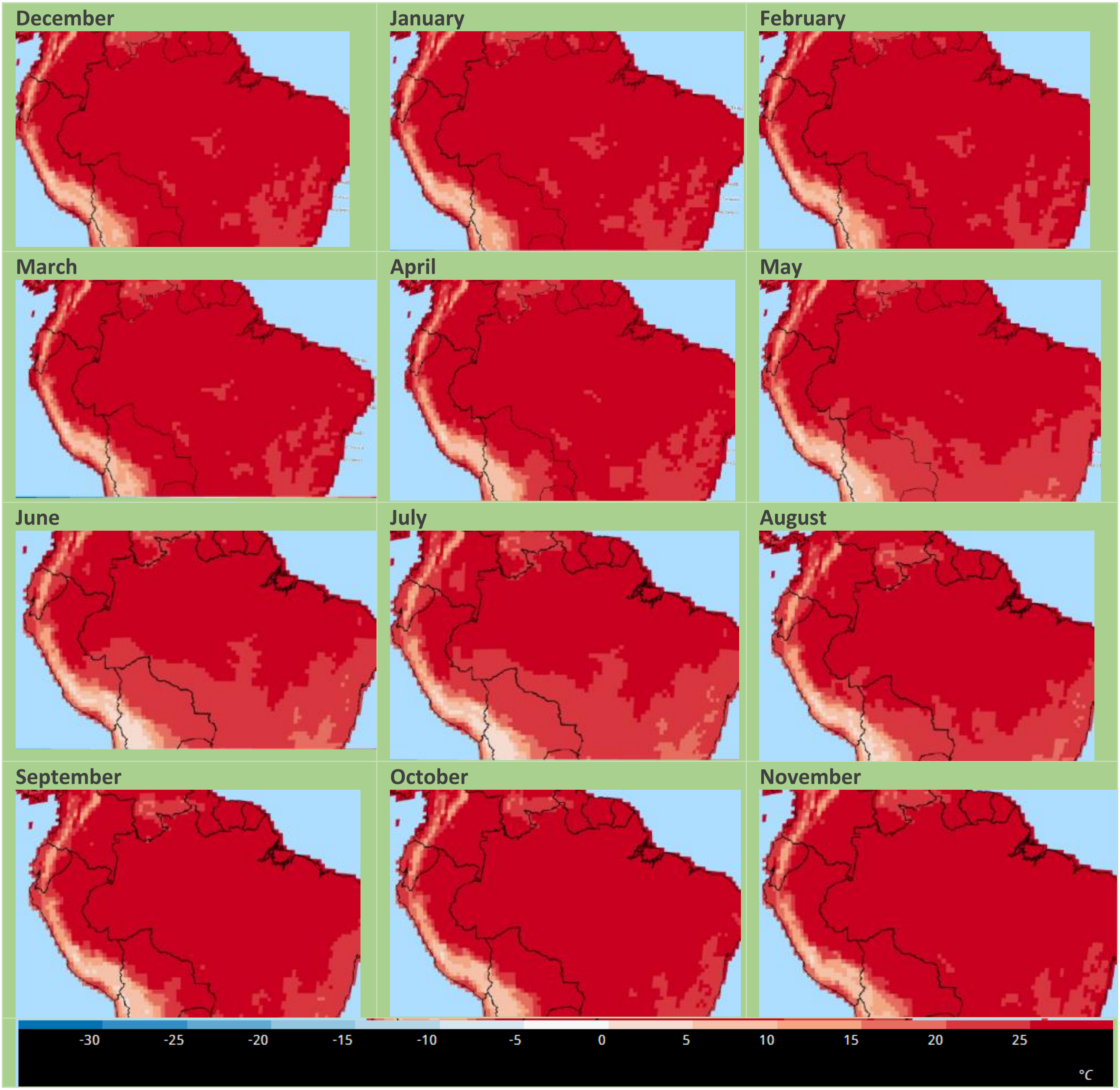
[49] Exposure is defined as "The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected." GIZ and EURAC 2017, 15.

[50] USAID 2018.

[51] USAID 2018.

[52] Espinosa Villar et al. 2008; USAID 2018.

Figure 17: Monthly mean temperature (°C); time period 1981-2010; model, Cordex South America; bias adjusted



Source: SMHI, Climate Information, https://climateinformation.org/, 19.04.2021

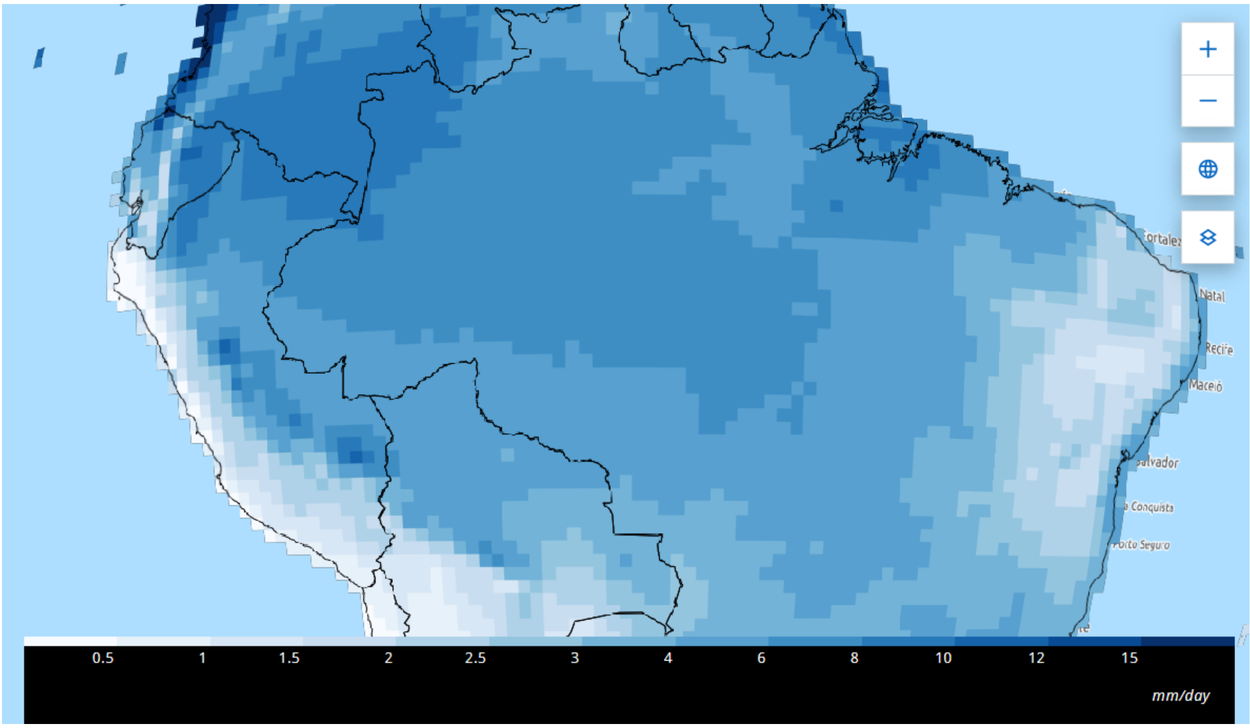
The mean annual precipitation in the western Amazon is around 3,000mm, whereas in the southeastern Amazon region it is around 1,700mm (Figure 18).[53] However, rainfall levels in the Amazon region vary spatially and temporally (Figure 19). Rainfall concentration studies show that the distribution of daily rainfall in the northwest (northern Peru) and central Andes is more regular yet diverse, where this is one of the rainiest regions in the world that interacts with topography (orographic effects), as well as large scale-circulations.[54] The Roraima region in (Brazil, Venezuela and Guyana), on the other hand, has

[53] Espinoza Villar et al. 2008; USAID 2018.

[54] Espinoza et al. 2015.

the highest daily rainfall irregularity.[55] Heavy rainfall events in Roraima are caused by humidity influx from the Caribbean.[56]

Figure 18: Annual mean precipitation (mm per day), Time Period:1981 – 2010

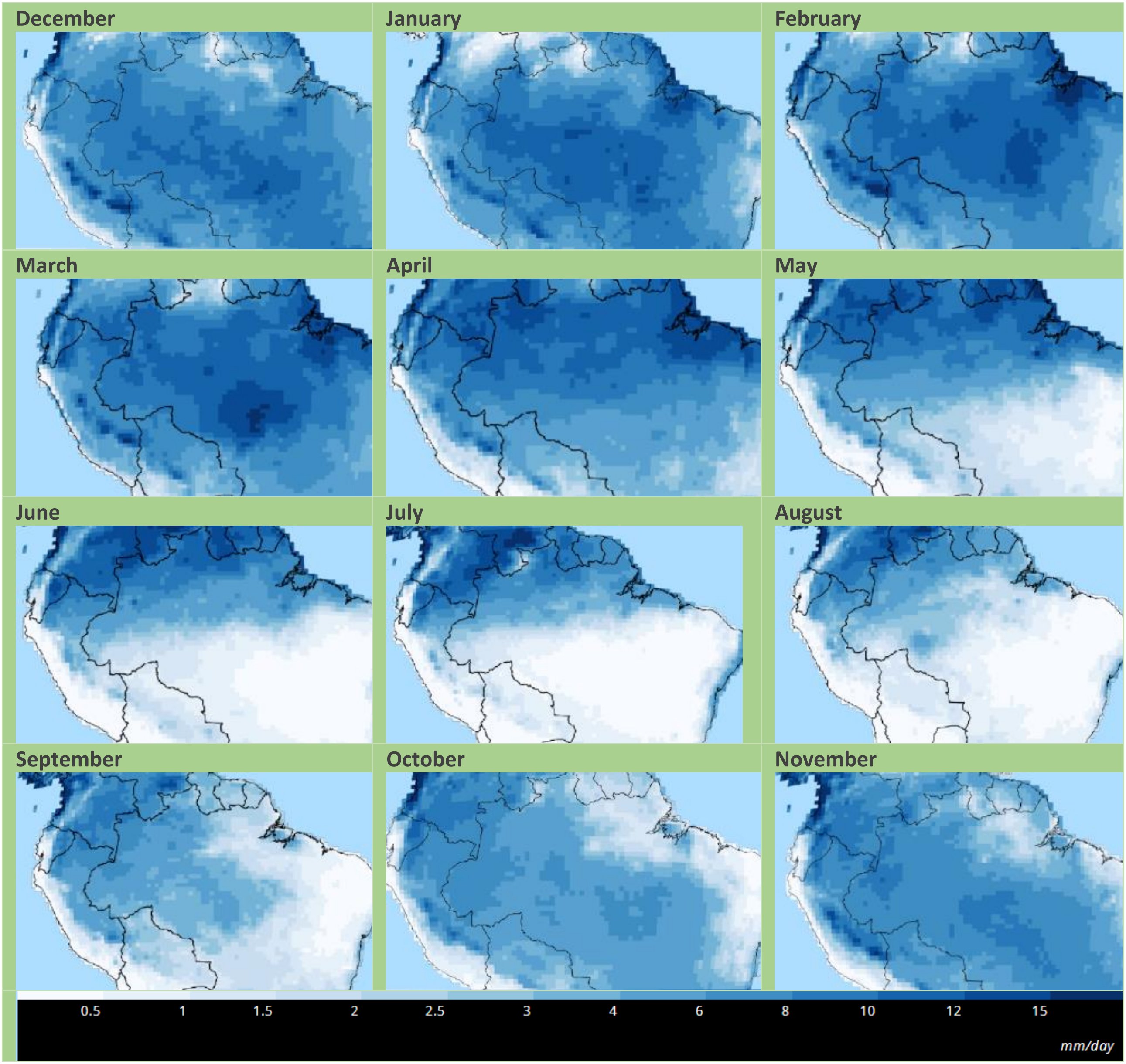


Source: SMHI, Climate Information, https://climateinformation.org/, 19.04.2021

[55] Zubieta et al. 2019.

[56] Zubieta et al. 2019.

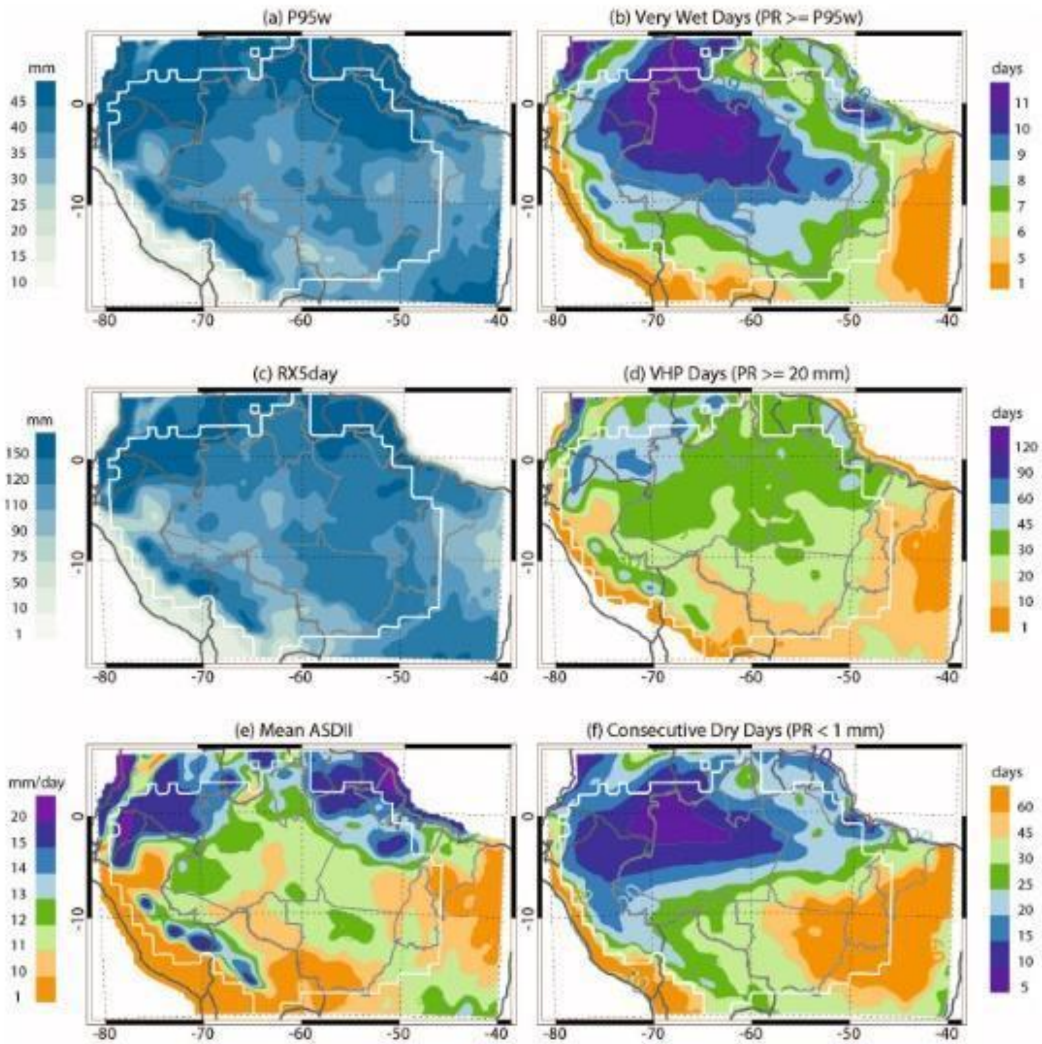
Figure 19: Monthly mean precipitation (mm per day); time period 1981-2010; model, CORDEX South America; bias adjusted, yes



Source: SMHI, Climate Information, https://climateinformation.org/, 19.04.2021

In addition to the values previously presented from other studies, Funatsu et al. 2021 present more climate parameters in the Amazon that complement and ratify what was previously assessed in previous studies. Figure 14 shows the mean spatial distribution of climatic indices for the period from 1981/2 to 2017-2018; The maximum 5-day accumulated precipitation (RX5day, Figure 20c) and mean yearly accumulated precipitation above the 37-year 95th percentile (P95w, Figure 20a) show a spatial trend similar to the annual simple day intensity index (ASDII; Figure 20e), with greater values at the northeastern and northwestern sides of the basin, as well as over the Amazon-Andes transition zone, which has been identified as a rainfall hotspot.[57] Moreover, as expected very wet days (R95w, RR ≥95th percentile; Figure 20b) occur more often in the north/northwest and less often in the south/southeast and around the eastern and southwestern basin margins.[58] Very wet days (R95w) varies from about 11 days a year in the northwest to 5–8 days in the domain's southernmost regions.[59] The spatial distribution of very heavy precipitation days (R20mm) reveals a north-south contrast, with about 50% more occurrences in the northern Amazon than in the southern.[60]

Figure 20: Spatial distribution of 37-year (1981/1982–2017/2018) mean for a) P95w (mm); b) R95w (days); c) RX5day (mm); d) R20mm (days); e) ASDII (mm day^-1), and f) CDD (days)



57 Funatsu et al. 2021; Espinoza et al. 2015.

58 Funatsu et al. 2021.

59 Funatsu et al. 2021.

60 Funatsu et al. 2021.

Note: P95w= very wet precipitation days (95th percentile of precipitation on very wet days, mm); Rx5day = maximum 5-day precipitation (mm), R20mm = very heavy precipitation day (days), ASDII = Average simple daily intensity (mm per day); CDD = maximum number of consecutive dry days where RR is less than 1mm (days)

Source: Funatsu et al. 2021, 8.

Note on climate variability

Several studies that focus on characterizing the climate in the Amazon basin recognized that there is a high degree of variability within the basin.[61] According to the IPCC 5th Assessment Report for Central and South America, rainfall dynamics in the Amazon region are influenced either by inter-annual fluctuations linked to *El Niño-Southern Oscillation* (ENSO) or inter-decadal variability (*Table 7*).[62] In addition, rainfall recycling from the Amazon rainforests is responsible for 50% to 75% of its annual rainfall, where deforestation and land-use change can play an important role in changing the regulating role of forests.[63]

Table 7: Overview of climate variability in the Amazon Basin

Regulating process	Sector of the Amazon where the effect is greatest	
	Precipitation	Temperature
Inter annual variability	Very notorious in north western, northern and southern Amazon. Not noticeable in the other parts.	The direct (positive) effect of El Niño and La Niña is very notorious in northern Amazon.
Temperature variability in the northern Atlantic	No outstanding effect on precipitation.	Evident effect on temperature.
Inter decadal variability in the Pacific	Notorious inverse effect in the extreme eastern part.	Basically no effect.
Inter decadal variability in the Atlantic	Basically no effect on precipitation	Notorious inverse effect in the extreme eastern part of the watershed.

Source: Suarez et al. 2015, 5

Temperature is affected by inter-annual variability and ENSO, as well as by temperature variability in the northern Atlantic and inter-decadal variability in the Atlantic.[64] Dry spells in the Amazon are often driven by the warm phase of the El Niño Southern Oscillation (ENSO) and warmer than normal sea surface temperatures (SSTs) in the Tropical North Atlantic (TNA), the latter especially affecting the southern Amazon.[65] El Niño particularly has had a strong impact on the Northern Amazon region,

[61] Espinosa Villar et al. 2008; Garreaud et.al 2009; Zubieta et. al 2019; among others

[62] Magrin et al. 2014.

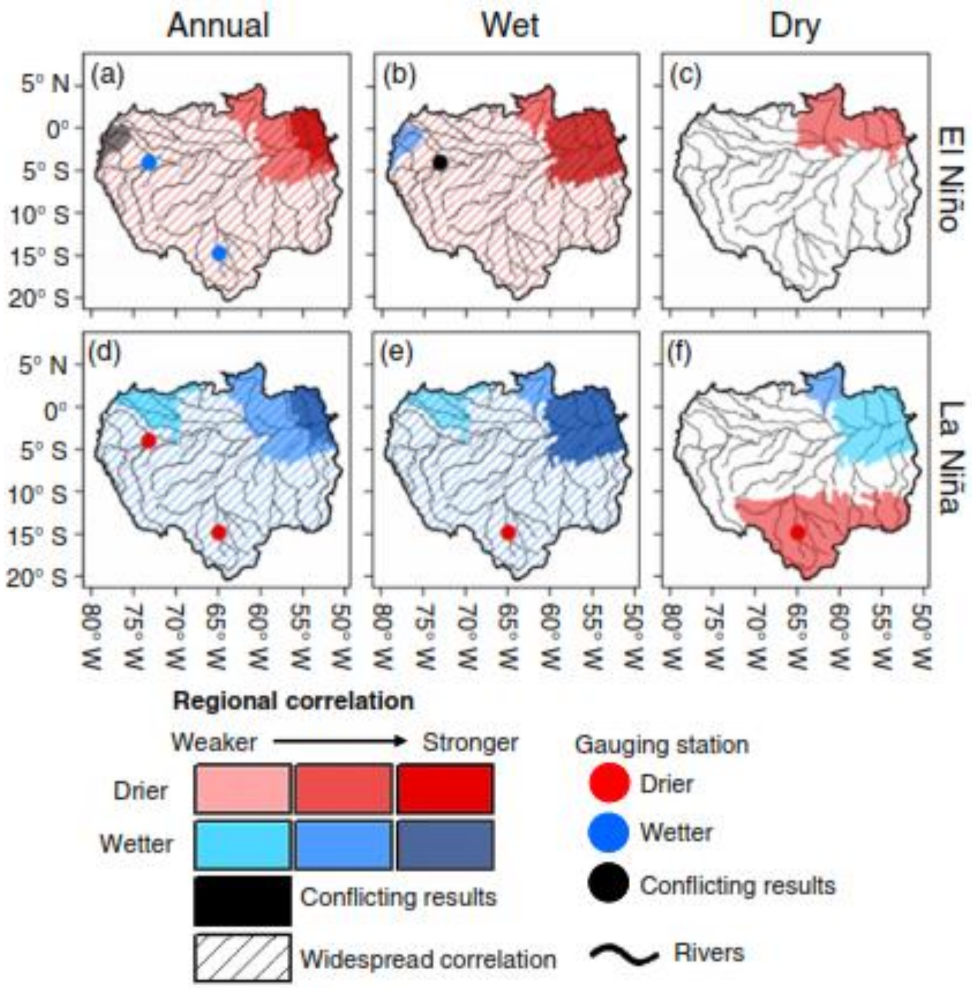
[63] USAID 2018, see discussion about the link between deforestation, rainfall recycling, and drought trends.

[64] Suarez et al. 2015.

[65] Marengo and Espinoza 2016; Barichivich et al. 2018.

where it leads to increased dry conditions within the rainy season (Figure 21).[66] Wetter weather, and flooding are often linked to the ENSO's cold period and a combination of warm(cold) SST anomalies in the Tropical South Atlantic (TSA; TNA).[67] Additionally, previous research has shown that warm conditions in the equatorial Pacific (El Niño events) cause a severe rainfall deficit in Amazonia, as seen in 1926, 1983, 1997–1998, 2010, and 2016.[68] Extreme rainfall and subsequent flooding in the equatorial Pacific, on the other hand, have been linked to cool conditions associated with La Niña events, especially in the Northern Amazon, as observed in 1989, 1999, 2011, and 2012.[69]

Figure 21: Influence of the El Niño Southern Oscillation (ENSO) on rainfall throughout the Amazon basin, based on results identified within the literature: (a, d) the entire year; (b, e) the Amazon wet season (December–April); and (c, f) the Amazon dry season (June-October)



Source: Towner et al. 2020, 16

66 Towner et al. 2020.

67 Towner et al. 2020.

68 Towner et al. 2020.

69 Espinoza et al. 2019.

Inter-decadal variability is mainly driven by the Pacific decadal oscillation (PDO) and the Atlantic multidecadal oscillation (AMO), with cycles of about 16 to 20 and 50 to70 years, respectively.[70] The PDO empirical orthogonal function of monthly anomalies of the SST in the North Pacific Ocean, whereas AMO presents SST oscillations in the North Atlantic Ocean, typically causing variations within a 0.4°C rage.[71] These oscillations studies focus on the relationships to ENSO anomalies and have shown that the PDO can intensify wet/dry anomalies when both it and ENSO are in a phase.[72] For the AMO, an opposing relationship was found where cold (warm) AMO regimes could be associated with stronger (weaker) ENSO variability.[73]

Climate-related natural hazards

To ensure consistency with this analysis, the risk of climate-related hazards was assessed using the ThinkHazard! Tool developed by the Global Facility for Disaster Risk Reduction (GFDRR). ThinkHazard! converts technical danger data in scientific parameters defining hazard severity, frequency, and susceptibility into four hazard categories: very low, low, medium, and high. The following Table 8 provides an overview of the risk classification criteria.

Table 8: ThinkHazard! Classification parameters

Risk classification	River flood	Landslide	Extreme heat	Wildfire	Water scarcity
High	10-year return period (threshold Inundation depth: 0.5m)	Annual frequency per km2 (1x10-4): >7.5	>32°C at a 5-year return period (WBGT)	Wildfire is difficult to control and often spread over large areas. FWI (The Canadian Fire Weather Index) >30; 2-year return period – likely frequent extreme fire weather	Water availability is <500 m³ capita/yr at the 5-year return period
Medium	50-year return period (threshold Inundation depth: 0.5m)	Annual frequency per km2 (1x10-4): 3.2-7.5	>28°C at a 20-year return period (WBGT)	Significant probability of fire but controllable in certain circumstances. FWI >20; 10-year return period – extreme fire weather likely within the design life of the project	Water availability is <1000 m³ capita/yr at the 50-year return period
Low	10,000 year return period (threshold Inundation depth: 0.5m)	Annual frequency per km2 (1x10-4): 1.8-3.2	>25°C at a 100-year return period (WBGT)	Wildfire spread is possible but does not typically cover large areas and is readily suppressed. FWI >15;	Water availability is <1700 m³ capita/yr at the 100-year return period

70 Towner et al. 2020.

71 Towner et al. 2020.

72 Towner et al. 2020.

73 Towner et al. 2020.

				30-year return period, extreme fire weather possible within the design life of the project	
Very low	Based on the current environment, models, and data, no floods are forecast. However, there is still some uncertainty.	Annual frequency per km2 (1x10-4): <1.8	<25°C (WBGT)	Little to no fire spread possible.	In this category no water stress is expected based on longest return period under the current climate, current models and data. However, some uncertainty remains.

Source: GFDRR. 2017. Methodology report*, Updated for ThinkHazard! Version 2*

The Amazon region is exposed to various climate-related hazards, although there is substantial variation within the Amazon basin, and within the Amazon region in each country (Table 9). All countries have at least one administrative area in the basin that is characterized as high risk in terms of flooding. Extreme heat is considered medium risk in most countries. Landslides are particularly of concern in the Andean foothills that transition into the Amazon biome in Colombia, Ecuador, and Peru, (all with areas ranking as high risk). The Amazon is susceptible to wildfires, with nearly all countries considered high or medium risk. However, fires are not only attributed to drought and extreme heat but are largely linked with anthropogenic activities, especially with the use of fire for clearing forest and agricultural land.

Table 9: Summary of climate-related hazard risk in the Amazon region[74] within each of the GCF program's target countries

Target country's Amazon region	River flood	Landslide	Extreme heat	Wildfire	Water scarcity
Brazil	High	Medium–low	Medium	High	Low–very low
Colombia	High	High–low	Medium	High–low	Very low
Ecuador	High	High-medium	Medium–low	High–medium	Very low
Guyana	High	Low	Medium	High	Very low
Peru	High–low	High–low	Medium	High	Low–very low
Suriname	High–low	Low	Medium	High–medium	Very low

Source: GFDRR n.d., https://thinkhazard.org/

2.4.3 Observed trends of climatic variables

Temperature

According to available data, the Amazon region has experienced a gradual warming effect, with a temperature increase ranging between 0.6°C and 1°C for the period 1949 to 2018 (Figure 22).[75] On

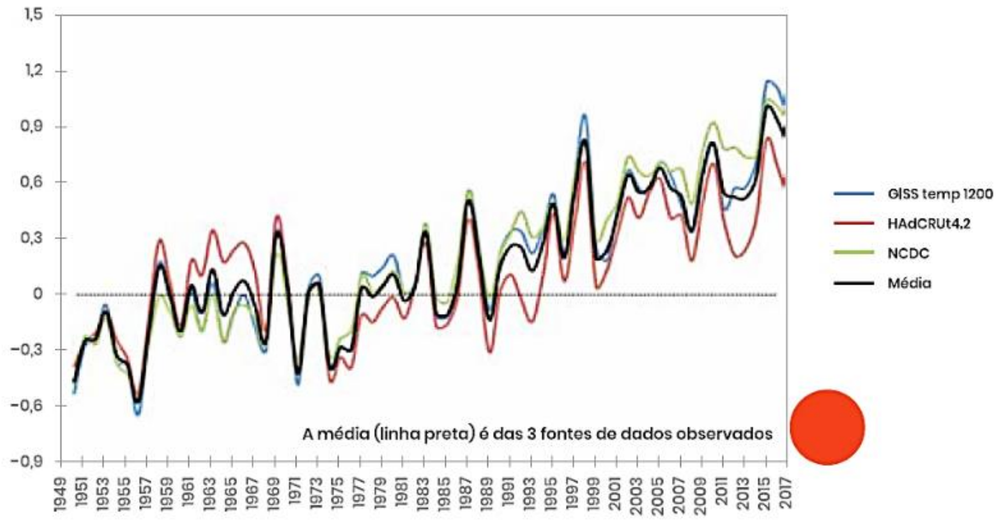
[74] Averages from the districts, regions, provinces, departments within each country that are located in the Amazon region. Some countries have administrative divisions that are only partly covered by the Amazon basin; however, Amazon level information was not available with the ThinkHazard! Tool. Refer to the country level profiles for more detailed information

[75] OTCA 2014; Marengo and Souza 2018.

average, temperatures have increased by 0.5°C since 1980 in the Amazon biome, with the largest increments observed in the southwest Amazon.[76]

A significant observed increase in heatwaves has been observed in the Amazon Region during the period from 1950–2017, with an increase in: heatwave days by 5.40 days per decade, an increase in the maximum duration of heatwaves by 1.16 days per decade, an average increase of heatwave intensity by 0.05°C per decade, and a cumulative heat increase of 3.03°C per decade.[77]

Figure 22: Temperature variability for the Amazon region for the period 1949-2017[78]



Source: Marengo and Souza, 2018, 4

Precipitation

Rainfall anomalies and variability have been recorded continually over the past decades; nonetheless, some trends have emerged:

- Evidence shows that the dry season intensity in the Amazon has been increasing (i.e., dry periods beginning earlier and ending later in the year), as well as the frequency of drought events during the period 1951-2014.[79] Notable drought years include 1983, 1998, 2005, 2010 and 2015/16.[80]

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[76] USAID 2018.

[77] Perkins-Kirkpatrick and Lewis 2020.

[78] The figure presents the observed temperature change in the Amazon from a reference period of 1961-1990 using three existing data sets from 1949 to 2017. The three data sets utilized are from the NASA Goddard Institute for Space Studies (GISS temp), the Hadley Centre/Climatic Research Unit Temperature (HAdCRUt4.2), and the NOAA National Climatic Data Centre. The three data sets use data from weather stations. GISS Temp includes data from GHCN v4 (circa 6,300 land stations and SST stations); HAdCRUt includes recorded data from circa 5,500 land stations from GHCN and SST stations; NCDC includes recorded data from circa 7,000 land stations and SST stations. The location of some of the weather stations as well as information shortcomings due to a limited number of weather stations in some of the countries in the region are described in section 2.4.2 of the feasibility study.

[79] Marengo and Souza 2018; USAID 2018.

[80] Papastefanou et al. 2020; Jimez et al. 2018; Marengo and Souza 2018; USAID 2018.

- While the northern Amazon experienced a particularly wet period from 1950 to 1976, it has since shown trends toward become increasingly dry.[81] The southern Amazon has shown trends toward becoming increasingly dry, where the standard precipitation index decreased by 0.32 per decade during the period from 1970 to 1999.[82] Espinoza et al. (2019) recognized a significant dry-day frequency increase in the southern Amazon during SON (September-November), and a decline in total annual precipitation, estimated at 18% during the period from 1981 and 2017. In the northern Amazon, a diminution of DDF was observed, especially during MAM (March - May) season.[83] The same study found an estimated rainfall increase of 17% during MAM, along with an increase in wet-day frequency during the same period and throughout the year in the northern Peruvian and Brazilian Amazon.[84] Figure 23 shows tendencies over the last 35 years toward extreme wet months and extreme dry months, as well as a shift in the end of the dry season. Likewise, Paca et al. (2020) found over the period 1981 to 2017, positive precipitation trends located towards the north and northwest regions of the basin, and negative precipitation trends tended to localize to the center and south of the basin. Moreover, variability during these 37 years exceeded more than 2.8 mm/year.[85]
- Consistent with what was presented above, Funatsu et al. (2021) present linear regression coefficients (Figure 23 and Table 10); where bold font reflects statistically significant patterns (95% confidence interval).[86] A statistically significant increase in the number of consecutive dry days (CDD) was observed in the Southern Amazon (defined as south of 5°S in this study) from November-March, whereas the Northern Amazon (defined as north of 5°S) had statistically significant increases in very heavy precipitation days (R20mm), and the maximum number of consecutive wet days (CWD) during the period from February until June. The rest of the trends were not statistically significant, however they indicated the following trends: average simple daily intensity (SDII), very wet days (R95wp), maximum 6-day precipitation (Rx5day), and very heavy precipitation days (R20mmm Figure 24a-d) trends indicate geographic consensus, with a signal that is broadly consistent with the overall precipitation trend: Positive patterns in the northern and western parts of the Amazon basin, and negative trends in Southern Amazon. The study also found that precipitation extremes happen in the periods from: February to June in the Northern Amazon, and November to March in Southern Amazon.[87]

[81] USAID 2018.

[82] USAID 2018.

[83] Espinoza et al. 2019.

[84] Espinoza et al. 2019.

[85] Paca et al. 2020.

[86] Espinoza et al. 2015; Funatsu et al. 2021.

[87] Funatsu et al. 2021.

Table 10: Seasonal trends and 2-sigma (95%) uncertainty for normalized precipitation indices averaged over the Northern and Southern Amazon Region (defined as north and south of 5°S, respectively)

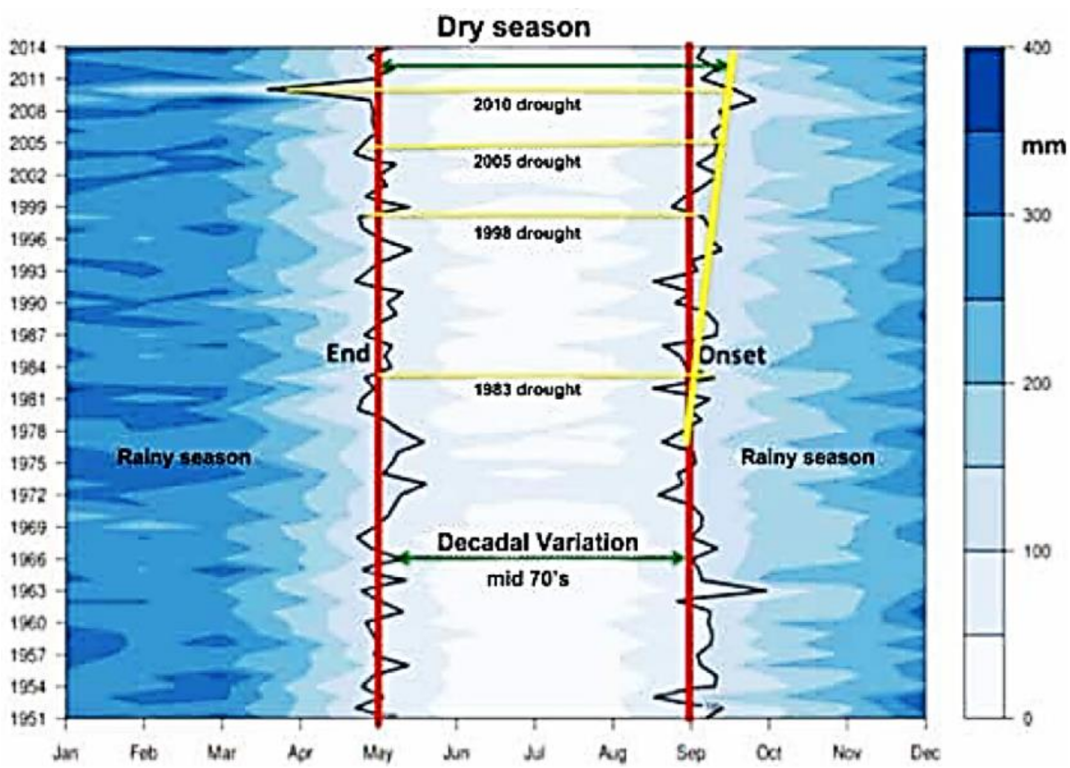
Index	NAM (Feb–Jun)	SAM (Nov–Mar)
R20mm	**3.7 ± 2.8**	1.7 ± 3.0
R95wp	0.0 ± 3.0	1.2 ± 3.0
Rx5day	0.3 ± 3.0	1.4 ± 3.0
ASDII	−1.9 ± 3.0	1.7 ± 3.0
CWD	**3.0 ± 2.9**	−1.9± 3.0
DC	18.5 ± 5.2	18.3 ± 5.4
COV	−12.3 ± 8.9	−15.4 ± 7.4
CDD	–	**3.7 ± 2.8**

CDD trends only are for SAM dry season (JJA). Trend values are in % yr^{-1}. Significant trends are shown in bold

Note: NAM= Northern Amazon, SAM = Southern Amazon, RR = precipitation (daily convective rainfall amount in mm), Rx5day = maximum 5-day precipitation (mm), R20mm = very heavy precipitation day (days), ASDII = Average simple daily intensity (mm per day), CWD = maximum number of consecutive wet days where RR is greater than or equal to 1mm (days), DC =, COV=, CDD = maximum number of consecutive dry days where RR is less than 1mm (days)

Source: Funatsu et al. 2021, 18

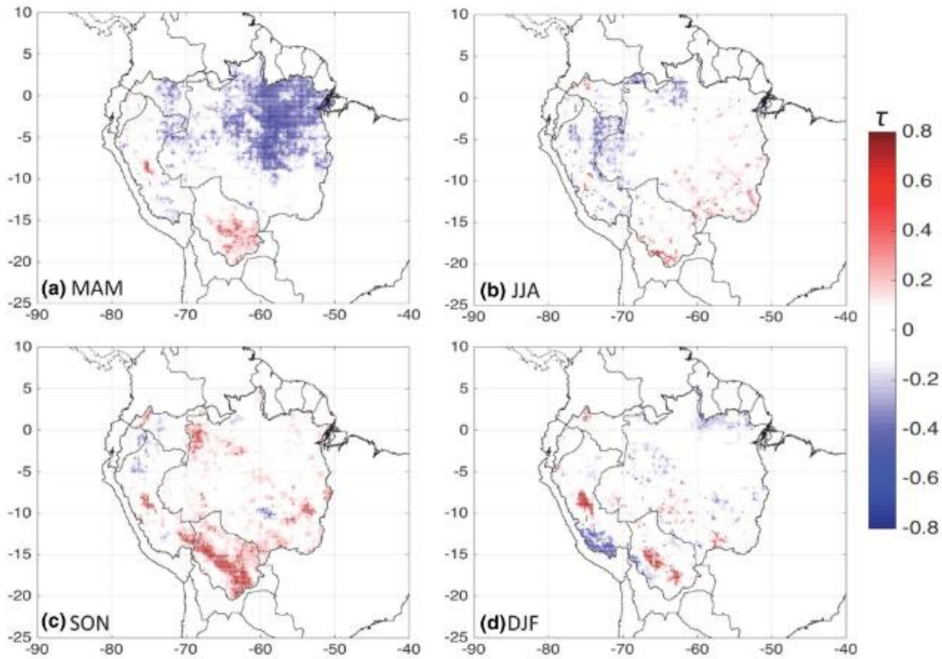
Figure 23: Hovmöller diagram for precipitation during the period 1951-2014[88]



Source: Marengo and Souza, 2018, 11

[88] The black line is the 100mm/month isoline, and the red line indicates the beginning and end of the dry season.

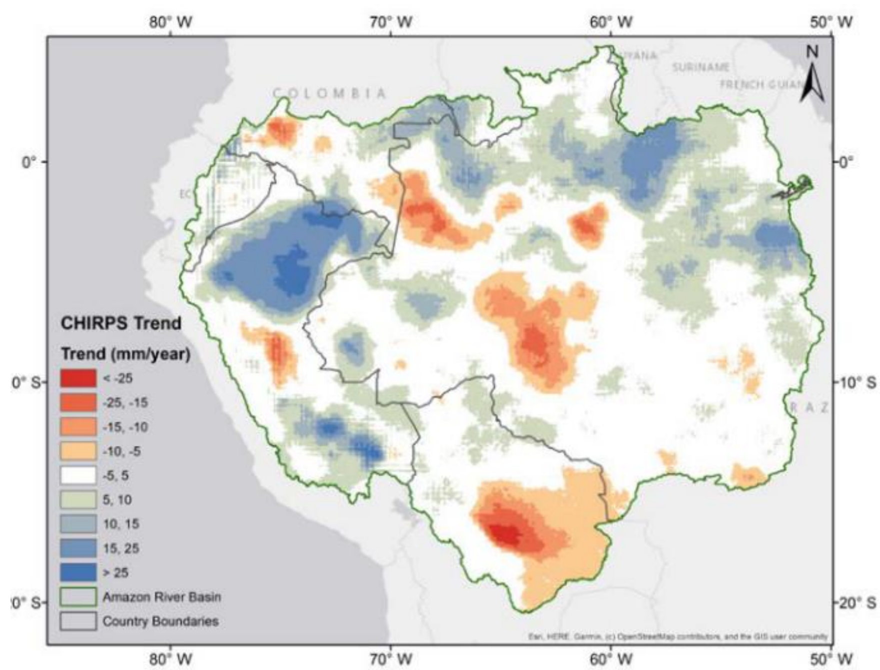
Figure 24: Spatial distribution of Kendall coefficient values indicating the trend for 1981–2017 dry-day frequency in a)March-May, b) June-August, c) September-November and d) December-February



ig. 2 Spatial distribution of Kendall coefficient values ($p < 0.05$ are ndicated with a dark dot) indicating the trend for 1981–2017 dry-lay frequency—DDF during **a** March–May, **b** June–August, **c** September–November and **d** December–February seasons. In panel **d** the trend analysis is computed for the 1982–2017 period

Source: Espinoza et al. 2019, 6

Figure 25: CHIRPS precipitation trends from 1981 to 2017

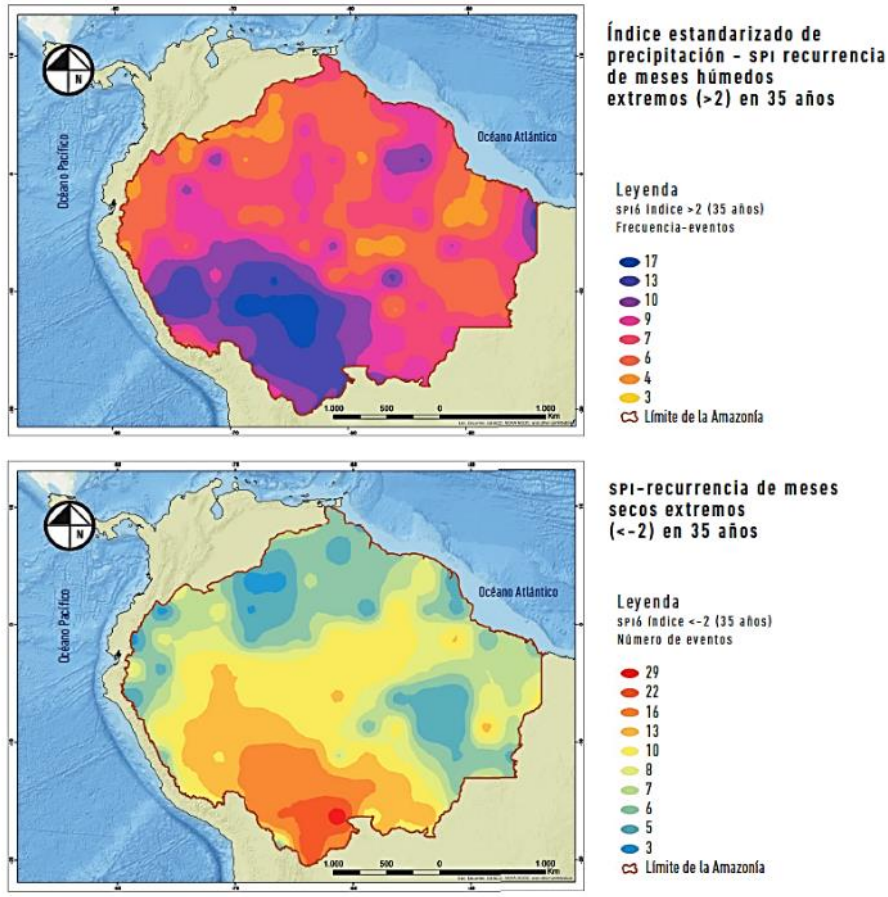


Source: Paca et al. 2020, 9

Figure 26: Standardized precipitation index (SPI) during the last 35 years for extreme events: (a) extreme wet months (SPI > 2); and (b) extreme dry months (SPI < -2)

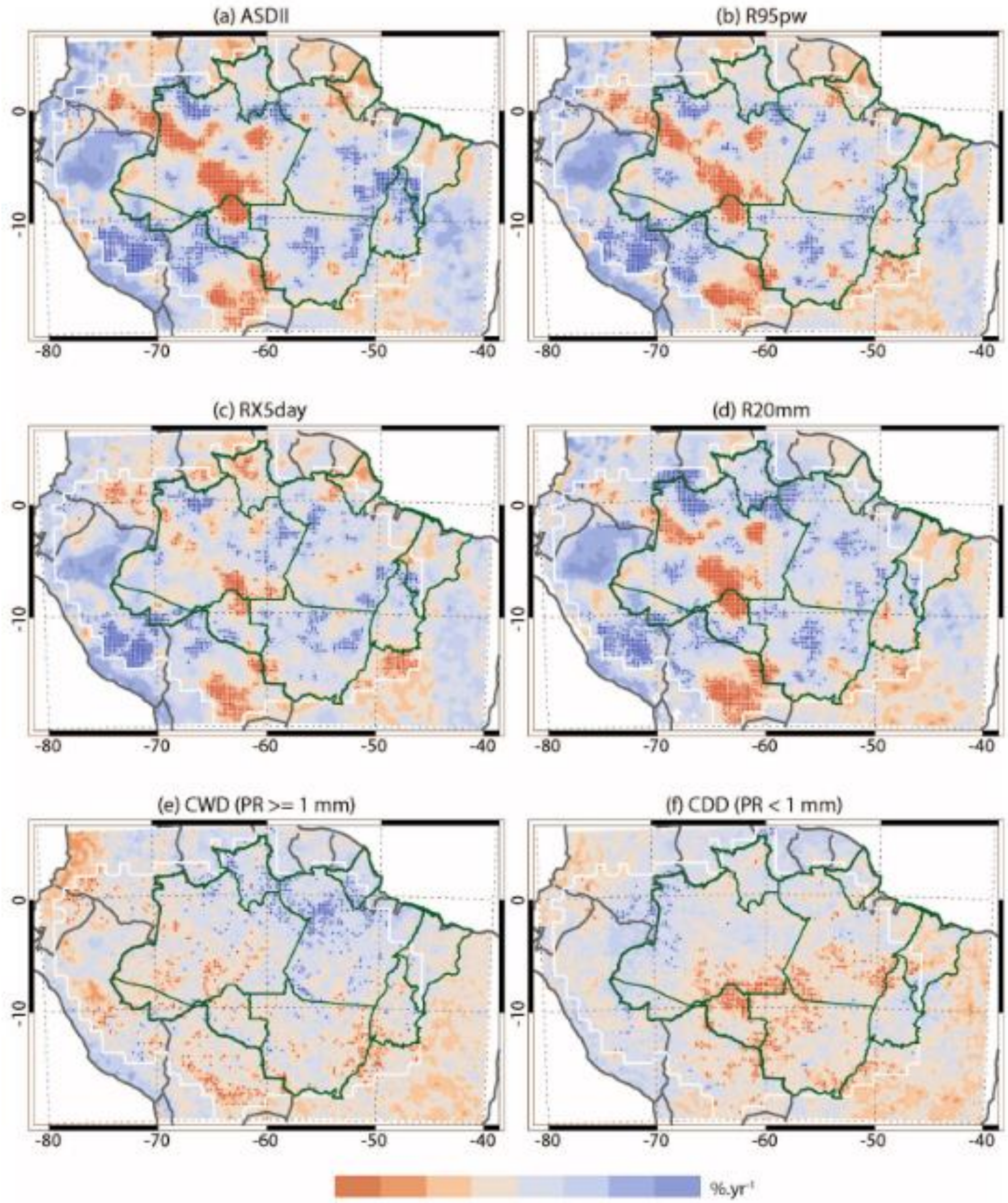
a)

b)



Source: Pabón-Caicedo et al. 2018, 36

Figure 27: Linear trends coefficient for standardized series of a)ASDII , b)R95pw , c) RXSday ,d)R20mm , e)CWD (PR>=1mm), f) CDD (PR < 1mm)



Source: Funatsu et al. 2021, 13

Climate-related natural hazards

The main climate-related natural hazards observed in the Amazon biome between 1970 and 2015 were floods (50%), landslides (27%), droughts (19%), and forest fires (4%).[89] Along with observed changes in temperature, there was an observed increase in droughts and forest fires (although the latter is also particularly linked with anthropogenic drivers).

89 Pabón-Caicedo et al. 2018.

Flooding: Precipitation events that generate floods are more frequent on the upper basin of the rivers Madre de Dios, Purús, Juruá, and Marañón, which are part of the Peruvian Amazon basin (Figure 28 and 29). In addition, it has been observed during the last 35 years that the areas along the Amazon river, its tributaries, southern part of the Brazilian Amazon, and near the border between Bolivia and Brazil have been prone to flooding.[90] A study in Brazil found severe flooding drastically increased in the Amazon region over the last century.[91] The study[92] focused on daily records of water levels from the port of Manaus from 1903 to 2015, and Amazon River at Obidos from 1970/2015, in addition to precipitation and atmospheric reanalysis data.[93] They futher mention »*precipitation data during recent decades, with better station coverage, show a general tendency for wet seasons to get wetter and dry seasons to get drier, a pattern that is highly consistent with the observed increase in amplitude between peak and minimum flows of the Amazon River since the 1990s". The study in Brazil found that the frequency of severe floods "steadily increased since around 1970, leading to exceptionally high levels of flood hazards in recent years We estimate that, over the study period, flood frequency has experienced a significant fivefold increase."*[94] Very heavy precipitation events are a common part of the climate system's variability; but, in the light of climate change, the frequency of precipitation extremes is likely to increase, especially in the western Amazon region, where Espinoza et al. (2019) and Haghtalab et al. (2020) show significant positive trends in mean annual precipitation and extremely heavy precipitation.[95] Relevant to note that there are several scientific publications that indicate that the change in trend (either increased or decreased) in precipitation is not distributed uniformly across the Amazon Basin. Paca *et al.* (2020) analyzed the trends of precipitation across the Amazon River Basin using remote-sensing-based data from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), and cross-validated the precipitation trends from CHIRPS with *in situ* data.[96] The study identified specific regions with anomalies, and validated the temporal changes detected by remote

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[90] Pabón-Caicedo et al. 2018

[91] Barichivich et al. 2018.

[92] Barichivich et al. 2018.

[93] Specifically, the authors mention "*Long-term daily water level data for the Negro River at Manaus Harbor were obtained from the Brazilian Water Agency [Agência Nacional de Águas (ANA); www.snirh.gov.br/hidroweb/publico/ medicoes_ historicas_abas.jsf] for the period 1903–2015. Quality- controlled daily water levels for the Amazon River at Óbidos were obtained from the Environmental Research Observatory SO HYBAM (www.ore-hybam.org) for the period 1970–2015. Both records were screened for inconsistencies; other than a few typing errors detected in the record of Manaus, no quality problems were found. The Manaus gauge has been maintained at the same site by Manaus Harbor Ltd./ Portobras since its installation in 1902. Changes in the river bed in the low-sediment Negro River have likely been small (13). The annual difference between high and low water levels may reach 15 m, and riverine life and navigation follow the pace of the predictable annual flood pulse. Disruptions to this cycle cause great impacts to riverine population, regional economy, and ecology (4, 9, 11). We chose to use the stage record directly rather than to derive discharge estimates (13 b e cause water levels are less uncertain and extreme anomalies are more easily related to the impacts felt by the riverine populations. Discharge estimates become unrealistic when water overflows to the large flood-plains during the wet season. An average of dry and wet season precipitation for the Amazon basin was computed over the period 1970–2015 using the Brazilian Network of rain gauges and four global gridded precipitation products (fig. S2). The network of rain gauges covers only the Brazilian Amazon And was created by combining data from the Brazilian Water Agency and the Brazilian National Institute of Meteorology (INMET; www. Inmet.gov.br/). Only stations with a minimum of 30 years with complete data during the dry (n = 278) and wet (n = 215) seasons were retained. To avoid biasing the average toward regions with higher station cover- age, the available stations for a given season and year were first averaged into 5° × 5° latitude-longitude boxes, and then the basin average for that season and year was computed by averaging all the grid boxes.*" More information on how they accounted for topical climate variability and atmospheric circulation, and how hydrological extreme events were analyzed can be found on Page 5 of the article.

[94] Barichivich et al. 2018, p.1

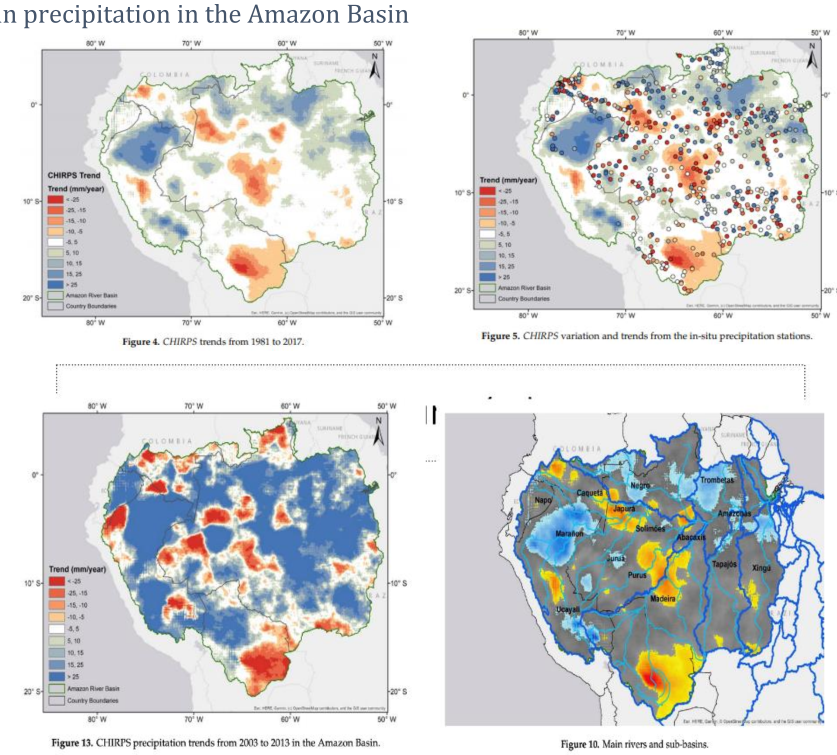
[95] Espinoza et al. 2019 and Haghtalab et. al 2020.

[96] Paca et al. (2020, p. 1) further notes "*Cross-validation was performed using 98 in situ stations with more than 20 years of recorded data, obtaining an R^2 of 0.981, a slope of 1.027, and a root mean square error (RMSE) of 363.6 mm/year. The homogeneous, standardized, and continuous long-term time series provided by CHIRPS is a valuable product for basins with a low-density network of stations such as the Amazon Basin.".*

sensing observations and ground measurements. The estimation of precipitation trend variability and anomalies within the Amazon Basin using novel products from remote sensing sources leverage our understanding of the basin and its impacts on the regional water cycle.

The figure below illustrates that the trends in precipitation are not uniform in the Amazon Basin, with some regions showing a declining precipitation trend (shown in red and orange) and others with an increasing precipitation trend (shown in blue) in the figure in the left-hand side.

Figure 28. Trends in precipitation in the Amazon Basin



Source: Paca et al 2020

The positive trends (increased precipitation) tended to be located towards the north and northwest regions of the basin.The negative trends (decreased precipitation) tended to localize to the center and south of the basin. There were three main clusters: one in Brazil in the Trombetas River basin, a larger cluster in Peru in the Marañon/Putumayo River basin, and a cluster with a higher trend with two centers in the Ucayali River basin. There were three negative clusters, two of them in the project intervention area: one in the Solimões River basin and one in Madeira/Solimões in Brazil. Moreover, variability during these 37 years (1981 to 2017), exceeded more than 2.8 mm/year. Espinoza et al. (2019) recognized a significant dry-day frequency (DDF) increase in the southern Amazon during SON (September-November), and a decline in total annual precipitation, estimated at 18% during the period from 1981 and 2017[97]. In the northern Amazon, a diminution of DDF was observed, especially during MAM (March - May) season. The same study found an estimated rainfall increase of 17% during MAM, along with an increase in wet-day frequency during the same period and throughout the year in

[97] Espinoza et al. 2019

the northern Peruvian and Brazilian Amazon. Espinoza et al. used CHIRPS rainfall dataset, as well as observed precipitation data,[98] atmospheric and oceanic data.

Consistent with what was presented above, Funatsu et al. (2021) present linear regression coefficients (Figure 23 and Table 10 of this feasibility study); where bold font reflects statistically significant patterns (95% confidence interval). A statistically significant increase in the number of consecutive dry days (CDD) was observed in the Southern Amazon (defined as south of 5°S in this study) from November-March, whereas the Northern Amazon (defined as north of 5°S) had statistically significant increases in very heavy precipitation days (R20mm), and the maximum number of consecutive wet days (CWD) during the period from February until June[99]. Funatsu et al. used CHIRPS and AMSU-B/MHS.[100]

Much of the amazing region is moderately or highly vulnerable to flooding, according to a study by Pabón-Caicedo et al. (2016).[101] The same study also finds many areas, especially those in the southern and eastern Amazon, are vulnerable to droughts (see Figure 41 on this feasibility study). In addition, it is recognized that river inflow in the Amazon depends largely on events in the Andes, so that changes in precipitation, extreme events and glacier melt have the effect of flooding in the Amazon.[102] Effects of extreme events are worsen by land use changes happening along the watersheds, as deforestation and forest degradation reduce the soil capacity of retaining water.[103]

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[98] The following excerpt explains their methodology "*Rainfall data from 1488 rain gauges located in the Amazon basin have been collected through the SNO-HYBAM observatory. This information comes from different national agencies responsible for hydro-meteorological monitoring: ANA in Brazil, SENAMHI in Peru and Bolivia, INAMHI in Ecuador and IDEAM in Colombia. First, rainfall data were collected at a monthly time-scale since 1975 (Espinoza et al. 2009a), then rainfall data were gathered from 1980 to 2009 at a daily time step (Guimberteau et al. 2012). Quality control of the rainfall data was applied using the Regional Vector Method-RVM (Hiez et al. 1991; Brunet-Moret 1979). As a result of the RVM method, 752 rain gauges (about 51% of the total number of stations) were ultimately retained, with data including more than 5-year continuous periods. HOP data were then spatially interpolated to a 1° × 1° horizontal resolution. After several geostatistical tests to interpolate rainfall values, an ordinary kriging was performed to generate an observation-based gridded daily rainfall data set for the 1980–2009 period. For more details about the interpolation method and the ability of the interpolated HOP data to reproduce hydrological variability in the Amazon River, see Guimberteau et al. (2012), Guimberteau et al. (2013), and Getirana et al. (2014). The HOP data set has also been validated with rainfall estimated by satellites, including CHIRPS at interannual and intraseasonal time-scales in Wongchuig-Correa et al. (2017) and Paccini et al. (2017), respectively. Daily-interpolated HOP data are freely available in NetCDF format on the http://www.ore-hybam .org web site.*" P. 546

[99] Funatsu et al. 2021

[100] While they did not use observational data, they provided the following information on why "*Comparisons between CHIRPS and the interpolated HYBAM (https:// www. ore- hybam. org) observed precipitation data (HOP) have been conducted by Paccini et al. (2018), and a recent study by (Cavalcante et al. 2020) provided a comparison between monthly mean rainfall estimated by CHIRPS and data measured at 45 ground stations in the Amazon region. Cavalcante et al. (2020) concluded that they are in good agreement though CHIRPS tends to underestimate large rainfall totals; this translates into an overall underestimation of extreme rainfall indices, compared to those derived from in situ data. Espinoza et al. (2019a) have shown a remarkable agreement between trends of heavy precipitation and dry days estimates derived from CHIRPS and the HOP datasets, and Haghtalab et al. (2020) shows also good correlation between CHIRPS and ground based data from the Brazilian National Water Agency (ANA). This suggests that even though the indices may be underestimated, trends estimates may be reliable assuming that the bias is relatively constant in time.*" P. 4

[101] These authors used the standardized precipitation index, using data for six month intervals from 1979-2014 downloaded from the library of the International Institute for Climate and Society Research. More detailed information on their methodology can be found on pages 31-33 of their article.

[102] Magrin et al. 2014.

[103] Magrin et al. 2014; Marengo and Souza 2018.

Figure 29: Flood prone areas in the Amazon basin based on data from the last 35 years

Source: Pabón-Caicedo et al. 2018, 36

Droughts: Evidence suggests that precipitation is declining, particularly in the southern Amazon, thus prolonging the dry season.[104] This change in frequency and intensity of precipitation, in combination with increasing temperatures, accelerating deforestation and reduced rainfall recycling, has contributed to the Amazon's increasing vulnerability to dry conditions and droughts, which often also leads to an increased occurrence of wildfires.[105] The Amazon experienced extreme droughts three times over the last 20 years, in 2005, 2010 and 2015-2016.[106] Drought events have been more frequent in the transboundary river basins of the rivers Beni, Mamoré, Guaporé/Iténez and Machado along the border of Bolivia and Brazil (Figure 30).[107]

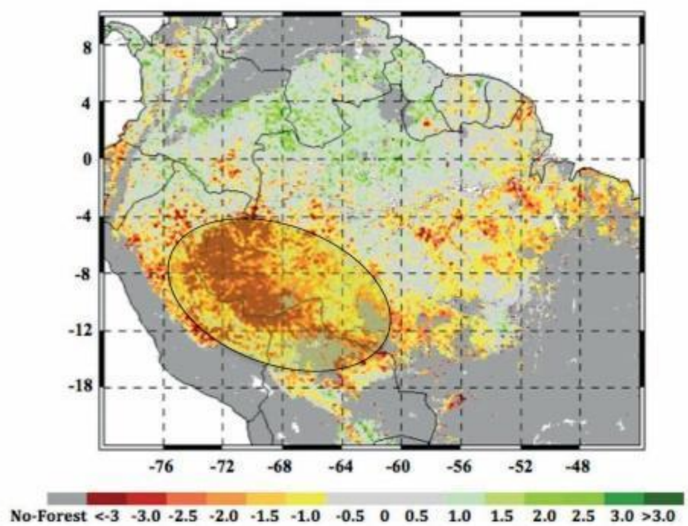
[104] USAID 2018.

[105] Marengo and Souza 2018; Staal et al. 2020.

[106] USAID 2018.

[107] Pabón-Caicedo et al. 2018.

Figure 30: Distribution and severity of drought in the Amazon basin in 2005



Source: Suarez et al. 2015, 8

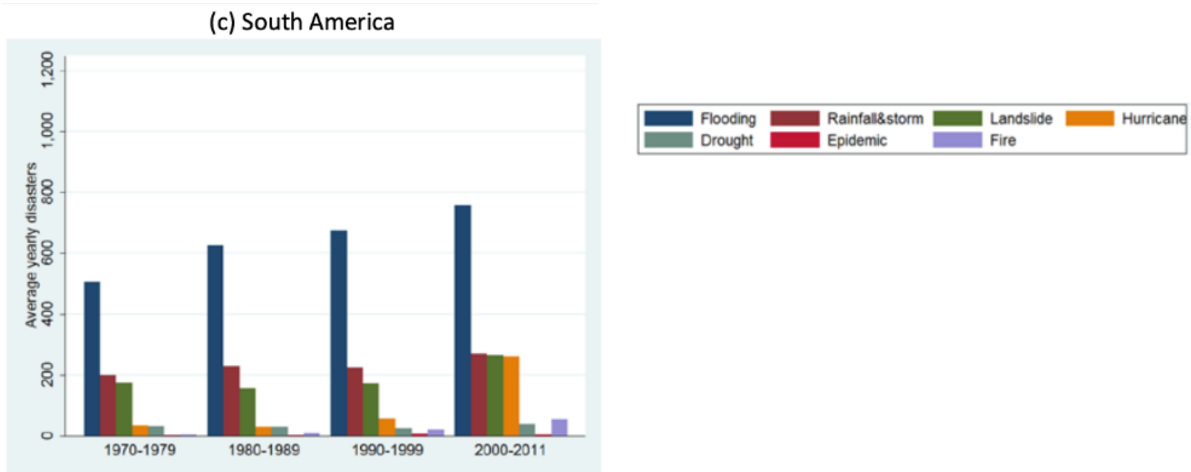
Wildfires: There are mixed findings on trends with wildfires in the Amazon region, and in general there are complex fire regimes. Anthropogenic activities such as using fire as a tool for deforestation and clearing large areas of forest, as well as change in the frequency and occurrence of dry conditions and drought associated with increasing temperatures, declining precipitation all influence the occurrence of wildfires.[108] Van Marle et al. (2017)[109] found that fire-related emissions increased rapidly since 1987, and are closely linked with deforestation. They found a peak in 1995, followed by a general decrease during the 2000s, with an exception in 2010 which was the highest fire year found in their dataset. Their assessment compared visibility observations, satellite-derived fire emission estimates (1997-2014), ad MOPITT CO concentrations for 2000-2014. They found lower fire-driven deforestation than FAO datasets, which previously suggested higher increases in fire-induced deforestation starting already in the 1970s. Garlati (2013) shows that fire is not the most frequent event, compared to flooding, landslides, rainfall and storms, but in the figure below, an increasing frequency from 1970-1979 compared to 2000-2011 has been reported.[110]

[108] For example, in Brazil there were 41,858 forest fires in 2019, which was the largest on record since 2010 where the Brazilian amazon saw a record 58,476 fires. In 2010 there was an extreme drought, which greatly contributed to the large scale outbreak of forest fires in Brazil. However, in 2019 the main driver was an increase in deforestation – which had increased by 88% in comparison to the previous year. Thus, while climate change has an impact on increasing temperatures and dry conditions, deforestation remains a main driver of wildfires in the Amazon region, which in turn exacerbates climate risk and vulnerability (Sax 2019). Cochrane and Barber in Suarez et al. 2015; Marengo and Souza 2018.

[109] Van Marle et al. 2017

[110] Garlati, 2013

Figure 31. Average Yearly Disasters

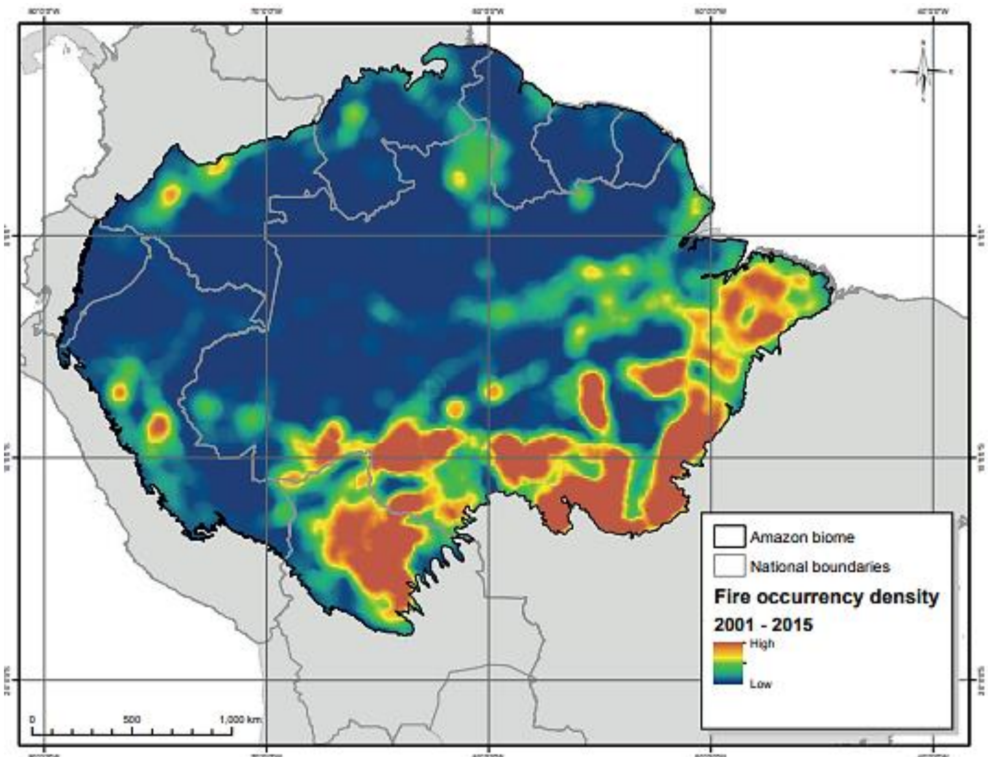


Source: Author's calculations based on DesInventar.

Garlati, 2013, P16.

De Faria et al. (2017) further note that droughts reduce forest understory air, and increase forest flammability through "decreasing soil moisture, triggering leaf shedding, branch loss, and tree mortality—all of which contribute to increased fuel loads."[111] Looking at the fire occurrence density from 2001-2015, fires greatly affected the Amazon region in Brazil, and and to a lesser extent, Peru and Colombia (*Figure* 32). During the same period, a positive trend was noted between forest fires and El Niño, where dry conditions exacerbated by El Niño result in particularly severe fires.[112]

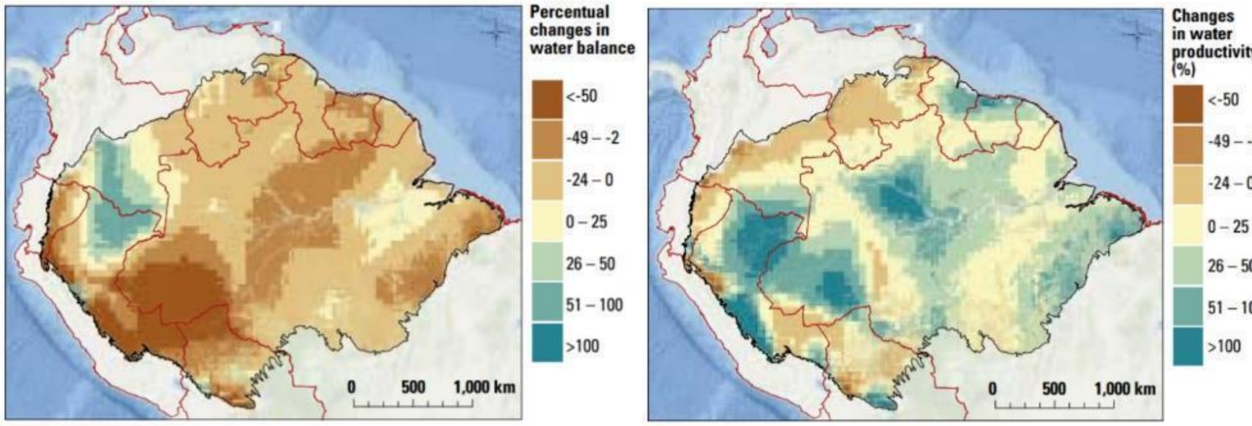
Figure 32: Fire occurrence density during the period from 2001-2016 in the Amazon biome



Source: Suarez et al. 2015, 7

Water scarcity: While all of the program's target countries' Amazon regions are ranked low or very low risk in terms of water scarcity, changes in water productivity and the water balance have been observed (Figure 33). While the risk is still low, there is a risk that climate change, exacerbated by ENSO, could increase water scarcity or cause seasonal shortages in the future[113]. As previous research has shown (and as described under 2.3.2), warm conditions in the equatorial Pacific (El Niño events) cause a severe rainfall deficit in Amazonia, as seen in 1926, 1983, 1997–1998, 2010, and 2016 leading to drought.[114]

Figure 33: Percentual changes in water balance from 2000-2005 (el Niño anomalies, left), and changes in water productivity from 2000-2010 (la Niña anomalies, right)



Source: Skansi et al. 2013 in Prüssman et al. 2016, 21

2.4.4 Climate change projections

This sub-section draws on existing literature on future climate change projections for the Amazon Basin—notably, the studies in Table 11.

Table 11: Overview of available scientific literature on climate change projections, including models and RCP scenarios used

Reference	**Model(s) used**	**RCP scenario**
Marengo and Souza 2018	CMIP5 models	RCP2.6 and 8.5 projections, with one figure on temperature showing RCP 4.5 and 6.0 scenarios
Magrin et al. 2014	AR5 CMIP5 models	RCP2.6; RCP4.5; RCP8.5
Duffy et al. 2015	35 CMIP5 models	RCP8.5
Chen et al. 2017:	37 CMIP5 models	RCP8.5
Sorribas et al. 2016	GCMs from AR5 CMIP5: CNRM-CM5, GFDL-ESM2M, HADGEM2-CC, MRI-CGCM3 and MIROC5.[115]	RCP8.5
Lyra and Sampaio 2016	HadCM3 model	RCP4.5 and RCP8.5

These studies mostly use the CMIP5 (Coupled Model Intercomparison Project Phase 5) models presented in the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCCC). Older studies also used the HadCM3 model, however the most recent and most comprehensive studies at the Basin level use the CMIP5 model. Thus, to the greatest extent possible, this assessment draws on

[115] For the purposes of the (projections on discharge and inundation) study, only these five models were assumed to provide realistic simulations of the main climatological features of the South American Monsoon.

the most recent studies using the CMIP5 model. Additional information on RCP 4.5 was integrated from SMHI, Climate Information website due to the limited mention of RCP 4.5 in the aforementioned peer-reviewed studies.

The World Climate Research Program (WCRP) notes that the CIMP5 protocol, comprised of at least 35 climate model experiments, is useful for: "1) assessing the mechanisms responsible for model differences in poorly understood feedbacks associated with the carbon cycle and with clouds, 2) examining climate "predictability" and exploring the ability of models to predict climate on decadal time scales, and, more generally, 3) determining why similarly forced models produce a range of responses."[116]

In the context of the Amazon Basin, the various selected studies highlighted the relevance of the use of this model. Duffy et al. (2015) noted the CMIP5's ability to "simulate important properties of historical meteorological droughts in the Amazon,"[117] as well as its ability to reproduce "observed relationships between Amazon precipitation and regional sea surface temperature anomalies in the tropical Pacific and the North Atlantic oceans."[118]

Note on RCP scenario

The IPCC's Representative Concentration Pathway (RCP) is a greenhouse gas concentration trajectory. For the IPCC's fifth Assessment Report (AR5) in 2014, four pathways were used for climate modeling and analysis.[119] The various climate futures described in the pathways are all considered possible based on the amount of greenhouse gases released in the coming years. While RCP 2.6 is considered a very strict pathway since it is likely to maintain global temperature increase below 2°C by 2100. The IPCC describes RCP 4.5 as an intermediate scenario. Emissions in RCP 4.5 reach a peak around 2040 and then begin to decline. And RCP 8.5 presents a pathway where emissions continue to tire throughout the 21st century.

The aforementioned peer-reviewed studies on the Amazon Basin concentrate mainly in the changes and impacts of RCP Scenario and 2.6 and 8.5, and highlight the need to implement adaptation measures in order to maintain global temperature increase below 2°C. Amazon-wide values for RCP 4.5 are not widely reported in the literature despite being the most likely scenario. Where possible we have also mentioned available results from RCP scenario 4.5 (including results from SMHI, Climate Information), although there is an information gap regarding this scenario within peer-reviewed literature.

Note on validation of climate projections against observed regional data

[116] WCRP 2021.

[117] Duffy et al. 2015, 13172.

[118] Duffy et al. 2015, 13172.

[119] It is important to note that the RCP scenarios do not include deforestation or urbanization rates in their configuration.

Below is a brief description of how the models referenced in the feasibility study related to climate projections were validated with observed data from the region.

- *Lyra and Sampaio* (2016) validate their model using regionally observed data from the Santarem-K83 tower. They undertake an Inland model validation using the Santarém flux tower measurements, and base it on the analysis of the mean diurnal cycle and statistical metrics such as mean square error (RMSE), linear correlation and standard deviation before assessing the impacts of future climate changes on the Amazon biome under RCP4.5 and RCP8.5.[120]
- *Duffy et al (2015)* examine how 35 CMIP5 models reproduce observed relationships between anomalies in SST and droughts in the Amazon. The study also assesses how CPIM5 model can capture the seasonal variability of precipitation. For validation, the analysis compares the correlation coefficients of monthly SST and local precipitation anomalies of CPIM5 models against observed correlation in the HadISST monthly observed SSTs and observed precipitation data sets (Princeton, MERRA, TRMM). Projections are built using the RCP8.5 scenario.[121]
- *Chen et al (2017)* use an empirical probabilistic diagnostic (EPD) to estimate different ENSO behaviours, including seasonal locking, differences in peak location, and the propagation direction and the El Nino-La Nina asymmetry in duration and transition. To validate the EPD the diagnostics are applied to observed data and find that the results are consistent with observed behaviou. Projections are built using GCM and the RCP8.5 Scenario.[122]
- *Sorribas et al.* (2016) use the MGB-IPH hydrologic model to assess potential effects of climate change on discharge and inundation in the Amazon basin under the RCP8.5 scenario (GCM with correction of biases). The choice of hydrological model for the analysis is due to its performance in previous validations against observations.[123]
- *Marengo and Souza* (2018) do not present in their study whether or how the data was locally validated.[124]

In addition, projections from the Fifth IPCC Assessment report (AR5)[125] were included in this feasibility study. A brief description of how a subset of the projections from peer reviewed literature referenced in in AR5 were validated or verified is included below.

- *Bombardi and Carvalho*, (2009) use as precipitation data the “5-day mean (pen-tad) rainfall from the global precipitation climatology project (GPCP) from 1979 to 2006.” They simulate the characteristics of the South America monsoon system comparing observed and simulated data of ten coupled global climate models for the A1B scenario. They find that most models tend to underestimate precipitation at the peak of the rainy season and mis represent the ITCZ and its seasonal cycle meaning that total seasonal precipitation, onset and end of rainy season are

[120] Lyra and Sampaio 2016.
[121] Duffy et al. 2015.
[122] Chen et al. 2017
[123] Sorribas et al. 2016
[124] Marengo and Souza 2018
[125] IPCC 2014.

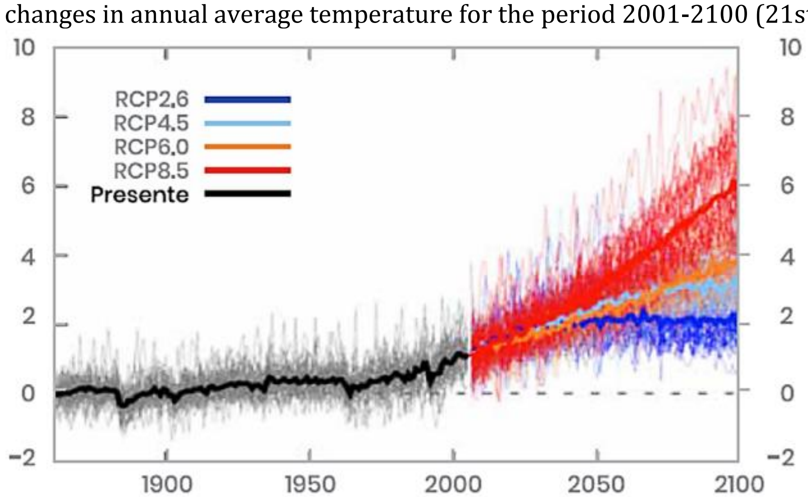
unrealistic over the north and northwestern Amazon. Variable - intensity of the south Atlantic convergence Zone and in rainfall in the South American monsoon region[126].

- *Mendes and Marengo (2010)* validate the artificial neural network model and downscaled scenario analyses A2, A1B, and B1 with data from rain gauges located within the Brazilian Amazon basin that are part of the country's national hydrometeorological network for 1970-1999 data. Variable – Precipitation in western Amazonia during the summer and in winter in Amazonia by 2100.
- *Seth et al (2010)* verify nine couple models from the CMIP3 database against data from CPC Merged Analysis of Precipitation 1971-2000. The analyses then projects changes under the A2 scenario. Variable – precipitation in the South American monsoon by 2100.
- *Jones and Carvalho (2013)* characterize precipitation in South America with gridded data from the Climate Prediction Center unified gauge from 1979-2010 and project changes to the South American Monsoon System under the RCP8.5 scenario.

Temperature

Different models and projections have different results. According to RCP projections, the Amazon annual temperature could increase between 0.6°C and 2°C by the end of the century for the RCP2.6 scenario[127] (Figure 34), between 3-4 °C in RCP scenario 4.5 (Figure 35).[128] If emissions continue to rise throughout the 21st century (RCP8.5), the annual average temperature for the Amazon region could become 6°C warmer (RCP8.5).[129] Positive temperature trends are projected for all countries in the Amazon basin. The Amazon Basin is projected to have some of the highest increases in temperature due to climate change within the South American Continent, with the central Amazon area particularly affected (Figures 35 and 36).

Figure 34: Projected changes in annual average temperature for the period 2001-2100 (21st century)



Source: Marengo and Souza 2018, 5

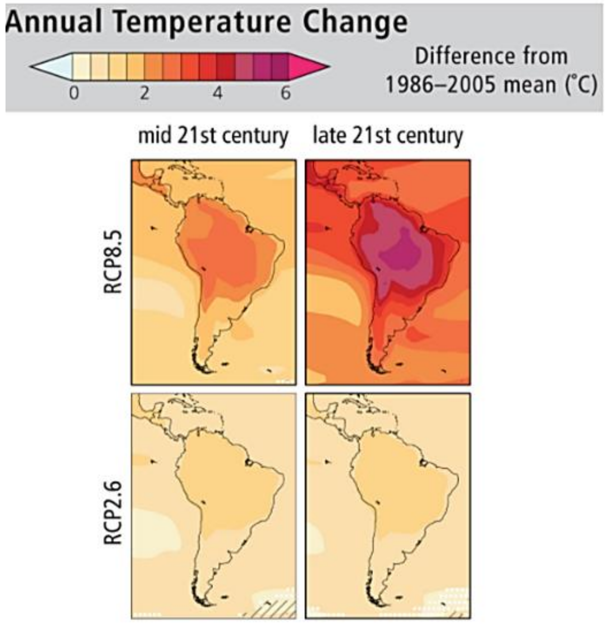
[126] Bombardi and Carvalho 2009.

[127] Magrin et al. 2014.

[128] Lyra and Sampaio 2016.

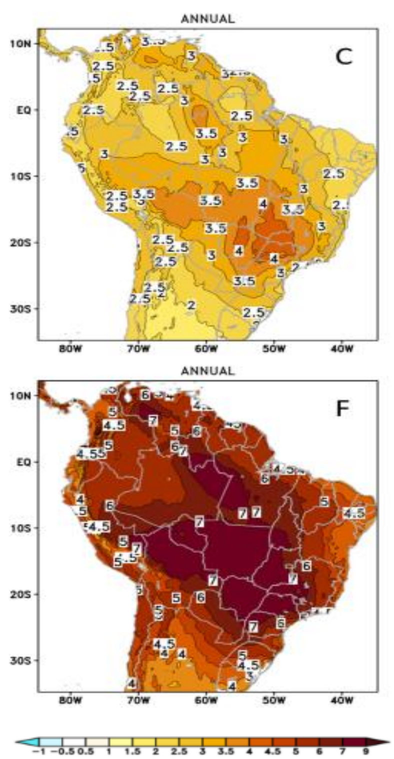
[129] Marengo and Souza, 2018.

Figure 35: Projected changes in annual average temperature for the period 2046-2065 and 2081-2100 (RCP2.6 and RCP 8.5)



Source: Magrin et al. 2014, 1513

Figure 36: Projected annual mean temperature (°C) difference between 1981-2005 and 2071-2098 simulated by the Eta-HadGEM2 for RCP4.5 (c) and RCP 8.5 (f)

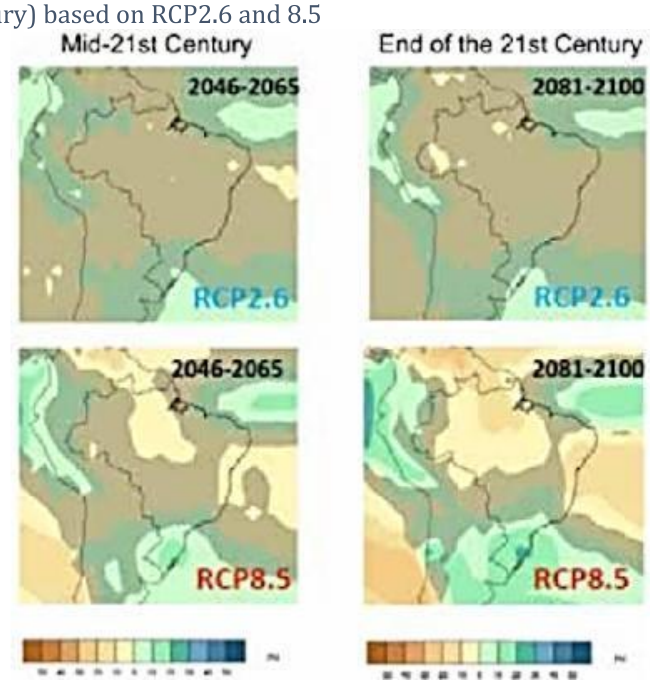


Source: Lyra and Sampaio 2016, 10

Precipitation

According to RCP2.6, RCP4.5 and RCP8.5 projections, the average annual precipitation in the Amazon region could decrease as much as 40% in some areas of central-north Amazon, while the central region could experience a decrease in precipitation of up to 20% (Figures 37-39).[130] Data collected from CORDEX South America predictions show variations and ensemble disagreement, as presented in Table 12. Precipitation is expected to increase 15% (RCP4.5) and 20% (RCP8.5) in some areas and decrease 11% (RCP4.5) and 25% (RCP8.5) by the end of the 21st century. An increase in aridity as well as in the longest dry spell are projected (Figure 30). Additionally, Zulkafli et al. (2016) project an increased severity of the wet season flood pulse in the western Amazon by 7.5% and 12% for RCPs 4.5 and 8.5 respectively for the 100-year floods.[131]

Figure 37: Projected changes in annual average precipitation for the period 2046-2065 (mid-21st century) and 2081-2100 (late-21st century) based on RCP2.6 and 8.5

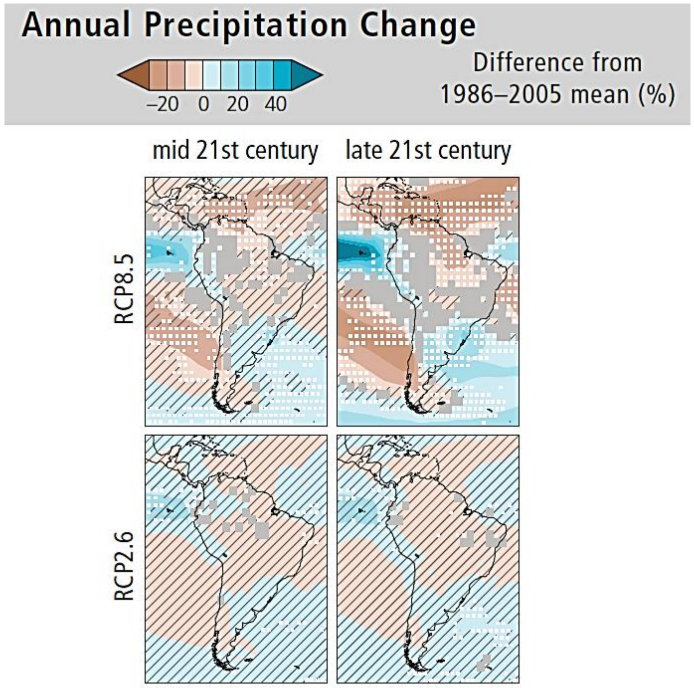


Source: Marengo et al. 2018, 4

[130] Marengo et al. 2018; Magrin et al. 2014, Lyra and Sampaio 2016.

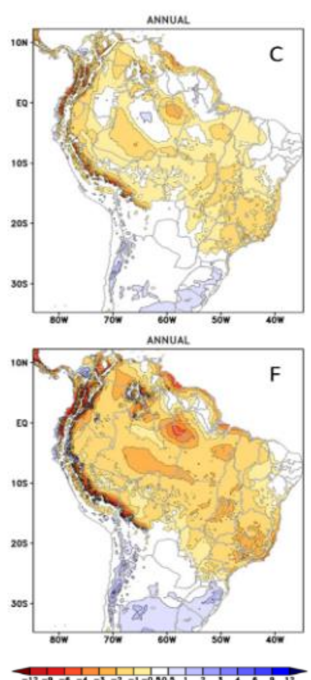
[131] Zulkafli et al. 2016.

Figure 38: Projected changes in annual average precipitation for the mid-21st century and late-21st century, according to Marengo et al. 2018



Source: Magrin et al. 2014, 1513

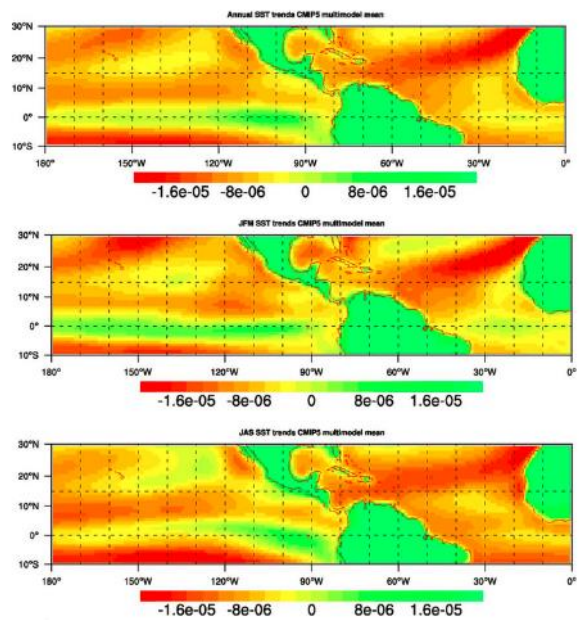
Figure 39: Projected annual mean precipitation (mm) difference between 1981-2005 and 2071-2098 simulated by the Eta-HadGEM2 for RCP4.5 (c) and RCP 8.5 (f)



Source: Lyra and Sampaio 2016, 10

Despite the insecurity in the projections, some studies such as Duffy et. al (2015) and Sorribas et al. (2016) note that projected trends in regional SST may act as proximate drivers of projected changes in hydrological variability over the Amazon basin (Figure 40).[132] These studies predict an increase in the occurrence and regional scale of droughts, while in the west, the opposite is predicted with an increase in mean annual precipitation. Nonetheless, CMIP5 projections from these two studies show that by 2100, the area affected by mild and extreme drought will nearly double and triple, respectively, for the entire Amazon basin.[133] Lyra and Sampaio (2016) further project a possible substitution of some areas of rainforest in the Amazon by deciduous forest types and grassland under the RCP4.5 scenario, and especially grassland in RCP8.5 scenario by the end of this century.[134]

Figure 40: Top: Relative trends in simulated SSTs or land skin temperatures, 1950–2099 (RCP 8.5); Bottom: Linear trends in simulated multimodal mean annual mean precipitation in the Amazon, 1950–2099 (RCP8.5)[135]

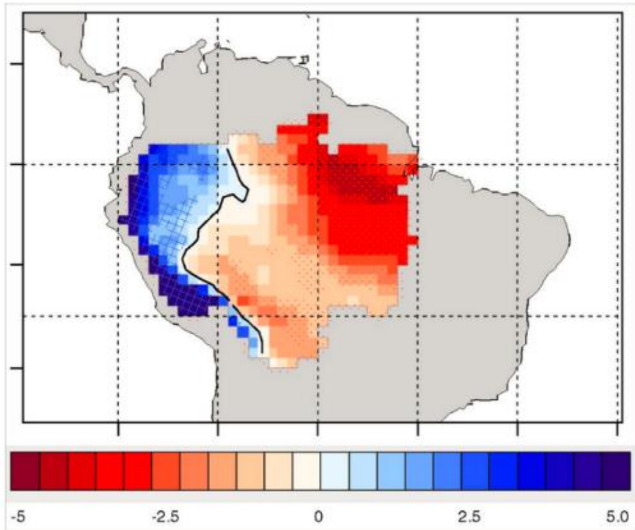


[132] Duffy et al. 2015.

[133] Duffy et al. 2015; Sorribas et al. 2016.

[134] Lyra and Sampaio 2016.

[135] The black line denotes zero trend; hatching (dots) indicate regions where >2/3 of models have a positive (negative) trend. Units are millimeters per day per century.



Source: Duffy et al. 2015

ENSO

Chen et al. (2017) indicate that, aside from the rising SST climatology, several aspects of ENSO that are reflected in SST anomalies are highly model based and largely beyond the spectrum of natural variance. The most robust shifts support eastward-propagating El Niño and La Niña. However, given multiple model biases for the twentieth century and a lack of model consensus for the twenty-first century prediction, future ENSO shifts are uncertain.[136]

Climate change projections within the program's timeframe

The following tables present a summary of values of the modelled climate change for the Amazon Basin, although it is important to note that there is substantial spatial variability throughout the Basin (as described in Section 2.3.1). As the program focuses on nature-based climate solutions to climate change, it is important to consider particularly medium- and long-term projections as it will take time for the for the project's investments to be established, and some investments will require several years (15-20 years) to reach their full potential in supporting climate change adaptation and mitigation (e.g. restoration of natural forest). As such, the description will zoom in on the time period from 2020-2050, with 2035 as a midpoint.

Table 12 presents an overview of date collected from CORDEX South America predictions while Table 13 shows estimated values for the programs specific timeframe read from the last IPCC report data. Temperature indicators show comparable increasing trends in the range of 1-2°C for RCP4.5 and 2-3°C for RCP8.5 in the next 30 years. Overall, projections on precipitation show high variability and a higher degree of uncertainty, although in general the Western Amazon may get more wet, and the Eastern Amazon more dry.

[136] Chen et al. 2017.

Table 12: Projected changes for various climate indicators for time periods: 2011-2040; 2041-2070 and 2071-2100 for RCP emission scenario 8.5; Model: CORDEX South America Ensemble Mean,

	2011–2040		2041-2070		2071-2100;	
	RCP 4.5	**RCP 8.5**	**RCP 4.5**	**RCP 8.5**	**RCP 4.5**	**RCP 8.5**
Temperature (annual mean)	0.70°C -1.1°C	0.61°C – 1.5°C	1.3°C - 2.4°C	1.8°C – 3.6°C	1.6°C - 2.9°C	3.1°C - 6°C
Max. Temperature	0.85°C - 1.4°C	1.3°C – 2.1°C	1.7°C - 3°C	2.7°C – 6.1°C	2°C - 3.5°C	5°C - 10°C
Min. temperature	0.4°C - 1.1°C	0.48°C – 0.72°C	0.9°C - 2.1°C	1.3°C – 3.5°C	1.3°C - 2.9°C	2.9°C - 4.3°C
Precipitation (annual mean)	Ensemble disagreement -1.8% - 6.4%	Ensemble disagreement -2.4% - 8.7%	Ensemble disagreement -6% - 13%	Ensemble disagreement -7% - 21%	-11% - 15%	Ensemble disagreement -25% - 19%
Aridity (actual)	Ensemble disagreement -3.3% - 11%	3.6% - 50%	Ensemble disagreement -3.1% - 21%	-3.3% - 26%	1.2% - 80%	0% - 83%
Precipitation: longest dry spell	-0.3% - 38%	3.5% - 43%	4.6% - 58%	-2% - 69%	13% - 81%	31% - 130%

Source: SMHI, Climate Information, https://climateinformation.org/, 20.04.2021[137]

Table 13: Estimated projections within the programs timeframe (CIMP5)

		2020-2050	Midpoint 2035
Temperature	**RCP 2.6**	1°C – 2.3°C	~ 2°C
	RCP 4.5	~2.5ºC	~2ºC
	RCP 8.5	2.1°C – 3.3°C	~ 3°C
Precipitation	**RCP 2.6**	-3%- 5%	~ -4%
	RCP 4.5	N/A	N/A
	RCP 8.5	-7%	~ -6%

Source: Magrin et al. 2014 (RCP 2.6 and 8.5); Marengo and Souza 2018 (RCP 4.5) (see above note on data limitations for RCP 4.5)

Climate-related natural hazards

- **Drought:** Increasing temperatures and changing precipitation regimes imply that much of the Amazon will become increasingly dry (increased length of the dry period) and increasingly exposed to droughts and extreme heat.[138] Trends toward an increase in occurrence and intensity of droughts are influenced by feedback loops with deforestation (see Section 2.3.5 which further discusses the tipping points and related drought-deforestation feedback loops), with areas in Brazil, and Peru particularly at risk.[139] The Andean foothills in Ecuador and Peru are also at risk from drought (*Figure* 41).[140]

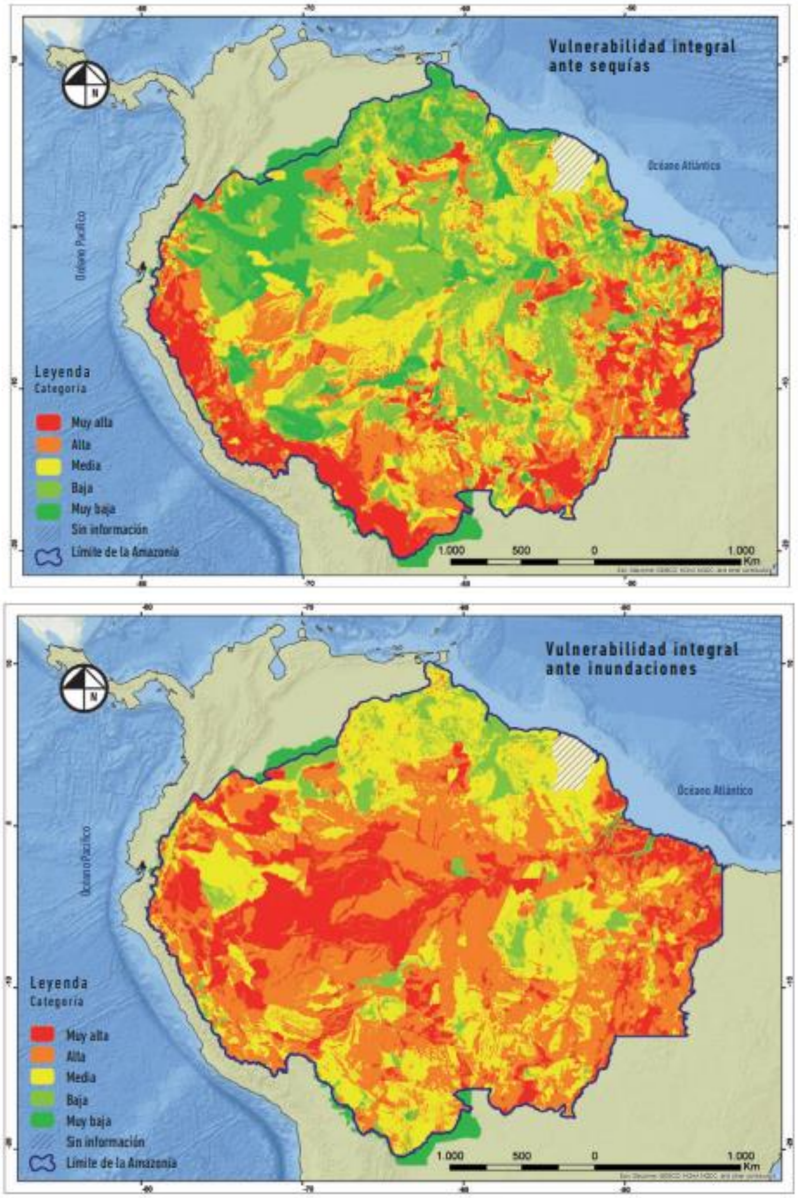
[137] These data show value ranges from different ensembles presented in https://climateinformation.org/ and spatial differences in the Amazon basin. Data were visualized in projection maps and compared to specific values in 6 points within the AB. Site and ensemble specific values can be found online at https://climateinformation.org/

[138] Marengo et al. 2013 in Prüssmann et al. 2016; USAID 2018.

[139] Staal et al. 2020.

[140] Pabón-Caicedo et al. 2016.

Figure 41: Vulnerability to drought (top) and floods (bottom) in the Pan Amazon



Source: Pabón-Caicedo et al. 2016, 45

Floods: Floods are projected to increase in the future, in terms of frequency and intensity.[141] This is likely to affect all countries in the Amazon basin. The Western Amazon in particular is expected to experience more frequent flooding in the rainy season, due to projected increases in precipitation. Deforestation is further exacerbate these trends, and contribute to intensified flooding.[142] IPCC Working Group II notes that there have not been widespread changes in the observed floods either in magnitude or frequency due climate change noting that socioeconomic losses from floods have increased to higher degrees of exposure and vulnerability. Floods, however, are projected to increase

141 Marengo et al. 2013 in Prüsmann et al. 2016.

142 Andrade Abe et al. 2018

in South America[143] even if there is a need to better understand how climate variability impacts flood risk and the ocean-atmosphere response mechanisms that lead to specific flood events[144].
An analysis focused on the Amazon show that under RCP4.5 and RCP8.5 scenarios the severity of the wet season flood pulse is projected to increase by 7.5% and 12.5% respectively for the 100 year return floods[145]. The analysis uses GCM projections but corrects them for biases in the following manner:
"The model output over the historical (1976–2005) and future projection (2006–2035, 2036–2065, 2066–2095) periods are bias-corrected using the equidistant quantile mapping adapted to river flows, using a coincident 22 yr (1984–2005) historical daily observations of river flows. In the quantile mapping, relative bias factor values are calculated at every 0.001 quantile between the cumulative distribution function (CDF) of the simulated flows for the historical period relative to the CDF of the observed flows. These quantile based change factors are then applied to the CDF of the projected flows to obtain the bias-corrected future"[146]. This approach corrects for both annual volumes and for the distribution of daily flows[147]. This is consistent with IPCC[148] outlining that the impact of droughts and floods are expected to vary across regions with "flood hazards increasing over more than half of the globe, in particular in central and eastern Siberia, parts of Southeast Asia including India, tropical Africa, and northern South America." Amongst the factors that can also have an impact over future projected floods is the rate of deforestation in the Amazon and its impact over the intensification of the hydrological cycle[149] and the potential impact of climate change over the seasonal and spatial variability in rainfall, as well as glacial melting.
Landslides: There is limited information on landslide risks and projections; however, deforestation on sloped areas, combined with increasing seasonal precipitation, is likely to increase the occurrence of landslides, especially in the Andean foothills of Ecuador and Peru.
Wildfires: Wildfires are expected to increase due to increasingly dry conditions and continued use of fire for clearing forest in the Amazon.150 The Southern and Eastern Amazon are particularly at risk of wildfires, and the risk will increase due to climate change projections indicating drier and warmer conditions. Working Group II for the IPCC Fifth Assessment Report (AR5, 2014), developed the following figures on forest fire danger index (FFDI), and the change in forest fire danger index from 1970-1999 to 2070-2099 (see Figure below). While the risk is low in the Amazon region during 1970-1999, by the end of the century it is projected to be more exposed to fire risks (especially under RCP 8.5).

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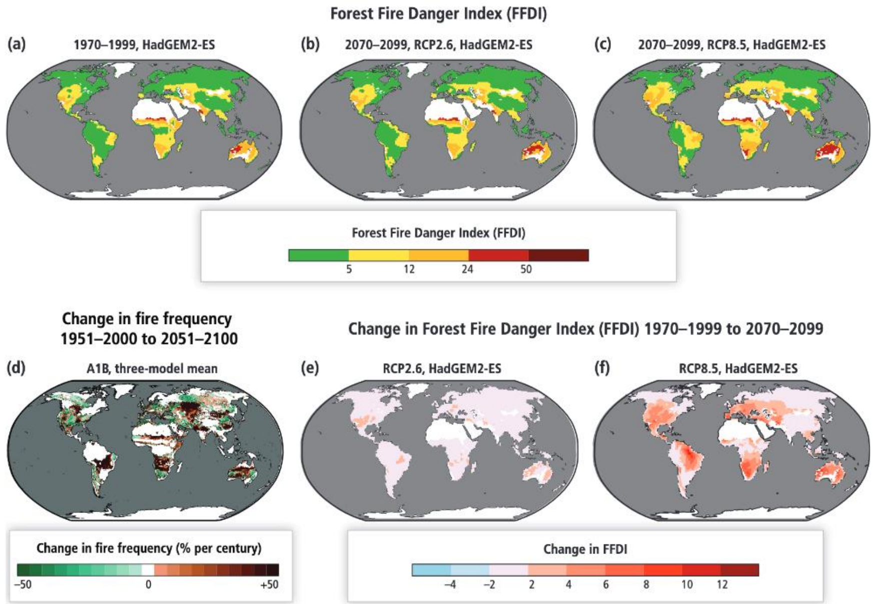
[143] IPCC, 2014
[144] Towner et al, 2020, p.27
[145] Zulkafli et al 2016
[146] Zulkafli et al, 2016, p. 3
[147] Zulkafli et al 2016.
[148] IPCC, 2014.
[149] Marengo, 2018 and Towner et al, 2020
[150] USAID 2018. De Faria et al. 2017

Figure 42. Change in forest fire danger index

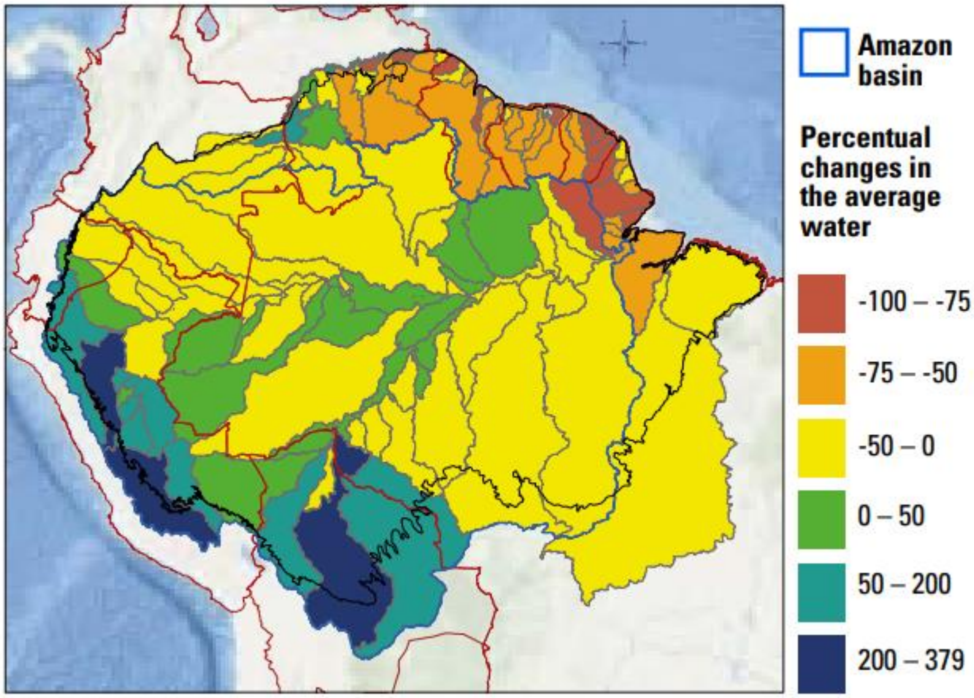


Source: IPCC, 2014.

Water scarcity: While all Amazon regions are currently ranked low to very low risk of water scarcity, with climate change, there are projected changes in water yields. Figure 43 shows that under the RCP 8.5 scenario, areas in the western and southern Amazon, especially in Peru, are expected to see large increases in water yields. At the same time, parts of the Northern Amazon (in parts of Northern Ecuador and Peru, as well as Colombia, Venezuela, Suriname, French Guyana and Guyana are expected to see larger declines in average water yields. Deforestation is also expected to contribute to not only flooding in the wet season, but also low-flow events in the dry season through reducing evapotranspiration, and reducing ground water recharge.[151]

[151] Andrade Abe et al. 2018

Figure 43: Projected percentual changes in future water yields under RCP8.5



Source: Skansi et al. 2013 in Prüssmann et al. 2016

2.4.5 Exposure and vulnerability

Chapter 2.2 of the FS provided an introduction to the people, livelihoods, ecosystems and resources in the Amazon that will are exposed to climate change. There are over 34 million people living in the Amazon basin, including over 3 million indigenous peoples,[152] many of which are dependent on agriculture, forests and other natural resources for their livelihoods. With over 115 million hectares of agriculture established in the Amazon Basin, the sector is both a driver of climate change (e.g., through clearing forested land, degrading natural forests and using unsustainable business as usual practices), yet is also particularly at risk due to climate change.

The following are some factors contributing to the varying degrees of sensitivity (a contributing factor to vulnerability) to climate change within the basin:

- Majority of soils in the Amazon Basin are highly susceptible to flooding, and low-slopes in majority of the basin further result in a physical susceptibility to flooding (Figure 44a).[153] In terms of hydrological endowment, the Western and Central Amazon region have conditions that are more susceptible to flooding than in the Eastern Amazon (Figure 44b).[154]

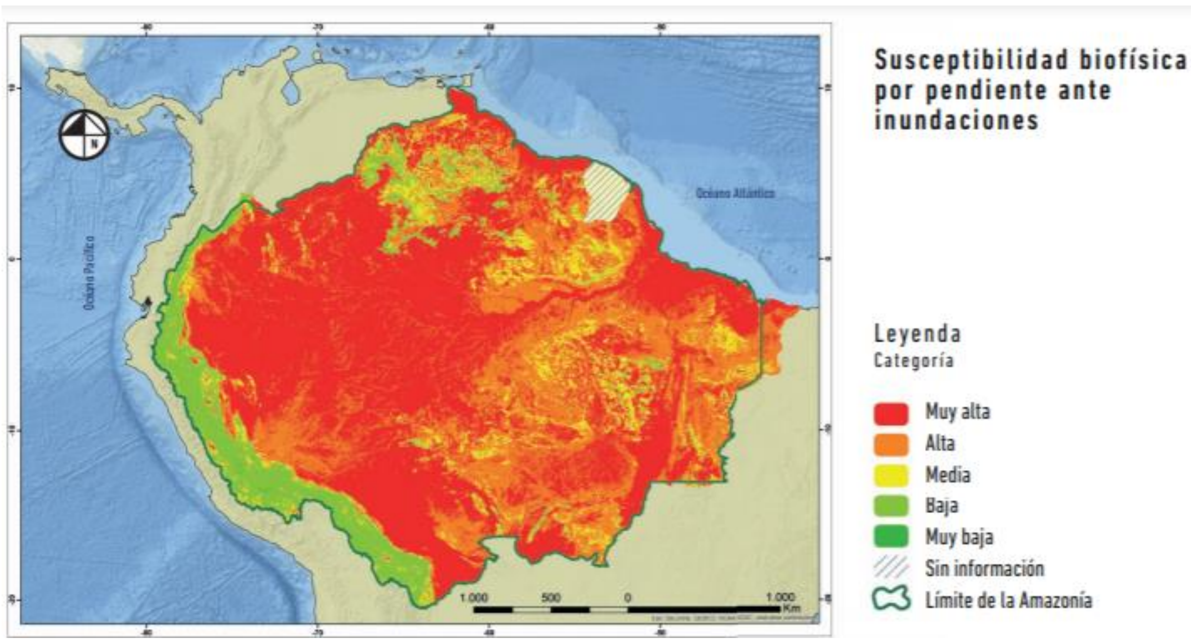
[152] USAID 2018.

[153] Pabón-Caicedo et al. 2018.

[154] Pabón-Caicedo et al. 2018.

- Southern and central Amazon have a more limited hydrological endowment making them particularly susceptible to droughts (Figure 44b).[155] In terms of soils, majority of the Amazon have soils with characteristics that make them have low susceptibility to droughts, with the exception of a few higher risk pockets located primarily in the Brazilian Amazon region.[156]
- Deforested and degraded areas are more sensitive to climate change, due to lack of vegetative cover, reduced forest and ecosystem health and the resulting decline in ecosystem services and function. Areas formerly affected by forest fires are also more sensitive to climate change, and more susceptible to recurrent burning as there is increased sunlight and drying of previously forested areas, which in turn increases the fuel load and ultimately the susceptibility of these areas to wildfires.[157]
- Intact forest areas in the Amazon Basin tend to have a lower sensitivity, as they are less impacted by degradation and pollution, and other anthropogenic impacts.[158]
- In terms of the economically active population engaged in the agricultural sector, majority of areas are considered to have a moderate to high sensitivity (Figure 46).[159]

Figure 44: Biophysical susceptibility of (a) slopes and (b) soil textures against floods in the Amazon Basin



a)

155 Pabón-Caicedo et al. 2018.

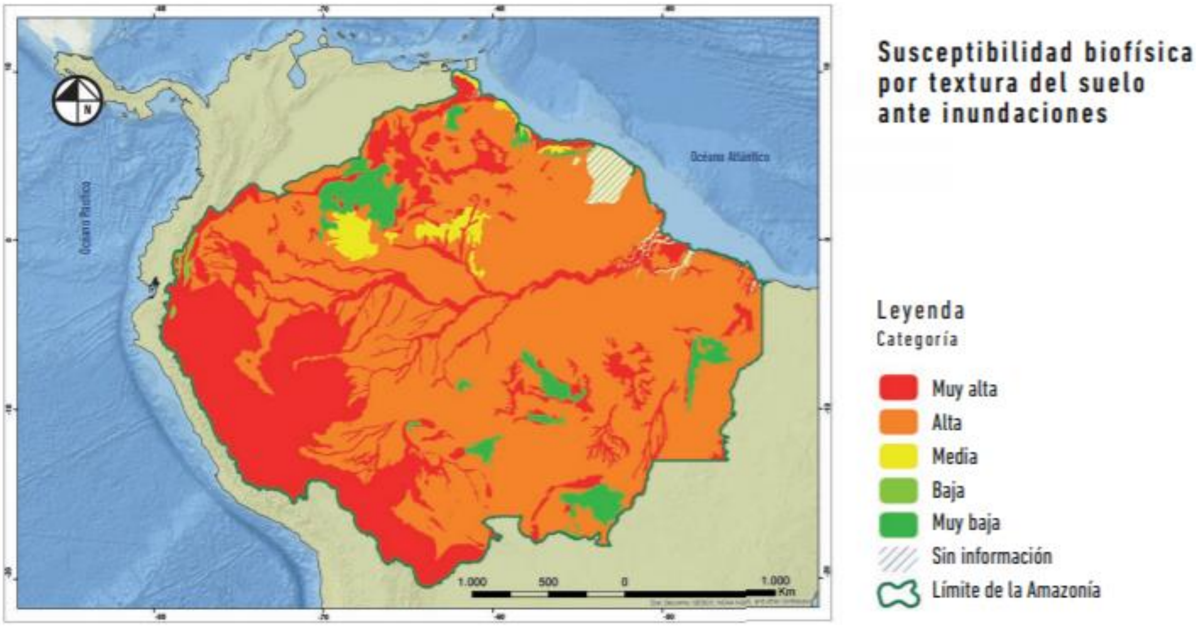
156 Pabón-Caicedo et al. 2018.

157 USAID 2018.

158 USAID 2018.

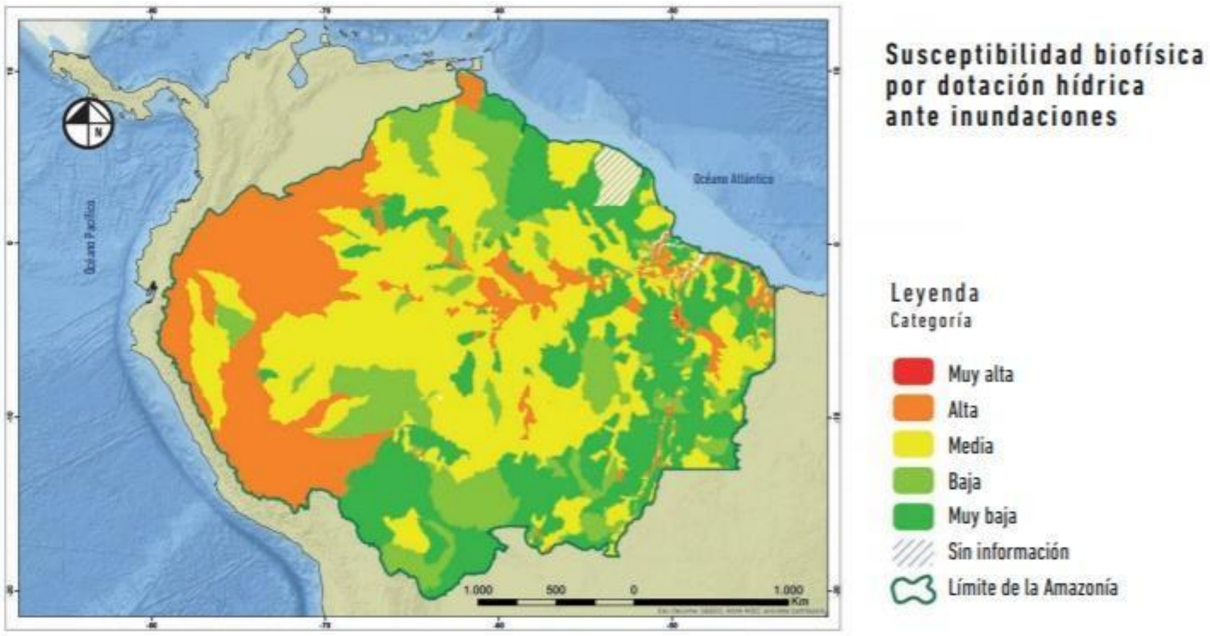
159 Pabón-Caicedo et al. 2018.

b)

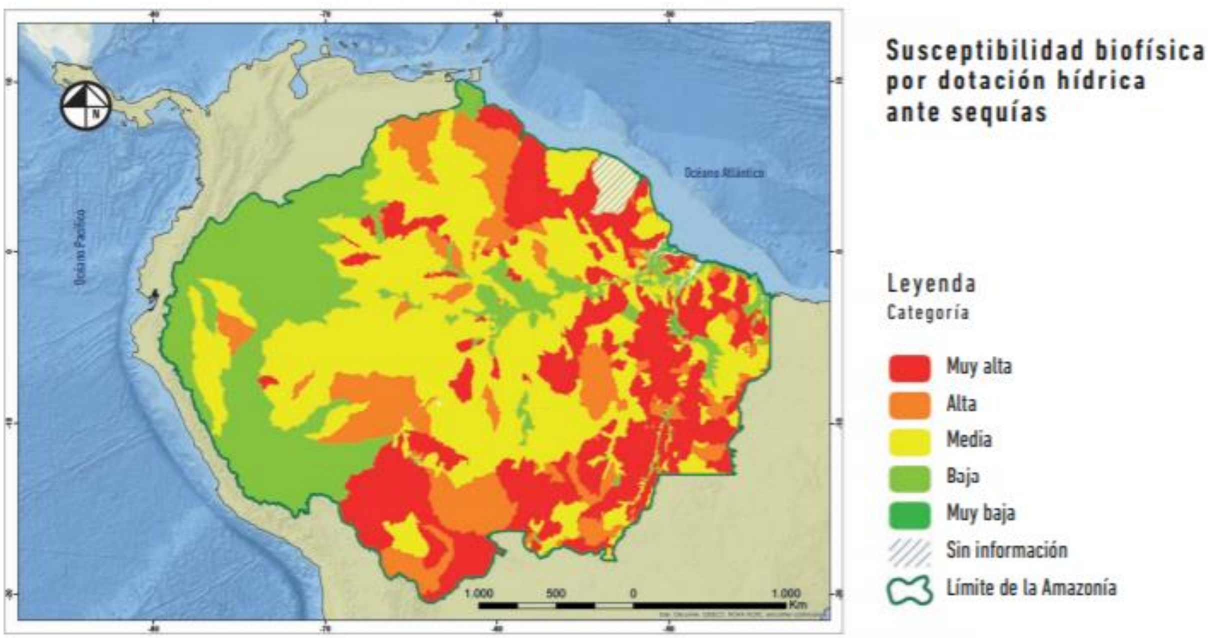


Source: Pabón-Caicedo et al. 2018, 42

Figure 45: Biophysical susceptibility in terms of hydrological endowment to (a) flooding and (b) droughts in the Amazon Basin



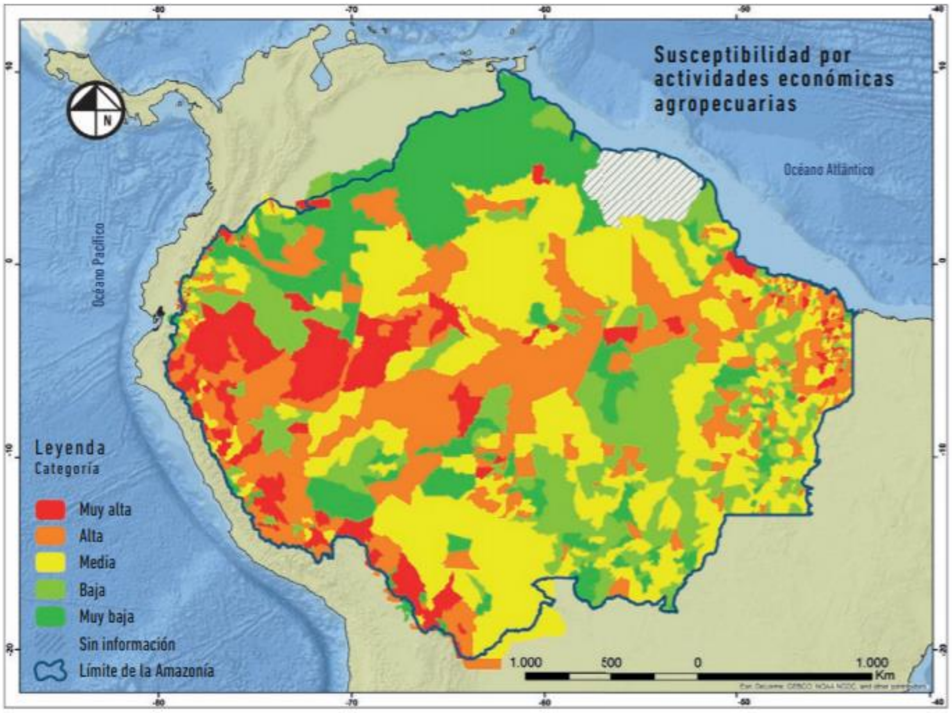
a)



b)

Source: Pabón-Caicedo et al. 2018, 42

Figure 46: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector



Source: Pabón-Caicedo et al. 2018, 41

Capacity

The Amazon region is vulnerable to climate change. In general there are low capacities to prepare for and respond to climate change and high sensitivity to climate change in the Amazon region. This is due to various factors:[160]

- Poverty levels tend to be above national averages in the Amazon region of most countries, [161] which limits the populations' ability to prepare for and respond to climate change.
- In general, in majority if not all of the target countries there is lower access to public services (e.g. health facilities, schools, among others), and lower investment in infrastructure (housing, roads, etc.). Housing and infrastructure is often vulnerable to climate change (e.g. damage from flooding), which limits coping capacity and disaster risk management. At the same time, limited public services also limits the ability of communities to plan for climate change, and cope with climate change (e.g. limited health services can be stretched thin in the case of a climate-related hazard/ emergency).[162] This is further exacerbated in more remote communities in the Amazon. As populated centers and communities in the Amazon are often located in more remote areas, it limits the populations' ability to evacuate during hazards, as well as the response time to receive government or external support during an emergency.

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[160] Note: It was not possible to find a comprehensive analysis of the capacity and sensitivity at the Amazon Basin level, and thus where possible citations from national and sub-national studies from target countries in the Amazon Basin will be highlighted.

[161] For example, 46% of households in the Colombian Amazon region have challenges maintaining their basic needs (above the national average of 28%; CEPAL et al. n.d.).

[162] Caldas et al. 2018.

- Limited climate information and hydro-met monitoring stations, limits forecasting[163] as well as early warning systems.
- Low adoption of more sustainable practices: While sustainable agriculture, forestry and other land use activities are in theory known, there is limited awareness and uptake of these practices among producers. This is due to various factors, which differ in relevance throughout the Amazon:
  - Insufficient access and use of climate information (to ensure matching of adaptation measures with localized climate information to reduce climate risk and vulnerability),
  - On average there are weaker institutional capacities on climate change in the region[164]
  - Minimal extension and technical support services within the region[165]
  - Poverty limits peoples' ability to invest in resilient practices (lack of time, financial and other resources)[166]
  - Limited access to finance/ credit[167]
  - When finance/ credit is available, there is often a tendency for banks and lenders to lend to business as usual practices (where sustainable practices may have lower returns, require more tailored financing packages, and may seem riskier to financial institutions from a financial perspective). [168]
  - In some countries there have been incentives to deforest/ clear land. This includes where (1) there are unclear or conflicting policies, regulations and ownership structures,[169] and (2) there is limited implementation of policies and/or monitoring and enforcement of clearing.[170]

In addition to these factors, ecosystem degradation and transformation further exacerbates vulnerability. The effects of increasing climatic exposure may deepen sensitive ecosystems with anthropogenic or intrinsic stressors (e.g., land-use change, open roads, and deforestation), which usually cause significant impacts on natural systems and may alter the ways ecosystems respond to climate change (e.g., erosion and sedimentation can contribute to an increased risk of flooding, exacerbated by projected increases in precipitation). Environmental contamination further limits communities' ability to respond to climate change. Examples of environmental contamination include pollution from artisanal mining and oil spills, among others, which may generate health impacts in local communities, and/or limit communities' use of available water sources, forests or other natural resources if contaminated, and ultimately increases their vulnerability to climate change.[171]

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[163] Each of the country profiles provides an overview of the available stations in the Amazon region, and it is clear the Amazon region has low-coverage in all of the target countries. However, forecasting and early warning systems, especially for drought forecasting methodologies and models has been improving in recent years (e.g., Ciemer et al. 2020 https://iopscience.iop.org/article/10.1088/1748-9326/ab9cff).

[164] For example, Colombia conducted an in-depth climate risk and vulnerability assessment, and found the departments in the Amazon were among those with the lowest adaptive capacity and highest sensitivity to climate change (IDEAM et al. 2017). This was partly due to limited adaptation plans for municipalities in the region, poor quality of infrastructure, quality of life and poverty, and a high anthropogenic pressure and transformation of ecosystems.

[165] Porro et al. 2012.

[166] See for example, Alves Menezes et al. 2018.

[167] Porro et al. 2012; Limited references are available for the Amazon region, however there are studies showing financing gaps in rural areas in South America (e.g., Roa 2015).

[168] See for example, CEPAL et al. n.d.

[169] GIZ 2016

[170] Carvalho et al. 2019.

[171] Caldas et al. 2018.

2.4.6 Climate risk/impact on the bioeconomy and local livelihoods in the Pan Amazon and beyond

It is evident that climate change will continue to have a major impact[172] on rural livelihoods and key sectors in the Amazon biome. With over 34 million people living in the Amazon basin,[173] it is critical to understand the diverse impacts and risks they face, in order to scale up targeted climate action to strengthen the resilience of their livelihoods and the ecosystems upon which they depend. The following highlights some of the adverse risks and impacts on the health and livelihoods of the local population as well as on vital ecosystems and key sectors in the Amazon region due to climate change:

Risk of injury and death due to climate change and climate-related hazards

- Climate change will affect the health and wellbeing of local populations in the Amazon, who often have lower access to medical facilities and related health services. Impacts could include: death or injury due to climate-related hazards (e.g. flooding, wildfires), health impacts due to smoke inhalation from forest fires, increasing disease outbreaks (e.g. cholera, vector-borne diseases),[174] and heat stroke, among others.[175]

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to impact production systems in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. Potential impacts could include changes in productivity, crop failure, increased or changing need for production inputs, increased plant evapotranspiration, losses and damages due to hazards (floods, droughts, fires), and pest and disease outbreaks.[176] It should be noted that impacts will vary, depending on the specific production systems and other factors (e.g., location, producer type, inputs used, infrastructure and equipment).[177] Fishery yields may also decrease due to reduced species diversity and reduced access to freshwater production areas.[178]
- Livestock production and health could be further at risk due to increasing temperatures and decreased feed (due to declining yields under climate change).[179]

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172 "*Impact* is the most general term to describe consequences, ranging from direct physical impacts of a hazard to indirect consequences for the society (so-called social impacts), which are finally leading to a risk." – GIZ and EURAC 2017, p. 17

173 USAID 2018.

174 UNDP 2017.

175 USAID 2018.

176 USAID 2018.

177 For example, in Brazil rice, maize, soybean and sugarcane yields are projected to decline by 14% with a 2°C increase in temperature, and by 31% with a 4°C increase in temperature (USAID 2018). In Madre de Dios Peru, a recent study found many people have been affected by severe drought and forest fires (e.g., in 2005), that resulted in loss of crops, reduced plantation and timber production, and loss and damages to NTFPs (e.g., shea, brazil nut, fruits; Chavez Michaelsen et al. 2020).

178 USAID 2018.

179 USAID 2018.

- Overall, given the vulnerability of the agriculture sector especially to increasing climate variability, a decrease in agricultural production can have cascading, cross-sectoral consequences across the Amazon basin. This may include an increase in land pressure from farmers around the Amazon territory, and an increase in urban migration, all of which can in turn exacerbate other climate-related risks.
- In addition to changing slow-onset climate trends, the sector is at risk from increasingly unpredictable and severe climate change-linked hazards, such as extreme drought, wildfire and flood events, which can impact food security. Extreme rainfall events in the Amazon region in 2020 and past years were reported to have affected the food security of indigenous peoples (e.g., due to crop rot and production failures, and restricted access to roads and other key infrastructure).[180] This may also limit access to food and foraging across the Amazon region. This is particularly relevant, given over 3 million indigenous people live in the Amazon basin, belonging to over 350 indigenous nationalities.[181]

Risk of damages and losses to infrastructure and homes

- Climate-related hazards could result in increasing losses and damages to communities in the Amazon, as well as infrastructure (e.g., housing, small-scale farms and tourism infrastructure). Sea level rise, storm surges, and river flooding will have substantial impacts on lowland livelihoods across the Amazon delta and mangrove ecosystem coastlines of Guyana and Suriname

Risk of biodiversity loss

- Higher temperatures and heat stress can alter the spread and survival of biodiversity, which is worsened by anthropogenic activities. In some cases, changes in the range and distribution of temperature sensitive species across the Amazon region and beyond are reported.[182] Climate change can further create improved conditions for invasive species.[183] A composite ecological risk index taking into account trends in deforestation, forest fires, urban spread, agriculture/livestock expansion, gas and mining concessions, and infrastructure development establish the southern Amazon basin area (spanning several Brazilian states) as the area with the highest risk.[184]

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[180] For example, floods in the Amazon region in 2020 were reported to have affected the food security of indigenous peoples in the Ecuadorian Amazon, where people were unable to forage and instead had to travel into cities to buy food. Given the covid-19 pandemic, this put indigenous communities and their elders at higher risk of contracting and spreading COVID-19 (Mongabay 2020).

[181] USAID 2018.

[182] Prüssman et al. 2016.

[183] USAID 2018.

[184] Prüssman et al. 2016.

Risk of loss of tourism revenues and tourist attractions

- The tourism sector may experience losses in revenue due to climate change due to diverse impacts including: loss and damages to tourism infrastructure,[185] outbreaks of vector and waterborne diseases,[186] changes in natural attractions (e.g. waterfalls, flooded rainforests).[187]

Risk of reduced energy security

- Changing precipitation regimes and water yields, exacerbated by deforestation, may result in reduced energy output from hydroelectric sources (e.g. due to reduced ground water recharge, increased surface runoff, reduced stream flow),[188] potentially threatening energy production and security in the region. This is expected to occur at the same time as demand for energy increases due to rising temperatures.[189]

Risk of loss and degradation to freshwater ecosystems and negative impacts on related livelihood activities

- Increased severity of drought can greatly affect the Amazon's freshwater ecosystems (reduced ground water recharge, increase in low-flows within the dry season) and the people that rely on them. Deforestation will further exacerbate negative impacts on water quality (e.g. increased sedimentation), and quantity. This will influence, among others:
    - Water availability for local populations[190]
    - Freshwater quality (sedimentation, pH, oxygen) and quantity for fisheries
    - Transportation of goods and persons (especially in areas dependent on riverways for transportation and navigation)
    - Freshwater ecosystem health and biodiversity.[191]

Risk of ecosystem transformation and loss of ecosystem services

- Beyond this, deforestation and forest degradation in the Amazon exacerbate the impact of climate change on ecosystems and local communities. Deforestation leads to increasing erosion and sedimentation, which can in turn increase flood risks and soil degradation. The conversion of forests into savannah or grasslands potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness, which reduce evapotranspiration and ultimately rainfall recycling. Forest degradation may also contribute to pest and disease outbreaks and to reduced provision of other key ecosystem services. Studies across the Amazon have shown a negative correlation between growth rates of trees and increases in annual average temperature, annual maximum temperature, and intensity

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[185] For example, at the national level in Peru, accumulated losses in the tourism sector from 2011 to 2100 could reach 1.1% of the national GDP (IDB and CEPAL 2016a)

[186] For example, Zika was introduced to Brazil in 2013, and the 2015 and 2016 outbreak in the Americas likely resulted from favorable climate conditions, partially caused by El Niño. Overall, Zika is reported to have contributed to an estimated $644–$888 million direct loss to Brazil's tourism sector between 2015 and 2017 (UNDP 2017).

[187] Ministry of Agriculture 2012; J-CCCP 2018; Hickey and Weis 2012.

[188] Mohor et al. 2015 and Mendes et al. 2017 in Andrade Abe et al. 2018

[189] USAID 2018.

[190] Andrade Abe et al. 2018

[191] Andrade Abe et al. 2018

of the dry season. This will result in stress and reduced net primary production and cause impacts to ecosystem function and structure as well as cause fragmenting forest margins. These areas are then more vulnerable to stresses such as increased wind speed, turbulence, elevated temperatures, reduced humidity, increased sunlight, increased drought, and fire risk.[192]

- The effects of increasing climatic exposure may deepen sensitive ecosystems with anthropogenic or intrinsic stressors (e.g., land-use change, open roads, and deforestation), which usually cause significant impacts on natural systems and may alter the ways ecosystems respond to climate change (e.g., erosion and sedimentation can contribute to an increased risk of flooding, exacerbated by projected increases in precipitation).

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[192] Bovolo et al. 2011.

Table 14: Overview of potential climate change impacts on key sectors in the Amazon region

Sector	Potential impact
Perennial Agriculture and Agroforestry (e.g. coffee, cocoa, avocado, fruits)	Coffee: Zones better suited for arabica coffee migrates upwards by about 500m in elevation, with negative ecosystem impacts (Bunn et al, 2015; Ovalle-Rivera et al., 2015). Reduction in 60% of area suitable for coffee production in Brazil (Gomes et al, 2020). Cocoa: Higher temperatures and erratic rainfall changes cocoa farming suitability and causes yield reduction (Lahive et al., 2019; Bunn et al, 2019). There is a reduction in current suitable cacao production areas, and a migration of suitable areas for cocoa production with negative ecosystem impacts. ▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures and reaching of upper heat thresholds ▪ Pest and disease outbreaks ▪ Changes in crop yields and productivity of key crops (particularly soybeans and cotton [moderate decline] and maize, wheat [large decline]) in inland areas ▪ Decline in livestock health and production due to increasing temperatures ▪ Increase in consecutive dry days will have severe impact on rain-fed agriculture ▪ Decrease in proportion of arable land and fertile soils
Native palm-perennial agricultural systems (Value chain Açaí)	▪ Interruptions to Açaí palm growth cycle from warmer temperatures and reaching of upper heat and water stress thresholds, new pest and disease outbreaks, and changes in crop yields and productivity. Higher temperatures combined with drought conditions may increase fruit abortion. Evidence of a decline in Açaí production during hot years that is largely attribute to regional temperature increases of around 1.5 °C in recent decades. Açaí producers estimate production losses of one to 40% of normal production (Tregidgo et al. 2020)
Non-timber forest products (NTFPs)	▪ Studies indicate that a warming, drying climate will reduce the mean net primary productivity (NPP) by approximately 52% by 2050 under a medium–high GHG emissions scenario. When the direct effects of CO_2 on plant physiology are included, NPP still reduces but to a lesser extent of 33% due to the enhancement of photosynthesis by CO_2 fertilization (Esquivel-Muelbert et al. 2018). Decrease in quality and availability due to inadequate growing conditions and pest and disease outbreaks (Oxfam, 2020); ▪ Decrease in NTFP quality and availability (particularly traditional medicines, essential oils, açaí berries, Brazil nuts, etc.) due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks (e.g.Chavez Michaelsen et al. 2020)
Aquaculture and fisheries	▪ Changes in the ecological balance that provides sustenance for fish; decreased availability of nutrients in the water; alteration of the reproductive behaviour of the species; degradation of areas that offer shelter to fish; migration of fish to other regions; decrease in river flows (Herrera et al, 2015). Loss of 1 km² of floodplain forest induces up to 9% decreasing in fish catches (de França Barros et al 2020). The size of fish species in the Amazon is negatively correlated to drought intensity (Fabré et al, 2017) ▪ Annual recurring drought events threaten water quality and quantity for fisheries sector (BID-DNP-CEPAL 2014)

	▪ Water quality deterioration severely threatens large areas of Amazon fresh water and fisheries. Includes changes in pH and oxygen due to drier conditions from prolonged drought, combined with increased evapotranspiration due to increased temperatures (Frederico et al. 2016) ▪ Sea level rise threatens marine fisheries (reduction in fish stocks and loss of incomes and nutrition for local communities) ▪ Sea level rise and increasing temperatures have adverse impacts on mangrove forest aquaculture
Tourism	• Damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) and trip cancellations (Simpson et al. 2008 in Government of Guyana 2012; MINAM 2016); • Damage to forest resources (tourism hotspots) due to wildfires; • Reduced attractiveness of tourism in areas with increasing disease incidence (zika, malaria, dengue; Government of Guyana 2012; MINAM 2016); • Decreased attractiveness of key tourism features (waterfalls) due to precipitation variability (Government of Guyana 2012); • Reduced attractiveness of eco-tourism opportunities contingent on unique species (giant otter (*pteronura brasiliensis*), macaws (*ara sp),* spider monkeys *(ateles sp.)*, etc.) that are highly vulnerable to climate change. • Damage to coastal forests (mangroves) and infrastructure from sea level rise and riverbank inundation (Government of Guyana 2012)
Ecosystem regulation services	▪ Deforestation and forest degradation bring the Amazon closer to its "tipping point" (Marengo and Souza 2018), where it is projected that the ecosystem will transition to a "drier savannah-like ecosystem" (TNC, 2020); risk of biodiversity loss (threatened flora and fauna species) due to changes in habitat (Sales et al., 2020); changes in ecosystem functions, including regulation and cultural services; risk of reduced ecosystem capacity to regulate key hazards (flood, drought). ▪ The transition to a savannah like ecosystem will result in the loss of key ecosystem services (including carbon storage), which will be continually spread due to climate change and drought-deforestation dynamics. This is expected to contribute to forest die back and may result in a drastic change in ecosystem structure (Marengo and Souza 2018). ▪ Decrease in biodiversity (threatened species) due to changes in habitat and changing climatic conditions, and endangerment of key flora and fauna ▪ Increase in spread of invasive species due to deteriorating ecosystem health (WWF n.d.). ▪ Loss of key ecosystem functions including regulatory, production and cultural services. ▪ Reduced ecosystem capacity to regulate key hazards (flood control and drought resilience) e.g., mangrove forests that serve as breeding grounds for marine species and double as natural barriers to prevent flooding and erosion. ▪ Local species adapted to seasonal flooding may not cope with changing flood patterns
Forests	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling; Slow shift to a more dry-affiliated forest genera in the Amazon (Esquivel-Muelbert et al, 2018); With more extended or intense periods of soil water deficit, large trees and those with low wood density may be at greatest risk of hydraulic failure due to cavitation (McDowell & Allen, 2015; Rowland et al., 2015). Large trees have been

	shown to be particularly affected by artificially-imposed drought (McDowell & Allen, 2015; Nepstad et al., 2007; Rowland et al., 2015) and drought events (Bennett et al., 2015; Phillips et al., 2010). This will result in a decline in forest productivity, tree growth and reforestation viability. ▪ Loss of carbon stocks, and increased emissions due to deforestation and forest degradation (Government of Guyana 2012) ▪ Reduced evapotranspiration and rainfall recycling (Staal et al. 2020) ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather (Government of Guyana 2012) ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume (Nepstad et al. 2004) ▪ Tree mortality due to invasive species, forest fires, pathogens (Government of Guyana 2012), excessive heat and dryness, especially along forest edges ▪ Forest degradation and interruptions to landscape connectivity ▪ Deforestation-drought cycles will increase the risk of increasing intensity and frequency of wildfires (driven by anthropogenic use of fire for land clearing), resulting in biodiversity loss, and the loss of ecosystem functions (USAID 2018. De Faria et al. 2017) ▪ Increased conflict/land use competition with and forest-adjacent communities ▪ Deforestation and climate change may trigger forest dieback and transition to savannah ecosystems (Marengo and Souza 2018)

Source: Own elaboration based on multiple sources, including World Bank CC Portal; USAID 2018; Prüssman et al. 2016; Suarez et al. 2015

2.4.7. Climate change benefits from bioeconomy investments

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g., country, region, site-conditions), many of the program's investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Maintained or improved ecosystem services (provision, maintenance, enhancement)
- Scaling up and replication of climate-resilient agriculture, forestry and other land-use activities (e.g., agroforestry, ecotourism)

These impacts are in line with target countries' NAPs, NDCs, and climate change strategies. In addition, the program will help address a critical gap for climate change mitigation and adaptation – insufficient and often not adequately aligned public finance. By mobilizing private sector finance, the program will help create additional incentives and commitment to catalyze sustainable investments in the bioeconomy.

It is recommended that the program align itself with ongoing processes and initiatives to enable integrated action toward climate adaptation. Specifically, it is recommended that the program's investments are accompanied by:

- climate-informed land-use planning, disaster risk reduction (DRR) and disaster risk management (DRM) planning (e.g., selection of drought-tolerant varieties in drought-prone areas, integration of climate-resilient infrastructure for tourism);
- Improved and aligned policy frameworks that facilitate the adoption and upscaling of climate change mitigation and adaptation;
- improved information dissemination and technical assistance to inform of suitable low-carbon and climate-resilient practices; and
- the design and use of integrated monitoring systems that consider both mitigation and adaptation.

These systems will help ensure the effective design of adaptation measures (matching climate change projections with local conditions and contexts), facilitating the adoption of measures that strengthen the resilience of ecosystems and local livelihoods. Responsive monitoring systems will further facilitate adaptive management, monitor maladaptation and other adverse risks, and facilitate learning, and the exchange of experiences and best practices.

Table 15: Climate change mitigation and adaptation interventions and benefits associated with bio-economy

Sector	Adaptation interventions and benefits	Mitigation interventions and benefits
Perennial Agriculture and Agroforestry (e.g. coffee, cocoa, avocado, fruits)	▪ Interventions: Agroforestry system combining food crops, fruit species, native tree species, and timber trees; manual weeding, composting, mulch; irrigation and water management by rudimentary drip irrigation; integrated pest management (IPM), phytosanitary measures (Bunn et al, 2019). Shade trees can decrease the mean daily temperature by up to 4 °C (50% shade can decrease temperature by 2−3 °C (Gomes et al, 2020)). Optimal tree cover, fertilization and irrigation adaptation practices could help prevent yield drops. Improved planting material, and management practices, would also reduce climatic stress. ▪ Benefits: Optimal tree cover and irrigation adaptation practices could help prevent yield drops. 30-40% canopy cover can increase yield by 22%. Better water management can increase yields (+73%) and trenches reduce soil erosion and flooding during intensive rainfall. Improved planting material, and management practices, would also reduce climatic stress. Correct quantity and timing of fertilizer application to avoid soil depletion can increase yields by 130%; IPM can raise yields by 25% (Bunn et al, 2019). ▪ Sustainable alternative to unsustainable livelihood activities (e.g., agricultural expansion, logging, mining)[193]	▪ Interventions: Agroforestry system combining food crops, fruit species, native tree species, and timber trees; manual weeding, composting, mulch. ▪ Benefits: Agroforestry systems can mitigate the effects of climate change and maintain 75% of the area suitable for coffee production (Gomes et al, 2020). The converted and new coffee and cacao agroforestry areas should reach an additional 1.5 tCO2/ha/year sequestration in low productivity conditions and up to 15.2. tCO2/ha/year sequestration for plantations established on degraded land. ▪ Increased carbon sequestration through trees and soil organic carbon (either renewal or expansion to non-forested areas)[199]

[193] Porro et al. 2012

[199] Porro, R., Miller, R.P., Tito, M.R., Donovan, J.A., Vivan, J.L., Trancoso, R., Van Kanetne, R.F., Grijalva, J.E., Ramirez, B.,L., Goncalves, A.L. 2012. Agroforestry in the Amazon Region: A Pathway for Balancing Conservation and Development. Agroforestry - the Future of Global Land Use, Advances in Agroforestry, 9: 391-428

	▪ Agroforestry trees can support the formation of micro-climates that can help buffer increasing temperatures and changes in precipitation[194] ▪ Agroforestry on non-forested land will also increase vegetative cover, which can limit soil degradation, erosion and sedimentation, improve soil health, while also supporting biodiversity conservation, and maintaining ecological integrity[195] ▪ Diverse agroforestry production systems can provide diverse income streams, and increase coping capacities[196] ▪ Support the recharge of hydrological systems on deforested landscapes or degraded landscapes[197] ▪ Increased change of crop productivity and survival through selection of climate-resilient species[198] ▪ Selection of certain crop varieties can return nutrient content to soil	
Native palm-perennial agricultural systems (Value chain Açaí)	▪ <u>Interventions</u>: Intensification of production, through optimal fertilization and micro-aspersion irrigation, as well as support to best practices including new cultivars, scheduling production to coincide with periods of low natural forest acai production, among others. (Oliveira et al. 2016, EMBRAPA, 2019). ▪ <u>Benefits</u>: Native palms, as a perennial woody crop, can increase canopy cover and limit soil degradation, erosion and sedimentation, improve soil health, while also supporting biodiversity conservation, and maintaining ecological integrity at the landscape level. Irrigation more than doubles productivity of Açaí cultivation (EMBRAPA, 2019).	▪ <u>Interventions</u>: Use of deeper-rooted species and non-crop trees with crops ▪ <u>Benefits</u>: Increased productivity is accompanied by above and below ground carbon stocks increases, reaching an additional 6.1 tCO_2/ha/year sequestration/ avoided.
NTFPs (e.g., Brazil nuts [*Bertholletia sp.*], Açaí [*Euterpe sp.*], Morete	▪ <u>Interventions</u>: Enrichment and active management (climate information management to anticipate management responses), as well as landscape level conservation approaches, and favor crossed pollination by maintaining natural forest cover. Research and monitoring of forest conditions and composition are also an	▪ <u>Interventions</u>: Protection of forest through intensification of forest-based NTFP value chain utilizing Brazil nut enrichment and other non-timber forest product best management practices (optimization of collection paths, in situ drying racks, among others).

[194] Verchot et al., 2007 and Mbow et al., 2014 in Vi Skogen. 2019. Agroforestry for Mitigation and Adaptation to Climate Change. Available online: https://www.siwi.org/wp-content/uploads/2020/02/Agroforestry-for-adapation-and-mitigation-to-climate-change_web.

[195] Verchot et al., 2007 and Mbow et al., 2014 in Vi Skogen. 2019. Agroforestry for Mitigation and Adaptation to Climate Change. Available online: https://www.siwi.org/wp-content/uploads/2020/02/Agroforestry-for-adapation-and-mitigation-to-climate-change_web.

[196] Vi Skogen. 2019. Agroforestry for Mitigation and Adaptation to Climate Change. Available online: https://www.siwi.org/wp-content/uploads/2020/02/Agroforestry-for-adapation-and-mitigation-to-climate-change_web.

[197] Vi Skogen. 2019. Agroforestry for Mitigation and Adaptation to Climate Change. Available online: https://www.siwi.org/wp-content/uploads/2020/02/Agroforestry-for-adapation-and-mitigation-to-climate-change_web.

[198] Porro, R., Miller, R.P., Tito, M.R., Donovan, J.A., Vivan, J.L., Trancoso, R., Van Kanetne, R.F., Grijalva, J.E., Ramirez, B.,L., Goncalves, A.L. 2012. Agroforestry in the Amazon Region: A Pathway for Balancing Conservation and Development. Agroforestry - the Future of Global Land Use, Advances in Agroforestry, 9: 391-428

[*Mauritia sp*.])	important part of the strategy to adequately adapt to the change processes at hand, considering the many uncertainties. ▪ Benefits: Enrichment and active management would increase productivity of Brazil nut forests and other NTFPs as it responds to external ecosystem stressors from climate change. ▪ Provision of diverse and supplementary income streams, particularly if value addition is possible, thus increasing local communities' ability to buffer against sudden natural or economic shocks. (e.g., medicinal plants, berries, etc.)[200] ▪ Certain products (e.g., wild plants) can supplement/enrich diet and contribute to food security	▪ Benefits: Reduced emissions from reduced agricultural encroachment and other illegal deforestation. Reduced degradation of natural forests for NTFPs[201]. Carbon sequestration through trees and soil organic carbon[202] Enrichment in Brazil nut concessions, especially those that have been subjected to logging or agricultural induced degradation, could lead to increased carbon stocks equivalent to 5 tCO_2/ha/year.
Native species Aquaculture and fisheries	▪ Interventions: Improvement of infrastructure, management practices and feed quality in aquaculture growing of in-demand local fish species (*Colossoma sp*. and other ´round fish´) in small-scale operations (fish from aquaculture management and managed sustainable fisheries). ▪ Benefits: *Colossoma sp*. and other ´round fish´ are a resilient fish species, used to high temperatures and still waters often encountered in aquaculture operations. Growing in-demand local fish species in small-scale operations reduces pressure on native wild fish populations, hence improving aquatic biodiversity, while waste stream water can be reused as fertilized irrigation water. Diet and income diversification for local communities (McGrath et al, 2020). ▪ Growing resilient/in-demand species in small-scale operations reduces pressure on native fish populations and improves aquatic biodiversity[203] ▪ Multiple uses for water (aquaculture, fertilizer, irrigation, etc.)	▪ Interventions: Growing in-demand local fish species (*Colossoma sp*. and other ´round fish´) in small-scale operations to substitute beef protein. Other measures as part of aquaculture and managed fisheries such as efficient energy (fuel) and raw material use, use of waste products for biodiesel, efficient post-harvest and distribution systems. ▪ Benefits: At the jurisdictional/landscape level the sector can convert to net emissions sink by substituting consumption of more emissions intensive protein sources, like beef, reducing emissions by 1.4 tCO_2/ha/year. ▪ Potential for reduced emissions through efficient energy (fuel) and raw material use, and use of waste products for biodiesel ▪ Potential for reduced emissions through efficient post-harvest and distribution systems. ▪ Emissions reductions from substitution of more emissions intensive protein sources like beef.

[200] Simelton et al., 2015 in Vi Skogen. 2019. Agroforestry for Mitigation and Adaptation to Climate Change. Available online: https://www.siwi.org/wp-content/uploads/2020/02/Agroforestry-for-adapation-and-mitigation-to-climate-change_web.

[201] Porro, R., Miller, R.P., Tito, M.R., Donovan, J.A., Vivan, J.L., Trancoso, R., Van Kanetne, R.F., Grijalva, J.E., Ramirez, B.,L., Goncalves, A.L. 2012. Agroforestry in the Amazon Region: A Pathway for Balancing Conservation and Development. Agroforestry - the Future of Global Land Use, Advances in Agroforestry, 9: 391-428

[202] Porro, R., Miller, R.P., Tito, M.R., Donovan, J.A., Vivan, J.L., Trancoso, R., Van Kanetne, R.F., Grijalva, J.E., Ramirez, B.,L., Goncalves, A.L. 2012. Agroforestry in the Amazon Region: A Pathway for Balancing Conservation and Development. Agroforestry - the Future of Global Land Use, Advances in Agroforestry, 9: 391-428

[203] E.g. Growth of resilient/in-demand species in small-scale operations (such as tilapia) reduces pressure on native fish populations, and improves aquatic biodiversity. Use of additional best practices, e.g. establishing fishing calendars based on local and ancestral knowledge, can further strengthen adaptation benefits.; BID-CEPAL-DNP. 2014. Impactos Económicos del Cambio Climático en Colombia - Síntesis. Washington D.C.: Banco Interamericano de Desarrollo. Available online: https://www.cepal.org/es/publicaciones/37879-impactos-economicos-cambio-climatico-colombia-sintesis

	▪ Reduce nutritional deficiencies and support food security, reduce need to spend on and consume store bought food[204] ▪ Supplementary/diversified incomes ▪ Reforestation and watershed management will further reduce erosion and sedimentation that adversely impacts fisheries. It may also improve dry season flow, reduce impacts from flash flooding, support stream temperature regulation, and ensure continued provision or improvement of aquatic habitats and conditions (nutrients, oxygen, pH, etc.)[205]	
Wilderness and traditional use (community-led nature tourism)	▪ Activities: Community-led nature tourism ▪ Benefits: Well-organized community-led nature tourism can lead to cultural revival and economic diversification of local and indigenous communities (Izurieta et al, 2021). It can lead to jobs, income and social inclusion (Hoefle, 2016). It is inherently aligned with keeping natural forests and all their biodiversity in place and promotes ecosystem-based adaptation and resilience. Though nature tourism is vulnerable to outside shocks (e.g., COVID) it is also one of the key areas that can have a quick recovery in high forest landscapes once the economic recovery is underway. ▪ Economic diversification for local communities[206] ▪ Maintained or improved forest cover will help provide micro-climate and supporting buffering of changing climatic conditions, and will further protect soils from erosion, and sedimentation ▪ Ecosystem-based adaptation, combined with ecotourism, can help strengthen the resilience of tourism infrastructure	▪ Activities: Community-led nature tourism ▪ Benefits: The establishment of nature tourism operations and the ensuing protection of forests and wildlife species for observation by visitors leads to habitat conservation and avoided deforestation (Butts and Sukhdeo-Singh, 2010; Lorencini and Gomes, 2018). This avoided deforestation ´halo´ effect is estimated to lead to increased carbon stocks equivalent to 1.87 tCO_2/ha/year. ▪ Forest conservation resulting reduced deforestation and forest degradation, and additional carbon sequestration through forest restoration activities[207]
Ecosystem regulation services	▪ Interventions: Landscape-level interventions towards forest conservation and investments that reduce deforestation and forest	▪ Interventions: Sustainable Forest management and forest conservation and

204 E.g. Annual recurring drought events threaten water quality and quantity for fisheries sector, leading to water quality deterioration (changes in pH, oxygen, temperatures). For example, in Madre de Dios, this aquaculture was ranked as one of the most vulnerable livelihood activities. Fishing was further found to be particularly affected by drought and floods, and to a lesser extent by fire, cold fronts and high temperatures (Chavez Michaelsen, A., Huamani Briceño, L., Vilchez Baldeon, H., Perez, S.G., Quaedvleig, J., Rojas, R.O., Brown, F.I., Pinedo Mora, R. 2020. The effects of climate change variability on rural livelihoods in Madre de Dios, Peru. Regional Environmental Change, 20(70): https://doi.org/10.1007/s10113-020-01649-y). This can impact food security in communities dependent on fish for protein (MINAM, Ministerio del Ambiente. 2016. Tercera Comunicación Nacional del Perú a la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Available online: https://sinia.minam.gob.pe/documentos/tercera-comunicacion-nacional-peru-convencion-marco-las-naciones)

205 FAO. 2018. Impacts of climate change on fisheries and aquaculture. FAO Fisheries and Aquaculture Technical Paper, 627. Available online> https://reliefweb.int/sites/reliefweb.int/files/resources/i9705en.pdf

206 McDonough, R. 2009. Seeing the Peopple through the Trees: Conservation, Communities and Ethno-Ecotourism in the Bolivian Amazon Basin. Master Thesis, Georgetown University, Washington DC, USA.

207 WWF .2009. Ecotourism could help the Amazon reduce deforestation and handle climate change. Available online: https://wwf.panda.org/?unewsID=159321; McDonough, R. 2009. Seeing the Peopple through the Trees: Conservation, Communities and Ethno-Ecotourism in the Bolivian Amazon Basin. Master Thesis, Georgetown University, Washington DC, USA.

	degradation, while also maintaining and/or improving ecosystem services through small and medium developer organizations (finance to support the process of project development, certification and verification) ▪ Benefits: Micro-climate buffering, improved evapotranspiration, soil protection, water recycling, hydrological recharge and biodiversity conservation, among others will help to increase the resilience of the Amazon basin, helping the basin to avoid "tipping points". Climate-informed plans will help identify resilient species and will enable adaptive management. ▪ Investments that reduce deforestation and forest degradation, while also maintaining or improving ecosystem services will help to increase the resilience of the Amazon basin, helping the basin to avoid "tipping points"[208] ▪ Benefits include: micro-climate buffering, improved evapotranspiration, soil protection, water recycling, hydrological recharge and biodiversity conservation, among others.[209] ▪ SFM based on climate-informed plans will help to identify resilient species, and will enable adaptive management.[210] ▪ SFM will strengthen the resilience of forest ecosystems against climate change (forest cover to protect soils, reduced degradation to increase resilience against disease, and support buffering of climate extremes)[211] ▪ Integrated watershed management to strengthen resilience of watersheds to climate change (ensuring protective forests in vulnerable areas, improving forest health), which can help reduce the impact of floods, and drought[212] ▪ Healthy ecosystem regulation and function will help ensure communities can access water, food (plants and traditionally hunted animals) and maintain incomes/ livelihoods. This will increase the resilience of local communities.[213]	investments that reduce deforestation and forest degradation. ▪ Benefits: Reduced emissions from deforestation and forest degradation, enhancement of forest carbon stocks. Healthy regulation of soil and water cycle indirectly contributes to reduced emissions and carbon sequestration. Avoided deforestation is estimated to lead to increased carbon stocks equivalent to 1.87 tCO_2/ha/year. ▪ Healthy regulation of soil and water cycle indirectly contributes to reduced emissions and carbon sequestration ▪ Reduced emissions from deforestation and forest degradation, enhancement of forest carbon stocks, sustainable forest management and conservation ▪ Sustainable forest management (SFM) to improve carbon sequestration, support forest restoration while providing long-term incentivizes to maintain or increase forest cover

[208] Marengo, J., Nobre, C., Sampaio, G., Salazar, L. 2011. Climate change in the Amazon Basin: Tipping points, changes in extremes, and impacts on natural and human systems. In: Bush M., Flenley J., Gosling W. (eds) Tropical Rainforest Responses to Climatic Change. Springer Praxis Books, 259-283. doi:10.1007/978-3-642-05383-2_9; Marengo, J., Souza, C. 2018. Climate Change: impacts and scenarios for the Amazon. Sao Paulo: CEMADEN and Imazon. Available online: www.oamanhaehoje.com.br/eng/

[209] Ojea 2015, Shaw et al. 2014 and Munang et al., 2013 in Rubio Scarano, F. 2017. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation, 15 (2): 65-73.

[210] Magrin et al. 2014 in Rubio Scarano, F. 2017. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation, 15 (2): 65-73.

[211] Ojea 2015, Shaw et al. 2014 and Munang et al., 2013 in Rubio Scarano, F. 2017. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation, 15 (2): 65-73.

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[213] E.g. Climate change and climate-related hazards (such as floods) may limit access to food and foraging in the Amazon region. Floods in the Amazon region in 2020 were reported to have affected the food security of indigenous peoples in the Ecuadorian Amazon, where people

	▪ Supplemental, diversified income potential for local communities (e.g. in case of woodlots and trees that can be harvested post-maturity).	
Forestry (value chain of native species plantations)	▪ Activities: Reforestation with native species forestry plantations *(e.g., Shizolobium sp., Guazuma sp., Ochroma sp.)* ▪ Benefits: Native species forestry plantations can increase ecosystem resilience and help avert the Amazon tipping point by being structurally similar to natural forests, as far as hydrological and climatic functions; decrease in costs of restoration and reforestation; for every hectare of native forests planted and maintained 0.4 new local jobs are created (Rolim et al., 2019).	▪ Activities: Reforestation with native species forestry plantations (e.g., *Shizolobium sp., Guazuma sp., Ochroma sp.)*. ▪ Benefits: Decrease in deforestation and degradation (Rolim et al., 2019), higher carbon stocks in biomass and soil above and below ground carbon stocks increases, which should reach an expected 6.5 tCO_2/ha/year sequestration.

2.5 Characterization of types of producers and business models

2.5.1 Main producer types

We can distinguish three main types of productive actors in the Pan Amazon: small producers, indigenous and riverine populations, and large producers.

Small producers

This group, also known as family producers or smallholders, generally pursues a diversified income strategy with multiple crops and agricultural production systems; nonmonetary income from their land is often as important as monetary income, while nonrural income (urban or industrial jobs and services) is also an important component of the household economy. A significant proportion of small actors are recent migrants. In the Andean foothills, smallholders usually have less than 20 hectares of land (with 2 to 4 hectares under active management), but in the lowland Amazon, smallholders own up to 50-60 hectares. The small producer is characterized by deforestation events almost always smaller than 5 hectares. Smallholders often manage diverse, complex farming systems, often including agroforestry practices.

Indigenous and riverine community producers

Native indigenous and riverine communities generally practice integrated land management of highly varied forms, in which rotating agricultural and agroforestry practices are intertwined with the use of wood and NTFPs and other ecosystems. Commercial agriculture is being incorporated, slowly in some areas and rapidly in others, into this mix of uses. Communal lands and indigenous territories vary in size greatly, from a few thousand hectares to millions of hectares.

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were unable to forage and instead had to travel into cities to buy food. Given the covid-19 pandemic, this put indigenous communities and their elders at higher risk of contracting and spreading covid-19 (Mongabay 2020).

Large producers

This group tends to have a more focused business strategy, requiring greater asset holdings, production systems, and significant financial resources. Land sizes vary from medium-sized properties (50-500 hectares) to large business properties (1,000-100,000 hectares). Agricultural deforestation by large investors, including agribusiness developments for oil palm, soya, cocoa, and other crops is significantly on the rise. The deforestation events of these actors most often exceed 50 hectares.

2.5.2 Main business model types

The producers are organized, in turn, into four main business models, which are summarized below. Two of them focus on the supply side of the value chain (independent smallholder model and associative model), one focusses on the demand side of the value chain (aggregation model), and one focuses on the total value chain (integrated corporate model).

Independent model

This is the business model of most small producers, but also of family-owned large producers, especially in the ranching sector in Brazil. The foundation of management seeks economic returns, but also resilience, through the combination of various economic activities: production of crops, trees, and animals; sale of agricultural products and family labor; and related businesses, among others. Both agricultural and other activities (wage labor) are important. The term *independent* refers to the fact that the small producer is not obligated to an association or cooperative. This is the dominant model in Peru and Ecuador, and to a lesser extent Bolivia and Colombia.

Associative model

Small individual producers organize under a cooperative model of aggregation, processing, and/or commercialization. The distinctive element of the associative model is that governance is based on the one producer, one vote rule. The associative model can be simple when it involves a community or association or cooperative, or complex when it brings together a series of associations or cooperatives that share the additional benefits derived from economies of scale in production, processing, and distribution. This is an important model in the agriculture and agroforestry sectors in the Andean countries.

Aggregation and trading model

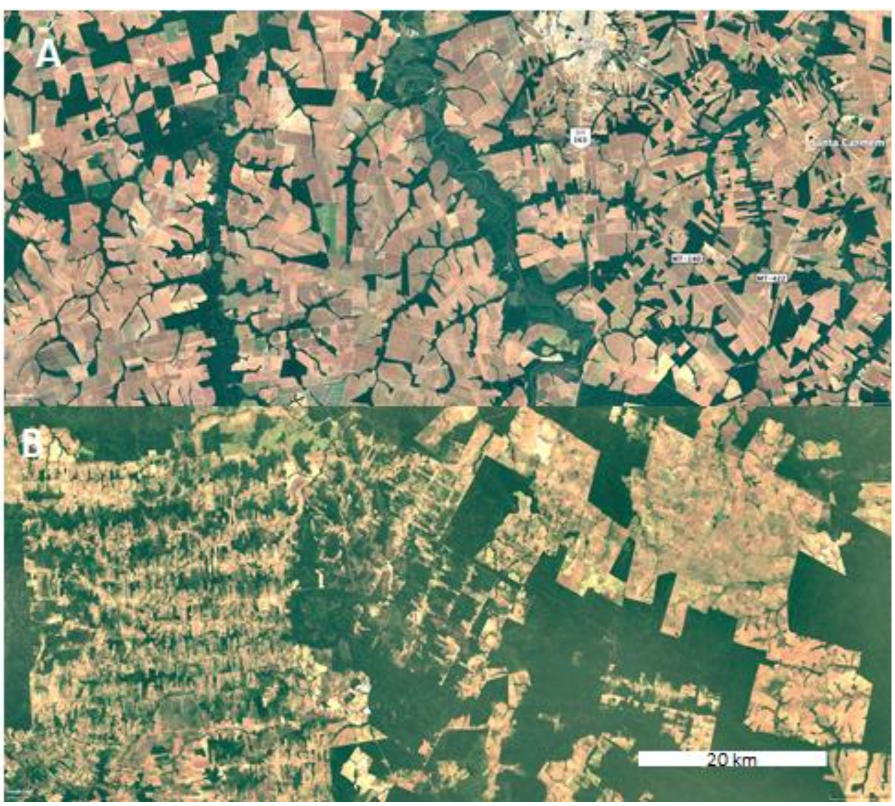
This business model is fundamentally organized on basic trading (the buying and selling of goods) without direct involvement in the primary production of raw materials. This model includes aggregation, partial, or complete processing of the raw material, which depending on the final product, requires differing investment level, in order to properly elaborate a finished product for each particular market. This model is important for products when quality control is important and when a distinct value-added market can be reached. The aggregator acts as a volume generation and quality control node, and often additionally plays the role of financial intermediary.

Integrated corporate model

This model consists of an integrated commercial operation that includes production in large plantations (several thousand hectares), processing, and marketing of goods. Land is often acquired through the appropriation of public lands, sometimes via concessions but also by extra-legal mechanisms. Historically, these enterprises engaged in large-scale deforestation, but some now seek to acquire previously deforested properties that will allow them to sell their production into global supply chains subject to deforestation monitoring. This model is typified by the vertical integration of the supply chain under a single commercial organization. Different business units or companies are organized for each step in the value chain, but they all follow an integrated business plan. Governance is based on a corporate framework that involves shareholders and a board of directors; nonetheless, some are family-owned corporations dominated by an individual acting as chairman and CEO.

The different types of producers and the different types of business models combine with local geographical and administrative realities to produce a multiplicity of forms of land use and land-use change, resulting in highly heterogenous land-use change outcomes, as exemplified in Figure 44.

Figure 44: (A) Agribusiness farms near Sorriso, Mato Grosso, have conserved riparian corridors (Permanent Preservation Areas) in their landscape, but have not set aside sufficient area as Legal Reserve. (B) Cattle ranchers tend to clear land in large blocks, often respecting Legal Reserves but not maintaining riparian corridors as Permanent Preservation Areas (arrows); smallholders leave forest remnants at the back of their properties, unintentionally maintaining an irregular forest corridor, but do not tend to respect riparian corridors either (box).



2.5.3 Business / entity types

In order to carry out the business models described above, the productive actors organize their work by adhering to formally recognized types of entities, as determined by the policies and national public registry services of each Amazonian country. Summarizing below, we have:

Companies (corporate entities)
Across Amazonian jurisdictions there are many forms of corporate entities. The five main types identified are corporate entities: corporations (open holding and closed holding), general partnerships, limited partnerships, limited liability commercial companies, and civil partnerships.

Cooperatives (non-corporate entities)
Cooperatives in the Amazon come in many forms but can be grouped into three main categories for the purposes of analysis:
1. Productive cooperatives: This category includes agricultural cooperatives, colonization agricultural cooperatives, communal cooperatives, fishing cooperatives, artisanal cooperatives, industrial cooperatives, mining cooperatives and special production cooperatives. These types of cooperatives play a very important role in the collection and primary transformation node of the agricultural, agroforestry, and NTFP value chains.
2. Financial cooperatives: This category includes savings and credit cooperatives and consumer cooperatives. In some countries, such as Peru, saving and credit cooperatives play a very important role in finance for micro and small producers in various value chains.
3. Service cooperatives: This category includes transportation cooperatives, housing cooperatives, educational service cooperatives, school cooperatives, public service cooperatives, multi-service cooperatives, labor and employment promotion cooperatives, temporary work cooperatives and special service cooperatives. Service cooperatives play an important role in the provision of inputs and technical services in various bioeconomy value chains.

Associations and other nonprofit entities

Across the Amazon, civil society forms important associations and nonprofit entities, often linked to livelihoods and productions activities. These include associations, foundations, committees, peasant and native communities, and grassroots social organizations. Productive associations and *ribereño* and indigenous communities are the two types of nonprofit entities with a significant presence in land management and production chains in the Pan Amazon.

2.5.4 Business size

In order to consistently distinguish between the different sizes of businesses a broad classification is needed. In this study, annual sales volume has been taken as the distinguishing characteristic, as this is the characteristic adopted by several economic and tax authorities in the Pan Amazon, and in turn by most other public organizations. Averaging across different national systems, four sizes of entities are distinguished: (1) Micro-enterprise, are entities with annual sales less than US$200,000, (2) Small enterprise, are entities with annual sales between US$200,000 and US$2,000,000, and (3) Medium-sized companies are entities with annual sales between US$2,000,000 and US$4,000,000 and (4) Large companies are entities with annual sales over US$4,000,000. As medium and large companies are much smaller in number, and on the whole more homogenous in skills and business practices than the other two categories, they have been grouped together in the analysis.

3.0 KEY BIOECONOMY VALUE CHAINS AND INTERVENTIONS

Key bioeconomy value chains were identified and prioritized for evaluation by the study team. The evaluation looked at the whole value chain, from primary production through aggregation and processing to final distribution to customers. For those value chains were climate change mitigation and adaptation potential was confirmed, and that are not included on the IDBs investment exclusion list, a Program intervention was developed. Due to the breadth of the bioeconomy, the interventions are not exhaustive, rather are indicative of the significant investment opportunities available. Value chains that have a direct impact on ecosystems and land cover have been prioritized, as ecosystems are the fundamental renewable natural capital assets on which climate change exerts pressure and on which the bioeconomy depends. The analysis is not predictive of new bioeconomy sectors, as a detailed review of bioeconomy innovation directions and initiatives has not been carried out. Table 16 lists the value chains included, evaluated but not included, and not yet evaluated, across the different sectors.

Table 16: Summary of (a)Evaluated & included, (b) evaluated but not included and (c) not evaluated bioeconomy value chains

Sector	Evaluated, Included	Evaluated, Not Included	Not yet Evaluated
Agriculture, Agroforestry & Aquaculture	Perennial: acai (*Euterpe oleracea*)	Silviculture- cattle intensification with native tree species	Perennial agriculture: Amazon oil palm (Elaeis oleifera)
	Perennial or Agroforestry: Cacao (*Theobroma cacao*)		Aquaculture: Pirarucu (Arapaima gigas)
	Agroforestry: Coffee (*Coffea arabica*)		Perennial agriculture: African oil palm (*Elaeis guineensis)*
	Aquaculture: *Tambaqui (Colosomma macropomum)* & Pacu (Piaractus brachypomus)		
	Perennial agriculture: morete (*Mauritia flexuosa*) & pijuayo (*Bactris gasipaes*)		
Forestry	Native species plantations: *Shizolubium sp*. & others	Exotic Hardwood plantations: African mahogany (*Khaya sp.*) & Teak (*Tectona grandis*)	Medicinal and pharmaceutical value chains
	Non-timber forest products: Brazil nut concessions (*Bertholettia excelsa*)	Sustainable managed primary forest hardwood Concessions	Exotic Softwood plantations
	Non-timber forest products: acai (*Euterpe oleracea*) & other palms		
Wilderness	Community-led nature tourism: run by indigenous and local		Traditional forest use by indigenous people: ´guardianship business´
Ecosystem services & habitat restoration	Ecosystem services: Climate regulation through carbon forestry	Commercial habitat restoration (Habitat and biodiversity banking)	Ecosystem services: hydrological regulation services
		Environmental liability restoration services	

Production is driven by economic, environmental, social, regulatory and political factors. These factors influence the process of production in different forms, times and intensity along the value chain of every agricultural, forestry or wilderness product[214]. Incentivizing a transition to climate and nature positive production requires the existence of enabling conditions and specific social and financial incentives to make value chains result in climate mitigation and adaptation benefits and net gains for natural capital. This requires an understanding of the economic behavior of the commercial actors along the chain, the motivation of the financial and technical companies that provide them services, and the constraints/incentives imposed by the institutions implementing law, policy and governance in the domain where value chains operate.

3.1. Agriculture, agroforestry and aquaculture value chains

3.1.1. Perennial Agriculture and Agroforestry

This sub-sector includes the sowing, harvesting, gathering, transformation and commercialization of perennial native crops originating from plantations or agroforestry systems. Perennial native crops can contribute to increasing the stock of biodiversity and organic carbon at the landscape level, thus contributing to compliance with greenhouse gas emissions management and economic resilience policies.

From a sustainable development perspective the unique opportunity for Amazon agriculture is to shift from annual monocultures (annual crops like soy and maize which entail high soil loss and low embedded carbon) to perennial, mixed species cultures (perennial crops and agroforestry based systems as are currently in existence for açaí and cacao), and thus strive for the sector to transition from being a net GHG emitter/source to a net GHG absorber/sink. This includes not only strategic decisions about the crops themselves, but also regarding soil management (till vs. no till), fertilizer and chemical use, and how conservation lands are integrated in agricultural landscapes, amongst others.

3.1.1.1 Cacao (Theobroma cacao)

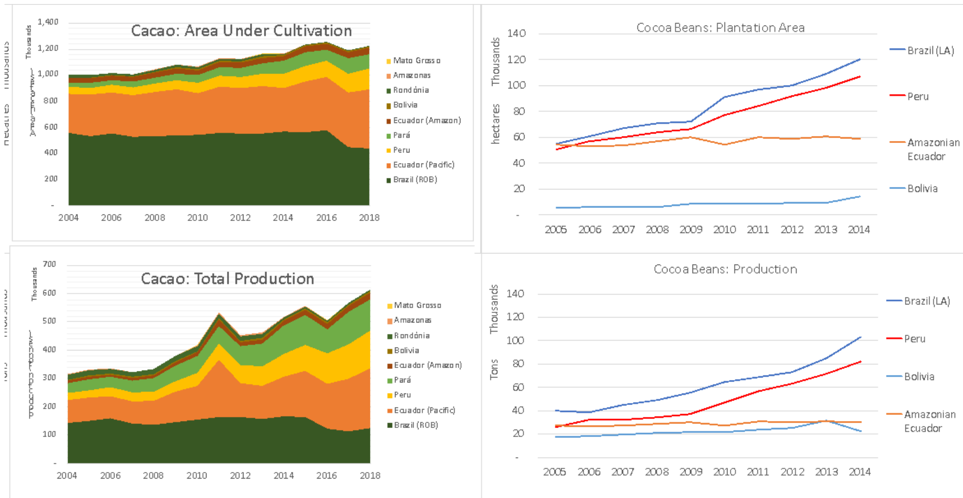
Production can be broadly segregated into two commodity types based on quality: *bulk cacao* which is used for most candy and food products, and *fine cacao*, which is preferred for specialty chocolates. West Africa has been the principal supplier of bulk cacao (~ 60% of global market) for decades, but the long-term sustainability of that supply is in doubt due to its reliance on a deforestation-based production model, which has motivated confectionaries and consumer-goods manufactures (CGM) to diversify their supply chains to the benefit of Latin America.[215] Fine cacao only represents about 5% of global cacao consumption, but almost all originates in Latin America, because several local varieties

[214] The value chain encompasses both the supply and demand relationships for a specific product – i.e. actors involved in supplying products and actors demanding and paying for products, which creates the income flows along the chain. It also includes the relationships and transactions between the different actors involved in transforming the primary commodity into a product for consumers, as well as the financial and technical institutions, policies and market in which the value chain operates. FAO-OECD, 2015. Guidance for Responsible Agricultural Supply Chains.

[215] Tondoh, J. E., Kouamé, F. N. G., Guéi, A. M., Sey, B., Koné, A. W., and Gnessougou, N. (2015). Ecological changes induced by full-sun cacao farming in Côte d'Ivoire. Global Ecology and Conservation, 3, 575-595.

provide higher levels of aromatic compounds that give chocolate its rich flavor. Cacao production in the Amazon has been increasing 10% annually over the last decade (Figure 45).

Figure 45: Cacao production trends in selected countries



Cacao is a labor-intensive crop that requires an artisanal-type, post-harvest fermentation process that makes it a good option for small farmers. It takes between three to four years for young trees to flower and fruit, after which light management is important for maximizing production and quality: too much light and plants will suffer stress; too little light and yields decline. An individual tree can live decades, but most commercial plantings last about 20 years. Cacao has become an increasingly popular crop in the lowlands of the Andean Amazon and in certain areas of the Brazilian Amazon, particularly in Pará state along the Tranzamazônica Highway. Brazil produced more than 275,000 tons of cocoa in 2015 with about 56% originating in Bahia and 38% in Pará. Ecuador produced approximately 160,000 tons with about 85% cultivated in the provinces of the Coastal Pacific, with the rest produced in the Amazon (Figure 45). Most of Peru's 135,000 tons per annum is produced in the Amazon, with the largest production landscape in Peru being the region of San Martin (44%). Most of Colombia's production occurs in other watersheds, but the Amazonian regions have all the climatic and edaphic attributes of cocoa growing regions and efforts to displace illicit coca are driving the growth of cacao.

Ecuadorian producers supply about 70% of the fine cacao commercialized in global markets, sourced manly from plantations of a local variety known as *Nacional;* however, its predominance is being challenged by a hybrid variety known as CCN-51, a bulk cacao with robust growth and high yields.[216] Chocolate connoisseurs and export companies voice concern that CCN-51 may displace *Nacional* and compromise Ecuador's dominance of the specialty cacao market. Currently, CCN-51 contributes about 36% to Ecuadorian national production compared to 37% from *Nacional* trees.

[216] Nacional trees yield only about 300 – 400 kg/ha compared to 700 – 1,100 kg/ha for CCN-51.

Smallholders in Amazonian Ecuador typically cultivate only between one and five hectares, while commercial producers on the Pacific Coast might have as much as fifty. Certified production of fine cacao delivers a price premium of about 20%, but this is not sufficient to offset the lower yields. Production in Amazonian Ecuador is static (see Figure 45), but efforts to expand cultivation in fallow fields and to improve yields are underway as part of the countries sustainable development strategy.[217]

In Peru, production has grown annually by about 10%, reaching more than 135,000 tons in 2019 which were produced on about 140,000 hectares. Prior to 2000, almost all cacao production was dedicated to meeting domestic demand and almost all subsequent growth can be attributed to exports which accounted for more than two thirds of total production in 2016 with a value of approximately US$200 million. These proceeds are distributed among 26 grower's associations representing approximately 30,000 families, with mean gross revenues ranging $1,500 to $2,000 per hectare.[218]

The smallholder associative model linked to sustainable production standards has the greatest potential to integrate and sustain climate adapted bioeconomy practices in cocoa. To this end, credit incentives must be aligned with a coherent crop policy program. With financing and best practices, annual productivity can be increased from the current 700-900 kg/ha to around 1,500 kg/ha. This model, which currently brings together 20-30% of small cocoa producers, includes in most cases the production and trade of certified products, since formal association is a precondition for the management of internal control and traceability systems. Marketing and processing companies can induce associative suppliers to produce deforestation-free cocoa as long as market demand and/or local policies support this change. Main good practices include: (1) improving density (about 1,100 cocoa trees/ha), (2) introducing the right mix of cocoa varieties for optimal productivity and quality through grafting, (3) effective combination of low emission fertilizers based on soil analysis, (4) introducing commercial timber species in the medium and long term, and (5) sustainable integrated pest management.

[217] PNUD (2017) Ecuador fortalece sus esfuerzos para enfrentar la deforestación en la cuenca amazónica,

[218] MINAGRI 2019. Observatorio de commodities: Cacao. Lima, Perú.

Model intervention based on agroforestry cacao value chain in Peru

Value chain structure, yields and prices	*Production: planting, maintenance, harvesting and fermentation:* In Peru, micro independent producers account for 65% of the cultivated area, with 80% of the cultivated areas estimated to be less than 3 hectares, averaging 720kg/ha/year. Micro associated producers represent 30% of the cultivated area. Due to better practices and technical support services such as pruning and fertilization, their average production is 950kg/ha/year. Finally, it is estimated that 5% of the cultivated area is under the management of corporate producers integrated into the processing and distribution chain. The yield for this group averages 1,200 kilograms per hectare per year. The ten year average farm gate price over producing locations is US$2.05/kg. *Aggregation, drying and selection:* productive cooperatives and companies, from small to large. In Peru, over 100 productive cooperatives active in this chain, and 200 companies,. The ten year average transfer price of cocoa beans for processing is 2.37/kg. *Transformation and export:* Peru cocoa is known for its high quality and is mainly dedicated to export, but also for domestic consumption. Exports 2018 reached US$190.2 million. Exports of raw cocoa beans achieved US$138 million, roasted cocoa beans achieved US$20.1 million and cocoa derivative products achieved US$32.1 million. Average sales prices in 2019 were US$2.5/kg, US$3.1/kg, and US$5.8/kg for these three categories, respectively.
Technical services and best practices	Better cultivation and harvesting practices, genetic improvement, and the strengthening of marketing are being promoted by public-private partnerships and the Peruvian Amazon Research and extension agencies. State programs such as Agrorural and Agroideas provide technical support and limited non-refundable funds to producers via the Associations and Cooperatives in the value chain, while MINCETUR and Prompex carry out activities to promote exports, specifically through the Biotrade Program. State organizations, international technical cooperation organizations, and international universities and certifiers provide training, research capabilities and non-reimbursable funds to strengthen the chain. State institutions such as the National Agricultural Health Service and the National Quality Institute support the establishment and monitoring of the health and quality framework for the chain.
Financial services	Microfinance institutions active in the cocoa chain include Cajas Rurales and Credit Cooperatives. Most of loans currently only for working capital and range between US$1,000 and 2,500, at rates that fluctuate between 25% and 35% annually. In the aggregation and primary processing node, the above actors are present, as well as international social finance companies. Loans in this node of the chain fluctuate between US$/. 30,000 and 300,000, at interest rates that fluctuate between 8% and 15% annually. Second-tier financiers active in cocoa private banks such as BCP and Scotiabank, and international social financiers including RaboRural Fund, Responsibility and Oikocredit. These same entities provide first-tier financing to the largest companies in the final processing and export node of the chain, with loans in the order of US$500,000 to 2 million, at interest rates that fluctuate between 6% and 8% per year.
Climate vulnerability and other risks	Studies have determined that: (1) water limitation causes significant yield reduction in cacao, but genotypic variation in sensitivity is evident; (2) in the field, cacao experiences higher temperatures than is often reported in the literature; (3) the complexity of the cacao/shade tree interaction can lead to contradictory results; (4) elevated CO_2 may alleviate some negative effects of climate change[219];
Key Barriers and Enablers	It is estimated that 80% of cocoa plantation growth in the Andean Amazon is occurring replacing existing forests. Hence the importance to shift to deforestation free production. In Peru it is causing about 10% of annual deforestation in the Amazon. To ensure that investments in cocoa do not result in deforestation, the program will have to implement jurisdictional / landscape level deforestation free production approach, with adequate monitoring and enforcement of deforestation controls.
Current extents and potential program adoption	Ecuador main producer, but most of hectarage west of Andes, outside Amazon geographic scope. Peru and Colombia exhibiting 12% annual growth. No material cultivation in Guyana and Suriname. Target of 40% adoption rate of intervention, based on uptake of AlianzaCacaoPeru
Proposed intervention	Micro: one additional hectare deforestation free agroforestry cacao, and improved fertilization and best practices on existing 2 hectares requiring US$3,600. Increase average yields form 720kg/ha to 950kg/ha. Small/medium: Improved fermentation, drying and selection infrastructure at aggregation facilities in

[219] Lahive, F., Hadley, P. and Daymond, A.J. The physiological responses of cacao to the environment and the implications for climate change resilience. A review. Agron. Sustain. Dev. 39, 5 (2019)

	order to improve product quality requiring US$220,000 . Medium/large: expansion export facilities and processes and/or manufacturing facilities depending on business niche requiring US$2.2 million.
Mitigation activities and impacts	The agroforestry system involves arabica coffee, bananas and native tree species with a maturation age of 20 years. The bananas are the initial source of income, cropping years 1, 2 and 3. At year 4-5 cacao production begins. At year 20 or 21 timber harvest. With improved agroforestry and fertilization practices, income is accelerated (bananas) and diversified, with long term capital accrual through timber. The converted and new coffee agroforestry areas should reach and additional 11 tCO_2/ha/annum sequestration (Program Financial and Carbon Model).
Adaptation activities and impacts	Although future climatic predictions are worrisome, the program will ensure improved planting material, in combination with improved management practices, in order to help reduce environmental stress; In light of increase water stress, optimal tree cover and irrigation adaptation practices will help prevent yield drops. However, the emissions generated by irrigation should be better understood and quantified during program implementation, as part of the Technical Assistance package. Marginal cacao cultivation economics will be improved through the intervention increasing coping capacities and generating employment.
Financing aspects	Typical cacao smallholders can access working capital micro-loans of US$1,000-2,000 with 12 month tenor at interest ranges of 15-45% annual (Bolivia:15%, Peru:25-45%, Ecuador 20-25). Though terms highly unsuitable, producers are accessing these loans for agronomic inputs (fertilizer, etc). These micro-loans are however not suited for agroforestry expansion, where lower interest rate (4-8% annual) and tenor 5 years (cacao starts producing at year 4) are needed. Proceed with concessional loans, technical assistance and incentives
Number and size of beneficiaries and financial demand	Across Brazil, Colombia, Ecuador and Peru we estimate a total of 43,810 potential beneficiary entities (64,912 micro, 259 small and medium, and 18 large). Total potential financial demand in the order of US$331 million (micro: US$234 million, small and medium: US$57 million, and large: US$40 million). For details of beneficiaries, financial demand and intervention data refer to Appendix 11 and sources[220].

Potential beneficiary entity case study

Name of Entity	Pacari
Business Model & Value Chain Node	Pacari is an Ecuadorian chocolate producing company based on a sustainable model, with a core principle of building personal relationships with more than 3,500 small-scale farmers with whom they work directly. Pacari´s 100% organic and biodynamic chocolates come from locally sourced arriba nacional cacao beans. Its chocolate has been awarded more than 128 awards worldwide. Through its practices Pacari promotes ecosystem conservation, fair trade and capacity building for its associated farmers.
Location	Ecuador: Zancudo Cocha, Fauna Reserve Cuyabeno, Piura, Los Ríos, La Montubia, Manabí and Esmeraldas
Development Stage and Certifications	Pacari is well positioned country-wide, dedicated to provide a high-quality product and comply with the many standards they have earned over the years. Furthermore, they are part of an export consortium, which facilitates positioning a product internationally by resorting to lower export costs. Pacari has biodynamic (Demeter) and organic (EC-BIO-141 and USDA) certifications, as well as certified Kosher, Vegan and non-GMO. They also hold a Beyond Fair Trade small producers' certification. They are a certified B corporation.
Theory of Change & Impact Strategy	The company creates a culture of awareness on the part of entrepreneurs to preserve the balance of profitability and social responsibility business at the same time. As part of improving competitive capacity, the Pacari company encourages young small-scale farmers to continue with the tradition of cocoa production, showing them the importance of this activity for the success of organic product ventures. Also, this company works together with these farmers through training on how to produce organically and have a high-quality raw material, such as knowing in depth the weight and moisture of the fruit, a factor

220 MINAGRI, 2019. Anuario Estadístico Comercio Exterior Agrario 2018. Vos, Vincent Antoine, Olver Vaca Ruiz y Adrián Cruz (Eds.). Sistemas agroforestales en la Amazonía boliviana: una valoración de sus múltiples funciones a partir de estudios de caso / Editores: Vincent A. Vos; Olver Vaca; Adrián Cruz. -- La Paz, MINAGRI, 2019. Observatorio de commodities: Cacao. Schroth at al, 2016. Commodity production as restoration driver in the Brazilian Amazon? Pasture re-agro-forestation with cocoa (Theobroma cacao) in southern Pará.

	that influences in the price of bags of cocoa. By having a relationship of trust due to direct trade, this company has a competitive advantage over its competitors.
Innovation / R&D	From its origin, Carla and Santiago, founders of Pacari, were interested in using and preserving the legendary Arriba Nacional cacao variety. This particular variety, which had never been successfully grown elsewhere, produces a bean with distinctive floral overtones absent from the more commonly consumed bulk cacao. They have also produced single origin bars from Piura, Los Rios, La Montubia, Manabí and Esmeraldas.
Climate Change Nexus	
Spatial distribution and market	National and international markets (at least 42 countries worldwide).
Mitigation benefits	● Decreased risk of land-use change or deforestation ● Soil conservation and enrichment through biodynamic and organic agricultural practices ● Trees increase soil organic carbon sequestration (Niether et al. 2020), and trees largely sequester carbon into living biomass. A meta-analysis of studies comparing cocoa monocultures to agroforestry systems found agroforestry systems sequestered 2.5 times more carbon on average (Niether et al. 2020)
Adaptation benefits	● Pacari sources all its cocoa beans from agroforestry systems. Agroforestry trees can support the formation of micro-climates that can help buffer increasing temperatures and changes in precipitation (Niether et al. 2020) ● Biodynamic farming focuses much on soil quality, improving production for cacao ● Agroforestry Systems can function as biological corridors between protection areas. Which increases connectivity and strengthens biological diversity. A study comparing cocoa agroforestry with monocultures, found higher biodiversity in agroforestry systems (Niether et al. 2020) ● Cocoa in agroforestry systems results in enhanced soil moisture (shade cover reduces loss from evapotranspiration and transpiration, and leads to more available water in soils; Niether et al. 2017) ● The trees reduce runoff speed, increase infiltration, increase vegetation cover, control soil erosion ● Diversification of income and products from agroforestry systems (e.g., non-timber forest products, wood, agro-ecotourism, among others)
Climate vulnerability	There is lower risk of climate change impact in well-managed biodiverse agroforestry systems.
Sustainable management practices & models	Besides following best practices required by the various certifications earned, Pacari also aims to preserve as many cacao and other plant varieties as they can.
Beneficiaries	Cacao farmers, members of Pacari, and neighboring communities
Co benefits	
Environmental co-benefits	Ecosystem services provision (Soil conservation, water regulation, carbon sequestration, habitat conservation) Increased and conserved biodiversity. Pacari, in partnership with WWF Ecuador launched a new line of products, where a percentage of sales will be dedicated to conservation projects in the country. Reduced use of agrochemicals in agroforestry systems (in comparison with cocoa monocultures; Pérez-Neira et al. 2020; Niether et al. 2020) Conservation of agrobiodiversity (using national varieties, e.g., cacao arriba)
Social co-benefits	Improved livelihood of farmers and community members through equitable incomes and permanent community support and involvement.
Risks	
Potential (social, environmental) risks	● Agricultural frontier expansion at the various cacao farming communities. ● Lack of capacity building or technological transfer potential for Pacari to other communities. ● Lower short-term yields in comparison to monocultures, however there are greater additional sustainable benefits and in the long-term agroforestry has

	substantial benefits (improved soil moisture and nutrients, deeper/ more established roots, water cycling, vegetative cover and erosion control, among other benefits listed above)
Potential risk mitigation strategies	● Technical assistance programs for marginalized households ● Technical support to increase cocoa yields, and support selection of suitable and well adapted shade trees (considering soil nutrient dynamics)

3.1.1.2 Coffee (Coffea arabica)

There are two major cultivated species of coffee: *Arabica* (*Coffea arabica*) and *Robusta* (*Coffea canephora*), each with a multitude of varieties adapted to a broad range of ecological conditions. *Arabica* represents 70% of global production, while *Robusta* represents about 30%. Traditionally, *Arabica* has been cultivated as "shade coffee" grown at higher elevations, while *Robusta* is "sun coffee" cultivated at lower elevations. There are exceptions, including *Arabica* varieties grown without shade at higher elevations and with shade at lower elevations. Both species of coffee are cultivated in the Amazon. Premium coffee varieties come from *Arabica* trees grown under shade at optimum altitudes, which vary by latitude, but range between 750 and 1500 m above sea level. Harvesting and post-harvest processing practices are also important for quality and price in premium coffees.[221]

In the Andes*, Arabica* is the predominant coffee cultivar. Colombia is third largest producer of coffee and is well known for its high quality elite *Arabicas.* However, most Colombian coffee is grown in Magdalena watershed, outside the program area. *Robusta* was once widely cultivated in Amazonian Ecuador, but after about 2000 Ecuadorians began shifting production to oil palm or cacao.[222] *Robusta* is cultivated sporadically in Lowland Peru.

In Peru, coffee is commonly cultivated on small, diversified farms that also produce food crops and livestock; coffee is a cash crop that is harvested once a year over several weeks. More than 85% of production in originates on 150,000 family farms with coffee groves smaller than five hectares. Family labor is key to their success, because it allows them to absorb the fluctuations of price volatility; however, it also limits their ability to expand production. Commercial farms cultivating larger extensions obtain better yields, but since they rely on contract labor, they are also exposed to greater price risk from international markets. Net income varies depending upon production strategy, but gross annual revenues between US$1,500 and US$2,000 are possible with yields of about 700 kilograms per hectare. The coffee sector exported about US$670 million in 2016, about 2% of total exports. [223] According to the USDA, coffee generates some 455,000 jobs in Peru, most of which are on-farm jobs conducted by family members.[224]

[221] Management of the roasting and blending processes are essential to ensure consistent quality and these are done at the end of the supply chain, because roasted and ground coffee loses aroma and flavor over time. Consequently, the supply chain in producing countries tend to end with the commercialization and export of green coffee beans.

[222] This collapse of the Robusta coffee sector in Ecuador coincided with phenomenal growth of the Vietnamese coffee industry which expanded by an order of magnitude between 1990 and 2000; yields in Vietnam average about 1.5 tons per hectare versus about 300 kg hectare in Amazonian Ecuador.

[223] Gestión (Miércoles, 17 de mayo del 2017). Producción peruana de café aumentará 8% en el 2017, proyecta el Scotiabank http://gestion.pe/economia/produccion-peruana-cafe-aumentara-8-2017-reporto-scotiabank-2176971

[224] Chocolate Atlas (2016) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Coffee%20Annual_Lima_Peru_4-30-2015.pdf

The *Arabica* coffee plant grows in a climate zone that is subject to weather fluctuations that can greatly impact yield and, in some case, lead to the large-scale die off of plantations. When this type of event hits one of the major producing countries, particularly Brazil, price hikes can dramatically improve incomes.[225] Many coffee farmers go years with only marginal rates of return, but a price spike will provide a windfall that justifies what is essentially a long-term investment. On the other hand, producers may lose their investment due to local weather events, such as drought or exceptionally humid years, or a disease outbreak. Coffee plantations across the Amazon have been suffering from a coffee rust, known as *Roya*, which is fungal pathogen that can quickly devastate a plantation. Peru suffered from an outbreak of coffee rust in 2012/2013, which reduced harvest and forced growers to replant infected groves with resistant varieties[226]. Conventional and traditional producers in Peru represent about 70% of total production and typically do not participate in certification programs, choosing instead to emphasize yield, maximize income over the short term and reduce risk from plant pathogens. Those that choose to adopt shade or organic practices tend to participate in grower's associations in order to obtain certification, which improves market access and pays a premium for coffee with better flavor. Prices for shaded organic certified beans provide a premium of about 10-20% when compared to traditional systems. [227]

The Brazilian coffee industry produces about 25% of global coffee production. *Arabica* is the main coffee crop with production in the states of Paraná, São Paolo and Minas Gerais (outside the Amazon). contributing about 80% of national production. In Amazonian Brazil, production is concentrated in Rondônia where *Robusta* is cultivated by about 22,000 smallholders each with plots between 4 and 10 hectares in size. It is also cultivated in Acre and in the smallholder communities of Northern Mato Grosso. Referred to by Brazilians as *Conilon*, coffee is an important part of the smallholder production model in Rondônia, contributing about US$350 million in gross revenues in 2020.[228] Yields climbed from 550 kg/ha to 1.2 tons/ha over the same period. According to agronomists with EMBRAPA, the Brazilian extension service, the potential yield for Robusta varieties in Rondônia is about 4 tons/ha when grown with irrigation and optimum nutrient management.[229] Depending upon the price, which varies greatly from year to year, a small farmer in Rondônia can generate revenues of between US$1,100 per hectare to more than US$6,300.[230] The feasibility of this production system depends partially on family labor, but less so than in the Andes.

The global coffee market has experienced significant changes over the last decade. Global demand for mass market coffees has increased by an order of magnitude due to changes in consumer preferences in tea-drinking nations such as China. Simultaneously, traditional coffee-drinking counties, like the US,

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225 Large scale frosts or extended drought have decimated coffee plantations in Southern Brazil on 10 different occasions between 1900 and 2000; the 2016 harvest was also impacted by an extended drought. (source: http://www.coffeeresearch.org/market/frosthistory.htm)

226 According to the Peruvian ministry of agriculture, replanting coffee plantations decimated by coffee rust has reduced infestation by 50% of all trees to only 17% between 2013 and 2016.

227 Rainforest Alliance (2015) Climate-Smart Coffee And Cocoa In The Peruvian Amazon, http://www.rainforest-alliance.org/videos/icaa-megantoni-ra

228 Portal do Governo de Esrado de rondonia (27 Mar 2021) Rondônia supera expectativa e colhe 2,3 milhões de sacas de café na safra 2020, http://www.rondonia.ro.gov.br/rondonia-supera-expectativa-e-colhe-23-milhoes-de-sacas-de-cafe-na-safra-2020/

229 EMBRAPa (13/07/15) Agricultura familiar https://www.embrapa.br/web/mobile/noticias/-/noticia/3609412/investimento-em-tecnologia-impulsiona-producao-de-cafe-em-rondonia

230 yield = 0.5 t/ha @ $us 2/kg versus yield = 1.2 t/ha @ $us 2.6/kg.

have increased consumption of premium coffees. Peru and the other Andean countries are focusing on the premium coffee market and many producers are adding value to their production by embracing certification and organic production paradigms. These countries have large areas of idle land located on landscapes with current growing conditions capable of producing premium coffee beans that are highly competitive in global markets.

The smallholder associative model linked to sustainable production standards has the greatest potential to integrate and sustain climate benefiting bioeconomy practices in coffee micro-agroforestry. With financing and better practices, annual productivity can increase from the current 650-900 kg/ha to around 1,300kg/ha. To this end, credit incentives must be aligned with a coherent crop policy program. This model, which currently brings together between 10-20% of small coffee producers, includes in most cases the production and trade of certified products, since formal association is a precondition for the management of internal control and traceability systems. Marketing and processing companies can induce associative suppliers to produce climate smart, deforestation-free coffee as long as market demand and/or local policies support this change. Main good practices include: i) Proper selective pruning over a three-year horizon, ii) Introduction of rust fungus resistant varieties (when necessary), iii) Effective combination of low emission fertilizers based on soil analysis, iv) Proper shade management with commercial timber species and pruning of perennials, v) Integrated pest management, and vi) Rational water management in the harvesting process.

Model intervention based on coffee agroforestry in Colombia, Brazil and Peru

Value chain structure, yields and prices	*Production: planting, maintenance and harvesting:* Average smallholder producer holdings of 1-5 ha. Productivity 500-800kg/ha/year in Colombia and Peru, Brazil often up to 1,000-1,200kg/ha/year. In Peru of these producers, only 12% are associated and only 11% have had access to credit, while 20% have had access to training or technical assistance to improve their productivity. Price highly volatile. Average 10-yr farm gate price estimated at US$1.9/kg, Revenues from shaded/agroforestry organic systems are highest, with an average difference of up to 10-20% compared to traditional coffee systems. However, certification often necessary to access these premiums, and certification costs and challenges highly variable. *Collection and primary selection and transformation:* Approximately 3,000 companies and cooperatives involved in local coffee collection and processing (Colombia 750, Peru 750, Brazil 1,500). Average 10-yr internal transfer price estimated at US$2.57/kg. *Distribution and export:* The average 10-yr coffee export price was US$2.9/kg. Intense price competition, hence the need to promote national and other new coffee markets and the cultivation of agroforestry specialty coffees, which do not depend on the market for conventional coffees.
Technical services and best practices	NGOs and government extension agencies needed to provide technical support and professional input suppliers (fertilizer, pest management, etc.) to make successful migration from traditional sun coffee to shade coffee agroforestry amongst micro-producers. Penetration of extension service currently 10-20% in Peru and Ecuador, 30-50% in Colombia and Brazil. Government agencies, Chambers of Commerce, and others, to provide marketing and technical support for commercialization and export.
Financial services	Microfinance services to the smallholder producers in this chain are mainly provided by rural banks and credit cooperatives. Most of loans currently only for working capital and range between US$1,000 and 2,500, at rates that fluctuate between 25% and 35% annually. Established banks and social finance entities (Rabo, Root Capital, Acumen) provide first-tier financing to companies in the processing and export node of the chain, with typical loans in the order of US$500,000 to 2 million, at interest rates that fluctuate between 6% and 8% per year.

Climate vulnerability and other risks	Modeled global distribution of Arabica coffee under changes in climatic suitability by 2050s as projected by 21 global circulation models suggest that in South America close to the equator higher elevations could benefit, but higher latitudes lose suitability[231]. In Brazil, climate models indicate that the annual mean air temperature is expected to increase 1.7 °C ± 0.3 in the study region, which will lead to almost 60% reduction in the area suitable for coffee production in unshaded plantations by 2050[232]. In Colombia, on average, areas suitable for Arabica and Robusta coffee cultivation are projected to decline by 12.6% and 21.8%, respectively. However, these national averages hide important sub-regional variation. Steep suitability losses projected for Arabica coffee in the areas where it is traditionally grown are counterbalanced by substantial gains at higher elevations across the Andean region, as well as moderate gains across lower lying pockets in the north and southwest. In Peru, the average suitable area for Arabica and Robusta coffee cultivation is projected to decrease steeply by 24.5%, and 20.1%, respectively.
Key Barriers and Enablers	Coffee farmers are a heterogeneous group, historical low access to finance and credit. Working with intermediary financial institutions with a proven track record of growth with the sector will be essential to reaching them. Zero or low cost, high quality extension assistance will have to go hand-in-hand with finance, in order to facilitate incorporation of agroforestry models and Deforestation Free Production agreements. and achieve adoption targets. Limitations of staff and time of agricultural support orgs. Climate change is high threat to coffee viability as growers forced to "migrate upward" into intact montane and cloud forest habitat. Managing this migration within a Deforestation Free Production envelope will be challenging.
Current extents and potential program adoption	Brazil largest global producer, producing higher yields than neighboring producers. Peru and Colombia focusing more on premium coffees. No material cultivation in Guyana, Suriname, stagnant in Ecuador and Bolivia. Target of 40% adoption rate in Brazil and Colombia (thanks to consolidated public and private extension services), 20% Ecuador and Peru (greater logistical and technical services challenges, lower credit penetration).
Proposed intervention	Micro: 1 additional ha agroforestry/shade arabica coffee and improved fertilization and agroforestry practices on existing 2 ha requiring US$3,200 financing. Small: US$200,000 financing for improved aggregation, drying and selection facilities in order to improve volumes and product quality. Large: Expanded or new manufacturing capabilities and export facilities requiring average US$2 million. Proceed with concessional finance, technical assistance and incentives.
Mitigation activities and impacts	The agroforestry system involves arabica coffee, bananas and native tree species with a maturation age of 20 years. The bananas are the initial source of income, cropping years 2, 3 and 4. At year 4-5 cacao production begins. At year 20 or 21 timber harvest. With improved agroforestry and fertilization practices, income is accelerated (bananas) and diversified, with long term capital accrual through timber. The converted and new coffee agroforestry areas should reach and additional 11 tCO_2/ha/annum sequestration (Program Financial and Carbon Model).
Adaptation activities and impacts	The Andean Amazon may take advantage of new market opportunities. But they may require specific policies and strategies to ensure that expansion of coffee farmlands takes place in climatically, pedologically and ecologically suitable areas, to ensure Deforestation Free Production. Some areas will become more suitable while others will lose suitability. This calls for approaches at the local scale to help farmers to adapt to climate change. Moving to agroforestry, with fertilization, pest management and irrigation best practices will greatly assist in climate adaptation[233]. Agricultural practices (i.e. crop diversification, CSA, use of improved varieties, no-till, intercropping, precision nutrient management, and integration of indigenous knowledge), Forest, land, and water management, increasing efficiency in water use (i.e. expansion and/or rehabilitation of irrigation systems), and continued agricultural research. Marginal coffee cultivation economics will be improved increasing coping capacities and generating employment.
Financing aspects	Typical coffee farmers can access micro-loans of US$1,500-2,500 with 6-12 month tenor at interest ranges of 25-50% annual (Colombia:25-50%, Peru:25-45%). Though terms highly unsuitable, producers are accessing these loans for agronomic inputs (fertilizer, etc). These micro-loans are however not suited for agroforestry expansion and farming practices improvements, where lower

231 Ovalle-Rivera O, Läderach P, Bunn C, Obersteiner M, Schroth G (2015) Projected Shifts in Coffea arabica Suitability among Major Global Producing Regions Due to Climate Change. PLoS ONE 10(4): e0124155.

232 L.C. Gomes, F.J.J.A. Bianchi, I.M. Cardoso, R.B.A. Fernandes, E.I. Fernandes Filho, R.P.O. Schulte. 2020.
Agroforestry systems can mitigate the impacts of climate change on coffee production: A spatially explicit assessment in Brazil, Agriculture, Ecosystems and Environment

233 Pham, Y., Reardon-Smith, K., Mushtaq, S. Cockfield, G. The impact of climate change and variability on coffee production: a systematic review. *Climatic Change* 156, 609–630 (2019).

	interest rate (4-8% annual) and tenor 4 years (cacao starts producing at year 3) are needed. Proceed with concessional loans, technical assistance and incentives.
Number and size of beneficiaries and financial demand	Across Brazil, Colombia, Ecuador and Peru we estimate a total of 43,810 beneficiary entities (43,462 micro, 339 small and medium, and 9 large). Total potential financial demand in the order of US$237 million (micro: US$146 million, small and medium: US$71 million, and large: US$20 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[234].

Potential beneficiary entity case study

Name of Entity	Cooperativa de Servicios Multiples Bosque de Alto Mayo (COOPBAM)
Business Model & Value Chain Node	COOPBAM is a certified fair trade and organic coffee cooperative founded in 2008, with more than 500 members who commit to sustainably using natural resources in the Alto Mayo Protected Forest and to zero net deforestation. COOPBAM begun as an initiative to halt increasingly high deforestation rates at the national Alto Mayo Protected Forest. The Peruvian National Protected Area Service (SERNANP) and Conservation International teamed up to create incentive programs, or conservation agreements. They then identified coffee farmers, providing them technical and institutional support in exchange for their commitment to stop deforesting. COOPBAM grows coffee in agroforestry systems; cultivating, selecting, producing and selling quality coffee nationally and internationally, even to specialty coffee markets.
Location	San Martín region, Peru
Development Stage and Certifications	By 2019 the San Martín region was first in coffee production, with 25%. In 2020 COOPBAM had 463 registered associates, with 91 women. They cultivate in 907 hectares through agroforestry systems and environmentally friendly practices. The Women´s Cooperative also works with coffee seedling production and create artisanal crafts for sale. Certified fair trade and organic
Theory of Change & Impact Strategy	COOPBAM works with AFS coffee while also reforesting degraded areas with native tree species.
Innovation / R&D	Organic AFS coffee farming with sustainable land management practices.
Climate Change Nexus	
Spatial distribution and market	Farmers work in the northern part of the Alto Mayo Protected forest and export their coffee nationally and internationally to US, Europe and Japan.
Mitigation benefits	● Decreased risk of land-use change or deforestation ● Soil enrichment through biodynamic and organic agricultural practices ● Trees increase soil organic carbon sequestration (Niether et al. 2020; Solis et a. 2020), and trees largely sequester carbon into living biomass. Solis et al. (2020) conducted a study on coffee agroforestry in the Peruvian Amazon, and found that coffee agroforestry systems store substantially more carbon than conventional agricultural practices.
Adaptation benefits	● Agroforestry trees can support the formation of micro-climates that can help buffer increasing temperatures and changes in precipitation (Niether et al. 2020) ● Agroforestry Systems can function as biological corridors between primary forests, which increases connectivity and strengthens biological diversity. They also help to improve tree diversity (Solis et al. 2020).

[234] Linhares et al, 2014. ANÁLISE DO PROCESSO DE CONVERSÃO DE SISTEMAS DE PRODUÇÃO DE CAFÉ CONVENCIONAL PARA ORGÂNICO. EMBRAPA., Hajek, F. et al. 2017. El potencial para incentivar inversiones agrícolas y forestales libres de deforestación en la Amazonía peruana. Lima, Peru: Solidaridad, Nature Services Peru and Seed. MINAGRI, 2019. Observatorio de commodities: Café, Robiglio, V., Vargas, R., Suber, M. 2018. La Cesión en Uso para Sistemas Agroforestales. Los potenciales beneficiarios, su distribución geográfica y la estimación del potencial de contribución a las metas climáticas en el Perú. In: Apoyo al Desarrollo de Cesión en Uso para Sistemas Agroforestales en Perú. Lima: ICRAF., Assis, 2014. ANÁLISE DO ROCESSO DE CONVERSÃO DE SISTEMAS DE PRODUÇÃO DE CAFÉ CONVENCIONAL PARA ORGÂNICO: UM ESTUDO DE CASO1", HIVOS, Oxfam, Solidaridad, CI, 2020. Coffee Barometer 2020

	• Diverse products can be harvested from agroforestry systems, helping to strengthen local livelihoods and diversify incomes. For instance, a study from a polyculture coffee agroforestry system in Peru found species richness was high within agroforestry systems, with 18 tree species identified as important sources of fodder, food, wood, firewood and medicine (Solis et al. 2020). • Coffee in agroforestry systems results in enhanced soil moisture (shade cover reduces loss from evapotranspiration and transpiration, and leads to more available water in soils; Lin 2007) • The trees reduce runoff speed, increase infiltration, increase vegetation cover, control soil erosion (Lin 2007)
Climate vulnerability	High temperatures, intense rains and drought events may impact coffee production systems, especially non-shaded systems. Zones better suited for arabica coffee migrates upwards by about 500m in elevation, with negative ecosystem impacts (Bunn et al, 2015; Ovalle-Rivera et al., 2015). Reduction in 60% of area suitable for coffee production in Brazil (Gomes et al, 2020). In general coffee agroforestry systems (i.e., shade-grown) are considered an important adaptation measure, where shading can decrease air temperature fluctuations by 3-4oC (Camargo et al. 2008 in Haggar and Schepp 2012).
Sustainable management practices & models	AFS coffee cultivation which renews the soil and stops agricultural frontier expansion. They do not use herbicides or insecticides, only natural fertilizers.CI is providing benefits such as new facilities to treat wastewater, which reduces the environmental impact on the Mayo River, and simple improvements to the drying of coffee beans.
Beneficiaries	1. More than 500 cooperative members 2. Women members participants of the Women Cooperative 3. All members of COOPBAM operate within the northern part of the Alto Mayo Protected Forest, which provides vital fresh water to downstream communities, to more than 280,000 people in the Rioja and Moyobamba provinces, and is home to many threatened and endemic plant and animal species.
Other co-benefits	
Environmental co-benefits	Biodiversity conservation, water and soil regulation ecosystem services
Social co-benefits	Provide jobs and income for both women and men.
Risks	
Potential (social, environmental) risks	• Inadequate growing conditions may impact coffee production quality and availability. • Unexpected climate events (drought, flood, etc.) may weaken the crops and increase pest or disease outbreaks. • COOPBAM's ability to sustain the market or production shocks. Farmers migrate to unsustainable land-use practices. • Agricultural frontier expansion and other land-use change
Potential risk mitigation strategies	• Development and governance strategies are created and implemented to attain self-sufficiency • Diversify crops and COOPBAM services to promote food security and service provision for all members and communities • Continue connecting with and informing neighboring communities and farmers of the social, environmental and economic benefits of coffee AFS production.

3.1.1.3 Native palm-based agriculture

There are over twenty native Amazonian palm species that could possibly form the basis of new sustainable perennial agricultural models in the Pan Amazon. Several of these occur naturally in large monodominant or oligo-dominant populations. One palm species that has already made the jump from important Non-Timber-Forest-Product (NTFP) to important perennial crop is Açaí (*Euterpe oleracea).*

Açaí (*Euterpe oleracea*)

Açaí is a palm native to marsh habitats that has been a NTFP mainstay of the Lower Amazon economy for decades**.** The demand for *açaí* has surged as the nutritional benefits of *Açaí* fruits became recognized in national and international markets, making it a trend in health food bars and gymnasiums. Intensity of açaí management ranges from simple collection and enrichment management in natural forest (see section below under NTFP) to semi-intensive cultivation. It can generate income between US$1,300 and -2,700 per hectare in managed natural wetlands, to more than US$4,000 to US$7,000 in irrigated perennial agriculture.[235]

The federal statistical agency (IBGE) began reporting harvests from cultivated plantations of açaí in 2015 with an initial report of 135,000 hectares, which grew to 195,000 hectares by 2019.[236] The cultivated harvest is now approximately six times larger (1.4 million tons) than the wild harvest (230,000 tons), which together have a total supply value of approximately US$1 billion representing 2% of state GDP.[237]

The 2019 harvest was concentrated into 80,000 tons of pulp; 60% was consumed within Pará, 35% in other parts of Brazil, with remaining 5% directed to export markets, including North America (66%) and Europe (20%), as well as East Asia and the Middle East. Short-term projections forecast annual growth of 12.5% and analysts predict that 45% of production will be destined for export markets buy 2025. [238] The expansion in açaí production has been supported by state and federal agricultural research services, as well as producer associations that developed a technological package based on plantations established in upland soils with supplemental irrigation.[239] The novel technology maximizes yield by expanding the harvest between January to July when natural population stop flowering due to high water levels, while facilitating harvest logistics.

Another notable native palm is Macaúba (Acrocomia aculeta). It is a single stem palm that occurs throughout tropical and subtropical Americas on dry forest, savanna and scrub landscapes of the Pan Amazon, as well as a common constituent of secondary vegetation and cultivated cattle pastures, with mean annual rainfall between 1500 and 2000 mm and altitudes between 150 to 1000 m above sea level. The plant is a prodigious producer of fats in both the mesocarp (29%) and seed (46%), both of which can be processed to produce a vegetable oil that can be used as food or as a feedstock for

[235] Coelho, D. B., Zirlis, C., de Toledo, G. C., Tosi, N. V., and Fonseca, R. N. Cadeia Global de Valor Açaí. https://raia.espm.br/wp-content/uploads/2018/03/Setor-do-A%C3%A7a%C3%AD.pdf

[236] SIDRA - Sistema IBGE de Recuperação Automática (1 Nov 2020) Produção Agrícola Municipal, Tabela 1613 - Área destinada à colheita, área colhida, quantidade produzida, rendimento médio e valor da produção das lavouras permanentes https://sidra.ibge.gov.br/pesquisa/ppm/quadros/brasil/2019

[237] CONAB - Companhia Nacional de Abastecimento (Março 2019) Análise Mensal, Açaí, https://www.conab.gov.br/

[238] CONAB - Companhia Nacional de Abastecimento (March 2020) Análise Mensal, Açaí https://www.conab.gov.br/

[239] Oliveira, L. P. de., et al. 2016. Programa de Desenvolvimento da Cadeian Produtiva do Açaí no Estado do Pará - PROAÇAÍ – PA. Belém, ecretaria de Estado de Desenvolvimento Agropecuário e da Pesca – SEDAP.

consumer goods and biofuels.[240] Although it has been consumed by indigenous communities in the historical past; is not currently part of any industrial-scale food chain and has been under evaluation as a biofuel and food crop by the Brazilian agricultural research agency (EMBRAPA) since the 1980s.[241]

Macaúba has the potential to transform the global vegetable oil industry, because of characteristics that confer a competitive advantage compared to soya, rapeseed and palm oil:
Sustainability: It can be cultivated in degraded lands and pastures; plantings will reduce water surface runoff and support atmospheric recharge of hydrological systems on deforested landscapes. As perennial woody species, it sequesters carbon throughout its production lifecycle (30 years). It can be cultivated as a stand-alone plantation or as a component within a diversified production system, including cattle ranching and field crops.

Productivity and Quality: Intensively managed plantations yield up to 9 tons vegetable oil per hectare[242] with high content of preferred fatty acids, particularly lauric acid (kernels @ 41%) and oleic acid (fruit pulp @ 67%); high foliar biomass (30 tons/ha) have potential as feedstock for cellulosic ethanol.[243]
Robustness and Adaptability: The species thrives in different climate and soil types, enabling its widespread cultivation; it can be cultivated in regions that receive only 50% of the rainfall required to support oil palm plantations.

Like the African oil palm, Macaúba fruits must be processed within a relatively short time period or the fats in the pulp will become rancid; this dictates that plantings must be located near a processing facility. Consequently, Macaúba will require an industrial complex not unlike the African palm oil sector; however, because its fruits have a hard outer shell (exocarp), they are less susceptible to spoilage. Spoilage will be much less important, if Macaúba is cultivated primarily as a biofuel, because the refining process is indifferent to feedstock composition. This holds true when it is commercialized as fatty-acid-ester used for blending with conventional fuels, or as refined biofuel that is used in internal combustion engines (biodiesel) or a kerosene-like fuel used by the aviation industry (biojet).

Currently, in Brazil there are three important commercial plantation initiatives for the macauba palm that should attract the attention of other farmers. Entaban Brazil is starting macauba fruit production in an area of 600 ha and Solea Brazil has planted 1000 ha in 2016 and 2017 and the company is expected to reach an area of 5000 ha in the next five years. Another important initiative is being conducted by the German company Inocas which is currently planting 2000 ha of macauba in the region of Patos de Minas, Minas Gerais, through a project financed by the Inter-American Development

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[240] Coimbra, M. C., and Jorge, N. (2011). Proximate composition of guariroba (Syagrus oleracea), jerivá (Syagrus romanzoffiana) and macaúba (Acrocomia aculeata) palm fruits. Food Research International, 44(7), 2139-2142.

[241] de Oliveira, L. D. C. A., and Velasco, D. G. (2019). Los saberes tradicionales de la Macaúba (Acrocomia Aculeata) asociados a la feria agroecológica las Raíces del campo en Jaboticatubas, MG/Brasil. Revista Euroamericana de Antropología.

[242] Due to a smaller canopy and root diameter, Macaúba palms can be planted at greater density (stems/hectare) than the African oil palm (*Eleias guianansis*), which could translates into yields higher than oil palm (~4 tons/ha).

[243] Pimenta, T. V., ANDRADE, M. C., and Antoniassi, R. (2012). Extração, neutralização e caracterização dos óleos do fruto da macaúba (Acrocomia aculeata). In Embrapa Agroindústria de Alimentos-Artigo em anais de congresso (ALICE).

Bank[244]. The volume of oil to be produced by these plantations should have a guaranteed market for biodiesel production. Brazil is the second largest producer and consumer of biodiesel in the world, and through the years has built a network of 35 Biodiesel production plants, concentrated in the center-south region of Brazil, with capacity to produce 7.30 billion liters per year. In 2016, Brazilian consumption was 3.8 billion liters, according to the Bulletin of Biofuels of the Ministry of Mines and Energy of Brazil, revealing the idleness of the mills and the need to increase the production of raw material.

Other palm species with significant agronomic potential include:

Ungurahui (*Oenocarpus bataua*) and Aguaje (*Mauritia flexuosa)* are single stem palms native to floodplain and inundated forest of the Central and Western Amazon with fruits that have been used to manufacture artisanal beverages by indigenous communities over millennia. Like açaí, they have high nutrient value and important phytochemicals (beta-carotenoids) with known health benefits [245] Both are restricted national markets with an established consumption in Amazonian urban areas and the potential to expand to national markets (~10,000 tons per year).[246]

Caranda (*Copernecia prunifera*) from Central Brazil and Bolivia and Carnauba (*Copernecia alba*) from Maranhão and adjacent states in Northeast Brazil; both are single stem palms native to wetland savanna formations that produce waxes on their foliage and fruits with industrial applications. There are twenty processors of carnauba wax in Brazil who source carnauba wax from middlemen or directly from farmers; in 2019, the harvest was reported 20,000 tons (wax + powder) with a total value of US$70 million.[247] Production has been stable since about 2000, but prices (in $R) have risen at ~3% annually over the same period of time. The sector has been accused of exploiting their rural workers, which some labor and human rights advocates have characterized as slave labor, which motivated them and their supply chain partner sin the advanced economies to create a roundtable-like association dedicated to sustainable carnauba.

Babasu (*Attalea speciosa*) is a single stem palm native to transitional forests in Santa Cruz Bolivia and the Cerrado biome of Brazil. The palm produces large seeds high in saturated fats (lauric and myristic) that melt at body temperature making them suitable for skin and hair care product, as well as acting as a moisturizing agent with anti-inflammatory and antibacterial properties.[248] In 2019, revenues from the sale of the palm kernel were reported to be US$30 million, but that local middlemen and

[244] Building a Sustainable Macauba-Based Silvopastoral System and Value Chain in Brazil. CIF-GDI DELIVERY CHALLENGE CASE STUDY - MAY 2020

[245] Horn, C. M., Gilmore, M. P., and Endress, B. A. (2012). Ecological and socio-economic factors influencing aguaje (Mauritia flexuosa) resource management in two indigenous communities in the Peruvian Amazon. Forest Ecology and Management, 267, 93-103.

[246] PEDICP – Proyecto Especial Binacional de Desarrollo Integral de la Cuenca del Rio Putumayo (2014) Estudio de preinversión a nivel de perfil , Mejoramiento de los servicios de manejo sostenible de aguajales en tres (03) comunidades de la zona media de la cuenca del Rio Napo, Distrito de Mazan, Provincia de Maynas, Departamento De Loreto,

[247] SIDRA - Sistema IBGE de Recuperação Automática (1 Nov 2020) Produção da Extração Vegetal e da Silvicultura, IBGE - Instituto Brasileiro de Geografia e Estatística (, https://sidra.ibge.gov.br/tabela/289

[248] Healthline.com (3 Nov 2020) Benefits of babassu oil, https://www.healthline.com/nutrition/babassu-oil#benefits

processors contributed another US$70 million of value to the supply chain.[249] Production fell from 200,000 tons in 1990 to 115,000 tons in 2007 and 62,000 toms in 2016;[250] the loss of market share is probably due to displacement lauric acid distillates that can be refined from other vegetable oils that have come to dominate global markets.

Pejibaye/pupunha/pijuayo/chontaduro (*Bactris gasipaes*) is a multi-stemmed palm known for its palm hearts and edible fruits, which are rich in nutrients, oils and beta-carotenes. It does not occur in large monodominant or oligo-dominant naturally occurring populations, but is grown extensively in smallholder farms and commercial farms, and is being used successfully in agroforestry systems. A non spiny stemmed commercial variety has been cultivated and is rapidly gaining popularity with farmers and forest inhabitants.

Huasai, Açaí del monte (*Euterpe precatoria* and *Euterpe edulis*) are closely related species to *Euterpe oleracea,* which prefer terra firme habitats. They are popular NTFPs and are also grown in smallholder farms in Bolivia, Peru, Ecuador and Colombia. Both their fruits, which have very similar appearance and properties to açaí, and their palm heart are utilized.

Model intervention based on irrigated native palms (açaí) model in Brazil

Value chain structure, yields and prices	*Production: planting, maintenance and harvesting:* There are small farmers with a cultivation range between 5 and 15 hectares, small and medium producers with crops between 20 and 80 hectares and corporations with more than 1000 planted hectares. EMBRAPA estimates that the 198,000 hectares of plantations in 2018 was split approximately 40% micro producers, 40% medium producers and 20% large producers. Average farm gate price for 2019 was US$248/ton *Collection and transformation:* There is both artisanal collection and transformation for local consumption and industrial transformation for national and export markets. Micro, small and large companies are involved. *Distribution and export:* Of the total production 2019, approximately 50% was consumed 60% was consumed regionally in the Amazon, 30% was consumed in other regions of Brazil and 10% was destined for export.
Technical services and best practices	EMBRAPA has supported the transition of açaí from NTFP to perennial crop, and has launched the first two cultivars BRS Para and BRS Pai de Egua ComTec317 after 6 year improvement programs. Irrigation is the most promising technical improvement under current implementation. Robust pool of irrigation, fertilization, soil analysis service providers on the market to attend to different plantation sizes.
Financial services	Microfinance services to this chain are provided by rural banks and credit cooperatives. Most of loans currently only for working capital and range between US$2,000 and 5,000, at rates that fluctuate between 50% and 60% annually.
Climate vulnerability and other risks	Increased climate variability poses serious risks to agriculture, including native palm agriculture. In the case of açaí, a specialist of flooded habitat, these could take the form of: a) Interruptions to crop growth cycle from warmer temperatures and reaching of upper heat and water stress thresholds, b) New pest and disease outbreaks, and c) changes in crop yields and productivity.

[249] Porro, R. (2019). A economia invisível do babaçu e sua importância para meios de vida em comunidades agroextrativistas. Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas, 14(1), 169-188.

[250] SIDRA - Sistema IBGE de Recuperação Automática (1 Nov 2020) Produção da Extração Vegetal e da Silvicultura, IBGE - Instituto *Brasileiro* de Geografia e Estatística

Key Barriers and Enablers	Açaí cultivation has enjoyed very healthy growth in the last decade (over 10% annual) due to its inherent nutritional qualities, but also due to its pioneer status and the growth in national and international demand. Competition from other palm growing countries experimenting with cultivation in south east Asia is a significant medium term threat to continued growth, as would have a competitive advantage in Asia and Europe markets.
Extent and potential program adoption	Brazil is the only country so far to scale native palm (açaí) agriculture. Due to the great productivity improvements of irrigation a 50% adoption target is proposed. Palmito (*Bactris sp.*) more widespread and the second most consolidated crop. Morete (*Mauritia sp.*) under experimental phase in Colombia, Brazil, Peru and Ecuador.
Proposed intervention	Micro (10ha)/medium (50ha) /large (1250ha): Pump driven irrigation with micro-aspersion, as well fertilization and best practices. Productivity goes from 4.5 ton/ha to 9 - 12 ton/ha, across firm sizes. Financial requirement of US$2,400 per hectare, covers irrigation equipment and fertilization supplementation for 2 years. Açaí processing, packaging and export facilities, ranging from small to large. Potential financing beneficiaries, size of investments not scoped. Proceed with concessional finance, technical assistance and incentives.
Mitigation activities and impacts	Irrigation increases productivity of açaí cultivation significantly, with values well over 100% reported[251]. This increased productivity is accompanied by above and below ground carbon stocks increases. Irrigated açaí areas should reach and additional 6 tCO_2/ha/annum sequestration (Program Financial and Carbon Model).
Adaptation activities and impacts	As a perennial woody crop, native palms, including açaí, can support the formation of micro-climates that can help buffer increasing temperatures and changes in precipitation. This increase in canopy cover can limit soil degradation, erosion and sedimentation, improve soil health, while also supporting biodiversity conservation, and maintaining ecological integrity at the landscape level. Marginal açaí cultivation economics will be improved increasing coping capacities and generating employment.
Financing aspects	Smallholder and medium sized acai producers, as well as producers of other native palm crops, are limited due to the high interest rates and short tenors of rural finance in Brazil. Micro-aspersion irrigation is a ´sophisticated´ intervention which represents a large investment for these producers and delivers increased revenues gradually in the first 3 years. The minimum investment of US$24,000 is a ´large´ loan for existing rural financial intermediaries, land assets may not be accepted as collateral. Lower interest rate (5-10% annual) and tenor 4 years (acai palm productivity will increase in year 1and 2, but not fully until year 3) are needed. If farmers opt to use loan for palm agriculture expansion then interest rates would have to be a couple of percentage points lower and tenor 2 years longer. Proceed with concessional loans, technical assistance and incentives
Number and size of beneficiary and financial demand	Across all countries we estimate a total of 43,810 beneficiary entities (43,462 micro, 339 small and medium, and 9 large). Total potential financial demand in the order of US$237 million (micro: US$146 million, small and medium: US$71 million, and large: US$20 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[252].

Potential beneficiary entity case study

Name of Entity	Mixed Tomé Açu Cooperative (CAMTA)
Business Model & Value Chain Node	Sustainable agricultural cooperative producing fruit pulps and other NTFPs. Located in Pará, Brazil, CAMTA was founded in 1949 by Japanese immigrants. The cooperative production transitioned from vegetables and black pepper to a biodiverse agroforestry system in 1960. Its associated farmers produce under their SAFTA, integrating varied agricultural crops, with fruit trees and native timber species. Today they process, add value and sell açai, cupuaçu, cacao, black pepper, passion fruit, and Brazil nut, and mahogany amongst other products. Total production goes to national (50%) and international markets (50%), mainly to Europe and USA.
Location	Tomé-Açu, Pará, Brazil

[251] EMBRAPA 2019.BRS Pai d'Égua: cultivar de açaí para terra firme com suplementação hídrica1. ComTec317,

[252] EMBRAPA, 2006. Costos acai irrigado, STATISTICA.id1069776_brazil_-acai-berry-production-2016-2019
Kingo, 2009. Costo produccion acai irrigado aspersion. EMBRAPA

Development Stage and Certifications	They have more than 170 associates and benefit more than 1,800 farmers. Their projects and services create 10,000 direct and indirect jobs. CAMTA açai production in 2019, both irrigated and conventional/manual, ranged from 30 to 50 tons per month. This is then processed at the cooperative´s industrialized processing factory. CAMTA has Organic USDA certification.
Theory of Change & Impact Strategy	CAMTA is concerned with climate change mitigation and adaptation, promoting environmental awareness amongst its associates and farmers. They see their SAFTA system as a way to reduce forest degradation and mitigate negative CC impacts. Invest in Capacity building and technical assistance along the value chain, from seedling production, AFS management and harvesting, and continous staff training on agroindustry best practices. CAMTA does quality monitoring of raw material and final product through their laboratory for physical, chemical and microbiological analysis.
Innovation / R&D	Even though CAMTA does not actively promote açai irrigation technology, they partner with EMBRAPA, who offers capacity building workshops to inform farmers on its benefits, increasing the amount of adepts within its members. A 12-year analysis of two farms members of CAMTA show that açai production without irrigation was unstable, with positive and negative variations due to lack of rain and other pertinent environmental factors throughout the study. Irrigated production was comparatively higher in year 1 of production and increased, to a stable amount, from year 2 onwards. Both production methods were economically viable, with differences explored below: Non-irrigated açai production NPV of R$ 45,436.08, a liquid CBI of R$ 7,22, an IRR of 43,83% per year, and a payback of 5 years and 7 months. Finally, this farm would need to produce 124 kg/year to reach a balance point. Irrigated açai production NPV of R$ 83,129.00, a liquid CBI of R$ 3,86, an IRR of 39,00 % per year, and a payback of 4 years and 6 months with a balance point of 626 kg/year.
Climate Change Nexus	
Spatial distribution and market	Tomé-Açu municipality, with açai production selling to national and international markets. The 2019 harvest was concentrated into 80,000 tons of pulp; 60% was consumed within Pará, 35% in other parts of Brazil, with remaining 5% directed to export markets, including North America (66%) and Europe (20%), as well as East Asia and the Middle East. Short-term projections forecast annual growth of 12.5% and analysts predict that 45% of production will be destined for export markets buy 2025.
Mitigation benefits	• AFS açai production contributes to biodiversity conservation, potential forest connectivity and sustainable land-use management. • Reduce land and forest degradation • Carbon sequestration (Condé 2020)
Adaptation benefits	There is limited peer-reviewed research on adaptation benefits of cultivated acai from plantations. Tregidgo et al. (2020) noted the need for more research on agroforestry acai systems, where the integration of trees may support micro-climate buffering and help adapt the crops to climate change.
Climate vulnerability	Pará is located in a high climate change vulnerability area, with drier conditions and rainfall patterns which may impact açai production (e.g., Tregidgo et al. 2020). As is already observed by farmers and as showed in the 12-year comparative study.
Sustainable management practices & models	CAMTA actively trains and promotes for environmental conservation and adaptive capacity within its value chain. CAMTA follows Organic certification land management best practices and innovate along their value chain. Such as composting all organic residues coming from the factory to fertilize their crops. Irrigated açai production, in addition to the BRS-Pai d´ Agua variety, allows for higher production levels throughout the year. Nevertheless, current costs may hinder family farmers to transition at a larger scale.
Beneficiaries	Açai farmers, Agricultural cooperative members and associated workers, Tome-Açu municipality
Other co-benefits	

Environmental co-benefits	CAMTA has participated of a 12 year-old study working with palm oil AFS systems, in partnership with Natura and EMBRAPA. The study shows this AFS system, which includes açai, increased palm oil productivity, sequestered 47,5 tCO_2/ha and showed positive impacts on CC mitigation, adaptation and soil, water and biodiversity ecosystem service provision.
Social co-benefits	Social responsibility project supporting more than 800 families directed to farmer families and youth. Family farming capacity building and technological transference for agroforestry system implementation and management.
Risks	
Potential (social, environmental) risks	● Inadequate growing conditions may impact açai production quality and availability ● Unexpected climate events (drought, flood, etc.) may weaken the crops and increase pest or disease outbreaks. ● Small family farmers are unable to sustain the market or production shocks and transition to unsustainable land-use practices.
Potential risk mitigation strategies	● Improve knowledge and access to irrigated açai technology and implementation ● Promote biodiverse agroforestry systems for climate events shock mitigation ● Promote the inclusion of small-scale family farmers, and other vulnerable groups or individuals, into associations or cooperatives for support

3.1.2 Aquaculture

This sector includes the sowing, harvesting, and commercialization of native fish and aquatic species. Expanding Amazon aquaculture production can greatly reduce pressure from cattle-driven deforestation, while providing a healthy, land-sparing, low-carbon source of protein to regional and international consumers. Production of fish through aquaculture requires 30 times less land and emits just 3-5% of the carbon released through an equivalent volume of beef. It also gives cattle producers and communities a way to diversify income and secure food supplies. Fish is deeply embedded in the culinary traditions of the Amazon, and it is the dominant form of animal protein traded globally, with demand growing more rapidly than beef. Current fish production (8% of beef production) has already reduced the demand for 38,000 km2 of new deforestation— and could be far larger if the right measures are taken now[253].

A fish-based bioeconomy is also a socially inclusive economy; Indigenous peoples, traditional communities, smallholders and corporate producers are already participating. Amazon aquaculture production is now equivalent to about 8% of the region's beef production, with a much smaller land and carbon footprint; the annual production of a ton of beef requires 16 hectares of pastureland, 32 times more than the annual production of a ton of fish. Global demand for fish is far greater than the demand for beef, and is growing more rapidly, representing an important market opportunity for Amazon farmers and communities[254].

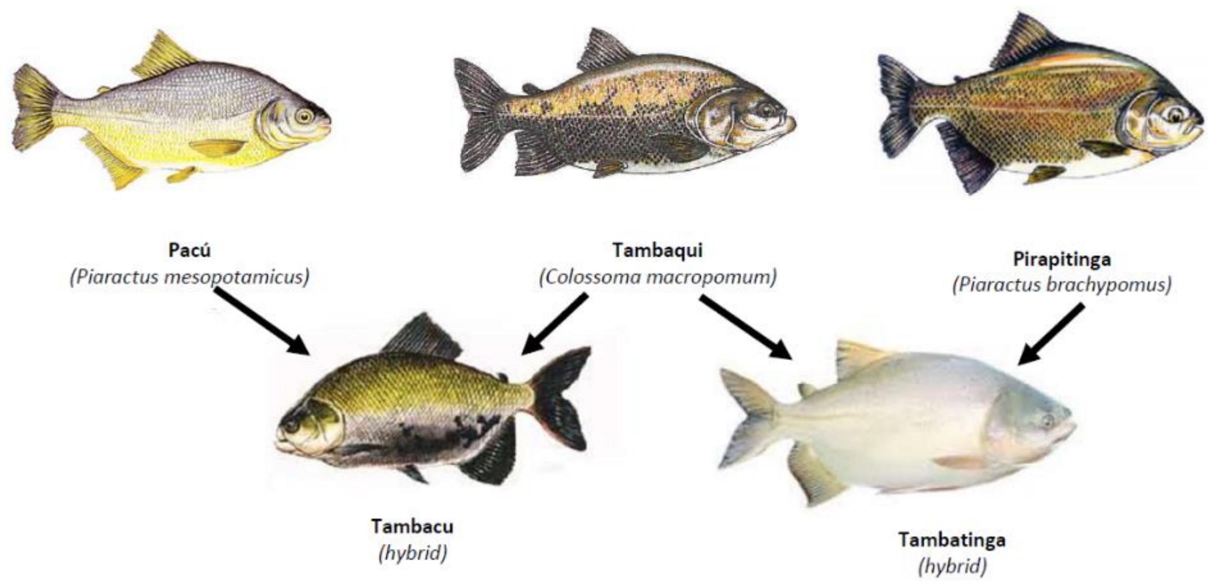
[253] McGrath et al, 2020. Can fish drive development of the Amazon? Policy Brief, Earth Innovation Institute

[254] McGrath et al, 2020. Can fish drive development of the Amazon? Policy Brief, Earth Innovation Institute

Freshwater fish farming is also ideal production system in the Amazon because of the abundance of freshwater resources, a favorable climate and a wealth of native species with commercial potential. As a production system, it is accessible to a large spectrum of potential producers, ranging from well-capitalized entrepreneurs to smallholders with limited resources, although in both cases, access to technology and careful management of environmental factors is key to success.

Fish farming in Brazil has expanded by approximately 200% between 2005 and 2015, with the states of the Legal Amazon contributing between 20% and 30% of national production of freshwater cultivated fish (Figure 46). This impressive growth is part of a global phenomenon that has seen the expansion of the sector in response to global demand and a growing realization that natural fisheries cannot sustainably meet that demand. The sector has been supported since 2003 by a dedicated field research service (*Embrapa Pesca y Acuicultura*), which is located within the Amazon (Palmas, Tocantins), while the *Secretaria Especial de Aqüicultura e Pesca* (SEAP/PR) has fostered policies and programs that contributed to its growth.

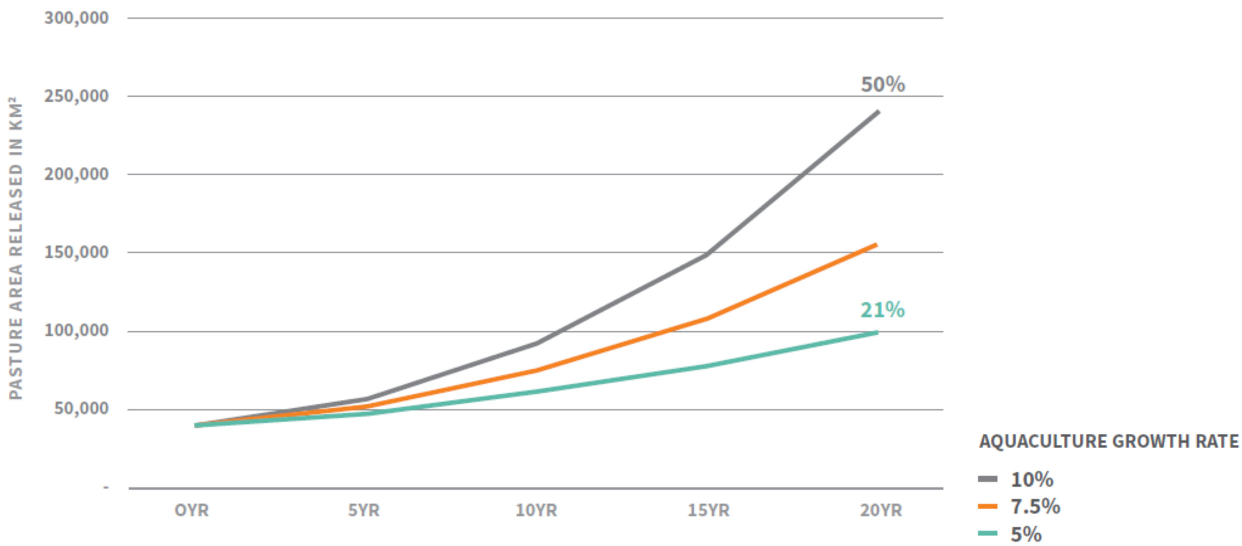
Figure 46: Freshwater native cultivated fish in the Amazon



The Brazilian statistical agency (IBGE)[255] has tracked national production since 2013 and lists 20 species that are cultivated in one or more of the Amazonian states. The most important species is *Tambaquí* (*Colossoma macropomum*) a native herbivore well suited for aquaculture that is known by a variety of regional names (*Pambaquí, Pacú, Patinga, Pirapitinga*) and hybrids with closely related species (*Tambacu, Tambatinga*). The next most important group of species are large-bodied catfish (Siluriformes), including the *Pintado, Cachara, Cachapira, Pintachara and Surubim*, all of which can be grown in cultivation or "ranched" in semi-wild production systems.

Figure 47: Aquaculture growth vs. cattle pasture release

[255] *Instituto Brasileiro de Geografia e Estatística – IBGE; Sistema IBGE de Recuperação Automática - SIDRA*



It is estimated that if aquaculture grows at a 10% annual rate for the next 20 years that 50 percent of the 2017 extent of pastureland will be released for other economic activities or restoration to forest. If the growth rate is only 5% per annum over the same time period then 21% of pasture area would be released.

A study of aquaculture in Mato Grosso found that an important factor in farmers' decision to invest in aquaculture was interest in diversifying farm production. The study found that farms that invested in aquaculture were 15% less reliant on beef production[256]. This suggests that an effective strategy for promoting the transition to aquaculture is to offer incentives to encourage commercial and small-scale farmers to invest in aquaculture. As these farmers gain experience in commercial aquaculture production and become increasingly competitive in national markets, they will be well positioned to expand aquaculture operations under favorable market conditions.

A core aspect of the incremental expansion of aquaculture as a strategy for reducing and mitigating Amazon deforestation is that rather than coercing farmers to stop clearing forest and forgo the income from new pasture, aquaculture provides strong incentives for farmers to shift from beef to fish on already cleared land. The high productivity of land use under aquaculture enables producers to comply with Brazil's Forest Code and meet market sustainability demands, while diversifying production and increasing farm income. Through this process, aquaculture can harness the enormous productive capacity of the Amazon's commercial and small-scale farmers to progressively reduce the total area in pasture while expanding aquaculture production and forest-based production systems.[257]

Proposed intervention based on *Colossoma sp.* aquaculture

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[256] IMEA. 2014. Diagnóstico da Piscicultura em Mato Grosso. — Instituto Mato-Grossense de Economia Agropecuária (IMEA), Cuiabá.

[257] McGrath et al, 2020. Can fish drive development of the Amazon? Policy Brief, Earth Innovation Institute

Value chain structure, yields and prices	*Production: planting, maintenance and harvesting:* Tambaqui aquaculture is growing rapidly in Brazil and Bolivia where feed rations can be produced at scale at low cost due to the ready availability of soy cake and feed grains. Aquaculture is also growing rapidly in Peru, and Colombia, but competes with highly efficient and sophisticated trout (salmo truta) producers in the Andes and other aquaculture products on the Coast. The production system is appropriate for small family farms, as evidenced by Rondônia's lead position in Brazil and the expansion of ponds on smallholder landscapes in smallholder landscapes in Bolivia and Peru. State of the art tambaqui aquaculture farm can yield up between 6,000 and 9,000 kg/ha per year . A well-designed system includes rectangular ponds of a determinate width and depth that facilitate harvest and temperature control, as well as reliable [source of fresh water to maintain water quality and a system to combat predation by birds and bats. Feed rations should contain about 25% soy [palm] cake and 50-75% maize (or sorghum, rice, etc.) and animal protein, but 100% plant-based formulations are under development.. The average area for micro-farmers in Peru is 0.4 hectares, while for small-scale fish farmers it is 6 ha. In Colombia it is 1 hectare and 7 ha respectively. Brazil is 2 ha and 10-20 ha respectively. The main species farmed is tambaqui, but many farmers farm mixed species. The cost of balanced feed for a micro-farmer's campaign is US$ 12,000. In the case of a small fish farmer, this cost varies depending on size from US$90,000 to 180,000, averaging around 60-65% of sales. *Collection, processing and distribution :* In Brazil, cold chain and processing in charge of medium and large food businesses and cooperatives. In Colombia, Peru, Bolivia and Ecuador cold chain not developed, small scale producers themselves collect and sell direct to local markets, with a small part of the production reaching the national market. Large producers sell to the national markets, no yet an export market for amazon species. Cold chain is key investment opportunity for large actors.
Technical services and best practices	Government and private technical institutions are working together for improving aquaculture performance. Brazil, Colombia and Peru have long term development programs backed by central government. In Peru, the National Aquaculture Innovation Program reaches producers directly with seeds, production technology and improved practices, and cold chain development which is key to expand market reach. In San Martin, the San Martin Aquaculture Association has been carrying out coordination and training activities to strengthen its members and develop cold chain. The Universidad Agraria La Molina, the University of the Amazon, and the IIAP are conducting research on production technology, seed development, and improved practices.
Financial services	Commercial financial services for the aquaculture sector in the Amazon are still underdeveloped, partly because aquaculture has only recently been consolidated as an economic activity in this region, and because loan amounts are higher than what is usually required by micro and small producers. As a result, the main lending experience is with state entities that promote the sector, specifically FONDEPES in Peru and IFIs working with development institutions in Brazil. The loan products focus not only on working capital for feed, but also on expanding aquaculture infrastructure, developing hatcheries and/or purchasing eggs and/or fingerlings. The amounts in Perú are up to US$18,000 at an annual interest rate of 3% and for loans over US$18,000 at 7%.
Climate vulnerability and other risks	Annual recurring drought events threaten water quality and quantity for aquaculture operations, which has led to increased events of hypoxia and fish die off across the region. In the medium and longer term, sea level rise and increasing temperatures will have an impact on aquaculture in coastal areas of the Pan Amazon.
Key Barriers and Enablers	Though great technical progress has been achieved in the last decade, significant technical hurdles remain for native species aquaculture: Rearing/seeding is in many case still artisanal, and fingerlings supply and genetics is still rudimentary, lacking standards. High level of dependence on distant feed producers is a cost and risk in frontier areas, more progress needed on high quality local feed production. Marker demand is predicted to continue to strengthen, both nationally and internationally, and so demand led growth is expected. Principal environmental risks include climate related water stress/supply and increased exposure to new diseases and outbreaks under production intensification trajectories.
Current extents and potential program adoption	Brazil leads on both the diversity, technology and volume of its native aquaculture sector, which is consolidated in both Mato Grosso, Rondônia and Para. The program should attend underrepresented states as an alternative to cattle on the deforestation frontier. In Colombia and Peru and remaining countries focus on aquaculture pipeline generated by government development efforts.
Proposed intervention	There has been significant investment in infrastructure over the last decade, but most farmers have yet to optimize operations. The intervention aims to finance infrastructure, equipment and farm technology, as well as securing best feed inputs, aiming for total production increase of 20%. Financing averages US$15,000 per hectare. Technical and financial assistance also to ensure high quality seed stocks and best productive and fit-sanitary practices. Target species should go beyond

	Colossoma sp. at the program implementation stage. Proceed with concessional finance, technical assistance and incentives
Mitigation activities and impacts	Efficient energy (fuel) and raw material use, use of waste products for biodiesel, efficient post-harvest and distribution systems can reduce emissions from operations. At the jurisdictional / landscape level the sector can convert to net emissions sink by substituting consumption of more emissions intensive protein sources, like beef, in both national and international markets[258]. This effect has been calculated to deliver a conservative value of 14 tCO_2/ha/annum emission reductions (Program Financial and Carbon Model).
Adaptation activities and impacts	*Colossoma sp.* and other round fish are a resilient fish species, used to high temperatures and still waters often encountered in aquaculture operations. Growing in-demand local fish species in small-scale operations reduces pressure on native wild fish populations, hence improving aquatic biodiversity, while waste stream water can be reused as fertilized irrigation water. Aquaculture production reduces dietary nutritional deficiencies and supports food security, reducing need to spend on and consume store bought food. This is especially important as climate change is already reducing availability of wild fisheries. Improvements in aquaculture profitability resulting from program will result in supplementary/diversified incomes and employment generation.
Financing aspects	Smallholder and medium sized aquaculture producers are limited due to the high interest rates and short tenors of rural finance. Aquaculture is highly capital intensive on a per hectare basis when compared to small scale subsistence or commodity farming. The minimum investment of US$18,120 is a ´large´ loan for existing rural financial intermediaries, land assets may not be accepted as collateral. Lower interest rate (5-10% annual) and tenor 2 years (to take account of annual production cycle) are needed. Proceed with concessional loans, technical assistance and incentives.
Number and size of beneficiaries and financial demand	Across all countries we estimate a total of 4,878 beneficiary entities (4,771 micro, 90 small and medium, and 17 large). Total potential financial demand in the order of US$159 million (micro: US$86 million, small and medium: US$22 million, and large: US$51 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[259].

Potential beneficiary entity case study

Name of Entity	Associação de Criadores de Peixe de Rondônia (ACRIPAR)
Business Model & Value Chain Node	ACRIPAR is a private fishermen association founded in 2009, with headquarters located in Ariquemes, Rondônia. They serve as processing, commercialization/distribuition industry to all its members and associated producers. They provide technical, infrastructural, legal and market support to all its members.
Location	Ariquemes municipality, Rondônia, Brazil
Development Stage and Certifications	Over the past 4 years ACRIPAR established strategic partnerships with government and private institutions to: 1. Improve production processes along the value chain 2. Develop technological solutions to implement and strengthen fish growing activities. 3. Promote market recognition of tambaqui production as a sustainable activity and nutritous product at a national level. 4. Facilitate legal registration of water body use by fishermen. An example of this is the 2019 organization of 12 events organized in partnerhip with SEBRAE which reached more than two thousand people and promoted Tambaqui fish with state level leaders and Brazil´s president, who invited them to host a version of their *Amazon Tambaqui Festival* in a tambaqui cook-out in Brasilia. This was great publicity and increased their exports in 648% in 2020.
Theory of Change & Impact Strategy	ACRIPAR aims for Rondônia to become a national and international referencia in the tambaqui value chain. It does this through forming collaborative partnerships

258 McGrath et al, 2020. Can fish drive development of the Amazon? Policy Brief, Earth Innovation Institute

259 PRODUCE, 2020. Catastro Nacional Acuicola (base de datos), Innovation Norway, 2016. KTP Market Brazil, Chile and Peru. A general overview and investments opportunities

	that improve their processes, techniques and tools along the value chain. This way they can better assist their members and the local communities. They are also committed to their social impact. In June 2021 they established a partnership with the Ariqueme municipality so they could donate fish to families in need. They managed to benefit 200 families during one week.
Innovation / R&D	ACRIPAR signed an agreement with the Rondônia Federal Institute for Education, Science and Technology (IFRO) in July 2020, to map production systems across the state and undergo scientific and technological exchange with all actors involved in fish-farming.
Climate Change Nexus	
Spatial distribution and market	Rondônia state, and potentially other Amazon states where Tambaqui producers can benefit. National and international markets incipient.
Mitigation benefits	Aquaculture requires no land-use change and generates smaller quantities of greenhouse emissions when compared to beef. One metric ton of fish can be produced in 0.48 ha compared to 16 ha for traditional beef production.
Adaptation benefits	Fish-farming is compatible with a large watershed-scale hydrological processes that maintain forest cover, Amazon farming systems and regional precipitation regimes. *Colossoma sp*. and other ´round fish´ are a resilient fish species, used to high temperatures and still waters often encountered in aquaculture operations. Growing in-demand local fish species in small-scale operations reduces pressure on native wild fish populations, hence improving aquatic biodiversity, while waste stream water can be reused as fertilized irrigation water. Diet and income diversification for local communities (McGrath et al, 2020).
Climate vulnerability	● Annual recurring drought events threaten water quality and quantity for fisheries sector ● Water quality deterioration severely threatens large areas of Amazon fresh water and fisheries. Includes changes in pH and oxygen due to drier conditions from prolonged drought, combined with increased evapotranspiration due to increased temperatures. Changes in the ecological balance that provides sustenance for fish; decreased availability of nutrients in the water; alteration of the reproductive behaviour of the species; degradation of areas that offer shelter to fish; migration of fish to other regions; decrease in river flows (Herrera et al, 2015). ● Loss of 1 km^2 of floodplain forest induces up to 9% decreasing in fish catches (de França Barros et al 2020). ● The size of fish species in the Amazon is negatively correlated to drought intensity (Fabré et al, 2017)
Sustainable management practices & models	Improvement of infrastructure, management practices and feed quality in aquaculture growing of in-demand local fish species (*Colossoma sp*. and other ´round fish´) in small-scale operations (fish from aquaculture management and managed sustainable fisheries). No specific sustainable management practices were found for ACRIPAR.
Beneficiaries	Small scale aquaculture producers
Co benefits	
Environmental co-benefits	Forest conservation
Social co-benefits	Provide fish-farmers access to national and international markets Guarantee fair prices and access to technology to improve aquaculture implementation and management
Risks	

Potential (social, environmental) risks	● Inefficient production and management for both aquaculture and wild fisheries. ● Informality in the supply chains is a reality for most fishers and aquaculture producers. ● Deficient supply chain infrastructure for Amazon logistical conditions ● Ineffective or limited penetration to non-Amazon markets ● Difficulties accessing technical assistance, quality supply and markets ● Lack of a governance structure and regulatory frameworks to promote transitioning to sustainable fish production and management
Potential risk mitigation strategies	ACRIPAR´s partnerships with state and federal government agencies, as well as with local/state universities could be the best paths towards creating solutions and mitigate the potential risks.

3.2 Forestry value chains

There is currently approximately 570 million hectares of natural forests and 8 million hectares of plantation forests in the Pan Amazon. Promoting sustainable forestry is essential to keeping the forest standing. In Brazil alone, 14 million m^3/year of logs are extracted from natural forests[260]. If current consumption trends continue, tropical timber from natural forests could be in short supply, leading to rising prices over the next 50 years[261]. This situation has created the urgent need to both better manage natural tropical forests and start large scale reforestation programs to meet current and future demand for solid timber from planted forests and relieve pressure on natural forests[262].

Timber is one of the most important products from the forest, but by far not the only one. Non timber forest products, traditional forest use by indigenous peoples, nature tourism, and ecosystem services are important sectors in their own right (see Sections 3.3 and 3.4 of this study). In this section we evaluate interventions for timber plantations, non-timber forest products and timber concessions.

3.2.1 Native Species Forestry Plantations

The limited extent of forest plantations is surprising if you consider that there is an estimated 40-80 million hectares of pastures in the Pan Amazon, 50% of which are underutilized. Brazil alone has an estimated 30–70 Mha of degraded pasture lands with low suitability for agriculture that could benefit from restoration and reforestation[263]. Even more surprising, is that less than 5% of the 8 million hectares of forest plantations is native species plantations. Consumption of wood from native Amazon species in Latin America and the rest of the world is high (and often illegal), and hence we know that there is a ready market for the products of native tree species plantations.

260 Veríssimo and Pereira 2014. Produção na Amazônia Florestal: características, desafios e oportunidades. Parcerias Estratégicas 19 (38): 13-44.

261 Buongiorno 2015. Global modelling to predict timber production and prices: the GFPM approach. *Forestry*, 88: 291-303.

262 FAO 2013. "Rediscovering wood: the key to a sustainable future". Proceedings of the Art and Joy of Wood Conference, Bangalore, India, October 19-22, 2011.

263 Dias-Filho, 2014. Diagnóstico das Pastagens no Brasil. Belém, PA: Embrapa Amazônia Oriental.

Amazon countries have so far collectively committed to the restoration of 26.7 million hectares. Commercial silviculture of native species is a viable business that should contribute to the reforestation target (see section on Habitat Restoration). If we consider that all commercial forestry in the Amazon covers approximately 8 million hectares, the large scale of the restoration undertaking for these commitments becomes clearer. At the same time, it is well recognized that shifting tropical timber supply from natural forests to forest plantations is a huge challenge. The shift requires not only great efforts from law enforcement, but also the development of science-based solutions. A multitude of public and private native species plantation projects, across all seven countries, have not delivered the expected results with regards to growth, production and revenues.

However, thought there is no legal barrier to the establishment of native tree species plantations for economic or environmental purposes, unclear and complex administrative structures and processes hinder progress. Urgent efforts are necessary to clarify the relevant forestry laws and define legal competence at government level. There is an urgent need to develop new commercially applicable technologies to improve the productivity and performance of the main native tree species[264]. Yield increases of 35% to 56% are deemed realistic if adequate forestry research and plantation implementation is implemented.

Silviculture with native tree species is helping to meet growing demand for tropical timber and generate other additional benefits, including helping to reduce deforestation and degradation, increasing local biodiversity, removing CO_2 from the atmosphere, increasing green jobs and income, and reducing the cost of countries restoration and reforestation commitments.

In Brazil, investment is estimated at USD 35 billion and the average volume of roundwood produced is now greater than 250 million m^3 per year. Despite the size of the mainstream reforestation industry, investment in native Amazon tree species is close to zero. It is estimated that 50 percent of tropical timber traded in the world is illegally harvested; in the case of wood from the Amazon the proportion could reach 70-80 percent. To develop a new tropical forest economy, it is necessary to combat the illegal timber trade because it is impossible to compete in a market so distorted by tax evasion, cheap labor, unsustainable harvest practices, and timber prices defined by illegal loggers who represent 70 percent of the market.

The potential timber yield from silviculture of native tropical timber species is 5 million m^3 of sawn wood, based on a 35 percent conversion of 14 million m^3 of roundwood timber. Using previous experience[265], and yield curves[266], silviculture with native timber species can yield a mean annual increment of 10 m^3/ha/year of roundwood, on 25- to 30-year rotation cycles. This level of production would require approximately 1.4 million hectare of silviculture of native species.

Model intervention: Native-species forestry plantations

Value chain structure, yields and prices	Production: planting, maintenance and harvest: Small farmers and smallholder foresters with average plantations in the range 5-15 ha, medium commercial operators producing for localized uses with average plantations in the range 50-150 hectares, and large corporate or fund backed operations, normally greater than 1,000 hectares. Over 50 native species have been prioritized for plantations in Brazil, Ecuador and Peru. With the exception of Ochroma sp., Shizolobium sp. which

[264] Rolim, S.G. et al., 2019. "Research Gaps and Priorities in Silviculture of Native Species In Brazil". Working Paper. São Paulo, Brasil: WRI Brasil

[265] Batista, A., A. Prado, C. Pontes, M. Matsumoto. 2017. "VERENA Investment Tool: Valuing Reforestation with Native Tree Species and Agroforestry Systems". Technical Note. São Paulo, SP: World Resources Institute Brasil.

[266] Rolim, S.G., and D. Piotto, eds. 2018. *Silvicultura e tecnologia de espécies da Mata Atlântica*. Belo Horizonte, MG: Editora Rona.

	have already become more consolidated, significant technological and genetic improvements are still necessary to improve yields and profitability. Harvesting and primary transformation, Distribution and export: dedicated transformation companies large and small, as well as large integrated plantation businesses that manage their own sawmills. Multitude of types and products, the key element is that most of them are multispecies, working with exotic or native species. Therefore outside the initial scope of the program.
Technical services and best practices	Technical services and best practices for native species are most advanced with balsa (ochroma sp.) plantations in Ecuador, including improved seed and nursery services, pest management, cropping, and others. In Brazil extensive network of service companies focused on eucalyptus and pine, these would have no problem serving native species plantations if these are profitable.
Financial services	Forestry plantation financing and management, specially of larger plantations, is a field of specific expertise, involving investment funds, fund managers, and professional forestry management operations. These actors are additional to the persons or institutions holding the land on which the forest assets are developing. Ecuador and Brazil have the most developed forestry finance community, and this private expertise should be engaged when the program passes to a national implementation level. Due to their attractive returns (if well executed) and long term nature, plantations are a cyclical hedge investment.
Climate vulnerability and other risks	Under climate change, tree mortality, both in plantations and natural forests, will increase due to invasive species, forest fires, excessive heat and dryness, especially along forest edges. Deforestation-drought cycles will increase the risk of increasing intensity and frequency of wildfires (driven by anthropogenic use of fire for land clearing), potentially resulting in catastrophic plantation losses, as is already occurring in other forest regions. Deforestation and climate change may trigger natural forest dieback and generalized forest degradation transition to drier savannah ecosystems, which in turn will increase risks of fire and drought to plantations.
Key Barriers and Enablers	Limited technological and genetic development of native species. Inherent long times to revenue, local banking system (with exception of Brazil and Ecuador) does not consider the sector bankable. Distance to market (logistics costs) is key blocker in Brazil, costs of trucking over Andes in Andean countries (main reason balsa wood sector in Ecuador (*Ochroma sp.* on coast) is thriving. One potential enabler is intercropping with established exotic commercial species. Mixed species forestry has a more even revenue profile (fast and slow growing species) and better pest evasion/resilience.
Extent and potential program adoption	Native species foresters have difficulties accessing credit due non-proven business model of many of the species. Adequately long tenors and concessionality of financing, as well as the technical assistance package through suitable partners (e.g., EMBRAPA) are key for encouraging adoption and eventual profitability.
Proposed intervention	Increase planted area of existing native species foresters by 50%, supporting growth of those foresters who have already committed to native species. Requiring US$3,500/ hectare. Covers planting costs, as well as maintenance plantation for three years, equipment and capacity building costs. Proceed with concessional finance, technical assistance and incentives.
Mitigation activities and impacts	Considering the pilot nature of *Shizolobium* and other native species plantations, planting and maintenance should occur following a best practices and technology package specially prepared for the Program with reliable country partners in both the public and private sector. Reforestation will lead to above and below ground carbon stocks increases which should reach an expected 9.5 tCO_2/ha/annum sequestration (Program Financial and Carbon Model).
Adaptation activities and impacts	Native species forestry plantations have great potential to increase ecosystem resilience and help avert the Amazon tipping point by being structurally similar to natural forests, as far as hydrological and climatic functions. For every hectare of native forests planted and maintained 0.4 new local jobs are created.
Financing aspects	Smallholder and medium foresters are limited due to the high interest rates and short tenors of rural finance. Even in the case of fast growing species, the first cut (revenue event) is only after 6-8 years, and this is often marginal compared to the 2 and 3rd cuts that happen anywhere from 15 years to 30 years into the cycle. The minimum investment of US$24,000 is a ´large´ loan for existing rural

	financial intermediaries, land assets may not be accepted as collateral. Lower interest rates (3-5% annual) and tenors (in the range 10 years-20 years depending on the species being planted) are needed. Proceed with concessional loans, technical assistance and incentives
Number and size of beneficiaries and financial demand	Across all countries estimated total of 9,083 beneficiary entities (8,640 micro, 432 small and medium, and 11 large). Total potential financial demand in the order of US$378 million (micro: US$151 million, small and medium: US$151 million, and large: US$76 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[267].

Potential beneficiary entity case study

Name of Entity	AMATA
Business Model & Value Chain Node	AMATA is a Brazilian company operating with exotic and native species silviculture for more than 15 years. AMATA is a B certified company, with FSC certification in their products. Their timber comes from planted forests, of native species (Parica), and exotic species (eucalyptus and pine). They work with low impact management. With a goal to substitute illegal deforestation timber with timber with guarantee of origin, AMATA works in the Amazon state of Rondônia focused on harvesting native timber through sustainable management.
Location	Pará, Brazil (there are also operations in Rondonia)
Development Stage and Certifications	In the triennium 2017 to 2019, they consolidated the knowledge arising from the planting of trees of the native species Paricá in degraded areas of the Amazon biome. In Pará, where they planted the native species paricá, the harvesting and sale of the forests began in 2019. With the progress of this process, they will be able to compile the lessons learned and evaluate the next steps for this business. AMATA is a B certified company, with FSC certification in their products.
Theory of Change & Impact Strategy	AMATA focuses on: ● Native species plantations, with focus on paricá (Schizolobium amazonicum), in degraded areas from the agricultural and livestock activities, with economic purpose. ● Development of native species forestry technology to enhance environmental recovery, with potential benefits towards commercial goals.
Innovation / R&D	Between the end of 2016 and throughout 2017, AMATA participates in the Verena Project (Economic Valorization of Reforestation with Native Species), in partnership with the World Resources Institute (WRI Brazil) and the International Union for the Conservation of Nature (IUCN). The objective is to demonstrate the technical and economic feasibility of large-scale restoration and reforestation with native species. Amongst other results, VERENA generated technical knowledge for paricá forest production with excellence and adequate cost.
Climate Change Nexus	

[267] FAO Forestry Statistics: http://www.fao.org/forestry/95632/en/, FAO, 2020. Small-scale forest enterprises in Latin America: Unlocking their potential for sustainable livelihoods, SERFOR, 2020. Anuario Forestal y de Fauna Silvestre 2019
Guariguata MR, Arce J, Ammour T y Capella JL. 2017. Las plantaciones forestales en Perú: Reflexiones, estatus actual y perspectivas a futuro. Documento Ocasional 169. Bogor, Indonesia: CIFOR, Maneschi, 2009. Viabilidade Econômica de Sistemas Silvipastoris com Schizolobium parahyba var. amazonicum e Tectona grandis no Pará, Rolim, S.G. et al., 2019. Research Gaps and Priorities in Silviculture of Native Species In Brazil" WRI Working Paper. Brasil.

Spatial distribution and market	Paricá certified plantations in Pará have a total area of 1.520 hectares, with aproximately 1,9 million trees planted.
Mitigation benefits	Carbon sequestration ● Each hectare of forest under development is capable of absorbing 150 to 200 tons of carbon. AMATA planted forests have already absorbed more than 3.3 million tons of carbon. ● In Para alone the 2018/2019 inventory for planted forests accounts for 182,000 tCO2 sequestered. Not including soil carbon sequestration.
Adaptation benefits	Planted forests are established on degraded non-forested land (ensuring no natural forest is cleared for plantation establishment), and will provide diverse adaptation benefits including (e.g. Galeão 2006 and Tonini 2006 in Machado et al. 2020): • Vegetative cover which protects otherwise exposed soils and enhances soil moisture (shade cover reduces loss from evapotranspiration and transpiration, and leads to more available water in soils) • Planted trees reduce runoff speed, increase infiltration, increase vegetation cover, reducing soil erosion and sedimentation. • Reduced pressure on natural forests by providing sustainably produced alternatives (Machado et al. 2020).
Climate vulnerability	Pará is located in a high climate change vulnerability area, with drier conditions and rainfall patterns. In general, the impacts of climate change on plantations is unknown. Productivity may be increased by rising levels of atmospheric CO2, but could be either increased or reduced by temperature, evapotranspiration and changes in precipitation patterns (Stephens et al. 2012). Pest and disease outbreaks could also occur with climate change(Stephens et al. 2012), however there is limited information on this in the Amazon basin in the context of forest plantations.
Sustainable management practices & models	● Following their purpose of keeping native forests standing, AMATA undergoes monitoring and mitigating any deforestation of degradation drivers. ● Operations in Pará have 8,200 hectares of conservation areas.
Beneficiaries	Neighboring communities, Municipality governments, and service providers
Other co-benefits	
Environmental co-benefits	Soil protection, water services regulation, decreased deforestation and forest regeneration.
Social co-benefits	Organized and lead events for community residents and employees, such as vocational fairs, educational lectures, field days with games, music and games made from recyclable materials. Signed a partnership with the Municipality of Ipixuna to renovate the access to a bridge to local communities, which was in a precarious state.
Risks	
Potential (social, environmental) risks	● Need to expand operations into forest land ● Potential invasion to plantation areas and reserves by illegal loggers or hunters. ● Seasonal unemployment ● Land and road degradation due to logistical operations
Potential risk mitigation strategies	● Mapped and established protected high conservation value areas.

	• Continuous monitoring and visits in plantation areas, reserves and communities • Prioritize hiring staff from local communities • Apply AMATA Human Resource plan in case of mass lay-off • Road maintenance and use planning • Avoid traffic during high rain season

3.2.2 Non-Timber Forest Products (NTFPs)

This sector includes the extraction, processing, and commercialization of a wide range of forest products, including food, materials, crafts, medicines and essences, known collectively as non-timber forest products (NTFPs), from managed primary or secondary forests, aligned with the vision of monetizing the value to standing tropical forests.

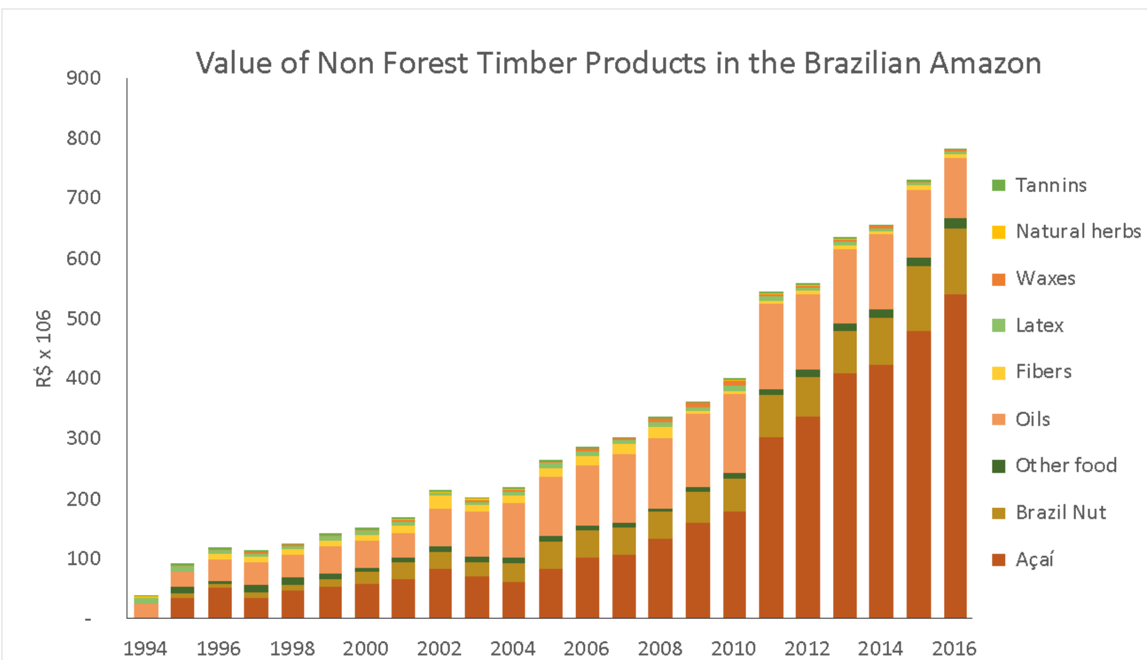
Commerce in NTFPs is a small fraction of the Amazonian forestry economy, representing less than 1% of regional GDP. Nonetheless, a large number of Amazonian families with subsistence livelihoods rely on cash income from the harvest of NTFP to purchase manufactured goods or, even more importantly, pay for modern medical care. The status of the NTFP economy is mixed, however. Data compiled by the Brazilian statistical agency (IBGE) shows that commerce in forest commodities has increased substantially over the last two decades; unfortunately, most of that growth has been restricted to two commodities with robust global markets: Açaí and Brazil nut (Figure 48). The success of these two forest commodities show the potential of Amazonian biodiversity to generate economic benefits for the region's indigenous and traditional communities.

It is essential to publicize and consolidate markets for a much broader range of native products, already with regionally or internationally consolidated markets , such as babassu (Attalea speciosa), cajá (Spondias mombin), cupuaçu (Theobroma grandiflorum), bacaba (Oenocarpus bacaba), buriti (Mauritia flexuosa), andiroba (Carapa guianensis), rosin (Protium sp.), Copaiba (Copaifera spp.), Pupunha (Bactris gasipaes), piaçava (Leopoldinia piassaba), coumaru (Dipteryx odorata). In addition to these, there is a range of other lesser-known products that may receive support from the current "best known" and also achieve the same popularity, a fact that occurred with açaí in recent decades, when it was only known in the northern region of Brazil and today, in addition to being known throughout the national territory, has already assumed a leading role in pro-biotic foods in industrialized countries.

In addition, there are many other natural products considered in extractive ventures, which can be directed to drugs, edibles or cosmetics. Such products arouse growing interest from national and international companies, and have not yet been looked into in detail at this feasibility study stage. The need for economically viable integrated forest production systems, that sum the direct and indirect use values of NTFPs, timber, ecosystem services, recreation and genetic resources, is particularly important in landscapes that have not been awarded some level of permanent protection. This includes 28 million hectares of multi-use protected areas that have been designated as sustainable development reserves

(RESEX and RDS),[268] and approximately 15 million hectares allocated to traditional communities for sustainable forest managements (PAE, PDS and PAF).[269] There are similar multi-use reserves in the Andean Republics summing to perhaps another 25 million hectares. The management of these reserves is predicated on production models that sustainably harvest forest and aquatic resources, including wild-caught fish, hunting, the harvest of NTFPs, and swidden agriculture.

Figure 48: Value of NFTP in the Brazilian Amazon



268 RESEX: *Reserva Extrativista*; RDS: *Reserva de Desenvolvimento Sustentável*, which are administered by *Instituto Chico Mendes de Conservação da Biodiversidade* (ICMBio)

269 PAE: *Projeto de Assentamento Agroextrativista*; PDS: *Projeto de Desenvolvimento Sustentável*, PAF: *Projeto de Assentamento Florestal* are administered by the *Instituto Nacional de Colonização e Reforma Agrária* (INCRA)

Most of the NTFPs produced fall into the category of food products, responsible for 84% of all types of NTFP and where the açaí, the Brazil nut and the Palmito stand out. The second category with the largest amount produced is oils, responsible for 15% of the NTFPs products, including babaçu, copaíba and cumaru stand out in this category. Some common species in the region and of great commercial value do not yet have a systematic database with data on production and marketing, but they are of great importance in the daily life and source of income of traditional families in the Amazon, such as cupuaçu, bacuri and andiroba, for example.

In the following paragraphs, we cover in more detail, the two most important NTFPs by volume and revenue: Açaí *(Euterpe oleracea)* and Brazil Nut (Bertholletia excelsa)

3.2.2.1 Açaí (Euterpe oleracea)

Açaí is a multi-stem palm native to floodplain forest and marsh habitats that has been a mainstay of economy of the Lower Amazon for hundreds of years.[270] Historically, its commercialization was based on the harvest of both its fruits, for sale in local markets, and its apical buds, which were the principal source of palm hearts in the national market of Brazil. Starting in ~2000, however, that business model was replaced by the commercialization of an extract derived from the flesh (mesocarp) and skin (exocarp) of the fruit for national and international markets. Long known to have restorative properties by local inhabitants, açaí was discovered to have extraordinarily high levels of natural antioxidants. Subsequent research confirmed that fruit's uniquely high concentration of anthocyanins and other flavonoids, which de-activate free radicals that damage cellular metabolism. A diet rich in açaí has been shown to decrease the incidence of chronic diseases such as diabetes, lower risk from cardiovascular disease and cancer and, possible, fight infections from certain parasites and bacterial disease.[271]

That subsequent growth in the demand for açaí by health food advocates has transformed the economy of the lower Amazon River. Upriver communities have also become engaged, particularly the Quilombola[272] settlements on the Solimões (Codajás) and Madeira (Humaitá) that started reporting significant harvests of Açaí after 2011.[273] Fortunately, the palm species' unique ecology and sociobiology facilitates its sustainable exploitation: (a) it occurs at high natural densities in river floodplains were populations commonly have between 500–1000 clumps per hectare and each clump with between 5 to 10 stems each; (b) local inhabitants have a long history of managing natural populations to maximize productivity; (c) the river transportation system provide access to Belem, the largest city in the Amazon basin; (d) the açaí palm has two commercially valuable products, its fruit and palm heart.[274]

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270 Strudwick, J.; Sobel, G. L. Uses of Euterpe oleraceae Mart. In the Amazon estuary. Braz. AdV. Econ. Bot. 1988, 6, 225-253.

271 Healthline.com (1 Nov 2020), 5 Impressive Health Benefits of Acai Berries, https://www.healthline.com/nutrition/benefits-of-acai-berries

272The *quilombolas* are descendants of Afro-Brazilian slaves who escaped from slave plantations prior to emancipation in 1888;

273 IBGE – Instituto Brasileiro de Geografia e Estatística(28/09/2017) Produção da Extração Vegetal e da Silvicultura - Série Histórica completa - 1986-2016 Sistema IBGE de Recuperação Automática – SIDRA, Instituto Brasileiro de Geografia e Estatística https://sidra. ibge. gov. br/pesquisa/pevs/quadros/brasil/2016

274 Anderson, A.B. (1988), `Use and Management of Native Forests Dominated by Acai Palm (Euterpeoleracea Mart.) in the Amazon Estuary', Advances in Economic Botany, 6: 144-54.

The annual wild harvest has increased by ~15% since 2005 with revenues in 2019 of more than R$580 million (~US$150 million).[275] The demand for açai drove an increase in the intensity of the harvest on the lower Amazon, as well as its expansion to isolated natural populations upriver and on both large and small tributaries with the number of municipalities participating in the annual harvest between August and December from 136 in 2000 to 230 by 2019. Producers adopted management strategies to increase the annual harvest using enrichment planting and the elimination of competing species (see above)

Despite the multiple benefits of açai management in Amazon floodplains, the large-scale expansion of this production system entails environmental risks in the medium and long term, including the sustainability of production itself of açaí. Enrichment planting being pursued by some communities is leading to a loss of floristic diversity in floodplain forests.[276] Incorrect management has been promoting "green felling", without burning, but with environmental impacts that can compromise the diversity of flora and fauna of this ecosystem. In many locations in these managed areas, construction of channels to facilitate drainage of water flooded by the tides and increased movement of boats for transporting fruits, which is changing hydrologic regimes, increasing erosion and impacting flora and fauna in as yet undetermined ways.

3.2.2.2 Brazil nut (Bertholletia excelsa)

The next most important NTFP is the Brazil nut,[277] an important constituent species of the landscapes that are most seriously threatened by deforestation. Although the range of this species is Pan Amazonian, economically viable populations are restricted to the southern Amazon, particularly in the frontier forests stretching from southern Pará across northern Mato Grosso into Rondônia, Acre, and adjacent areas in Pando, Bolivia and Madre de Dios, Peru.[278,279] Historically, the harvest from Pará was commercially predominant, but deforestation has greatly reduced its contribution to the Brazilian national harvest, which fluctuated between 20,000 and 30,000 tons per year between 1995 and 2015. A severe drought linked to the El Niño phenomenon in 2015 led to a 40% reduction in the harvest in Acre, Pará and Mato Grosso in 2016 and 2017.[280] Curiously, the drought did not impact populations in neighboring Bolivia and Peru, nor in the state of Amazonas where an increase in the annual harvest partially compensated for the fall in production in Acre.

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[275] SIDRA - Sistema IBGE de Recuperação Automática (1 Nov 2020) Produção da Extração Vegetal e da Silvicultura, IBGE - Instituto *Brasileiro* de Geografia e Estatística (, https://sidra. ibge. gov. br/tabela/289

[276] Freitas, M. A. B., Vieira, I. C. G., Albernaz, A. L. K. M., Magalhães, J. L. L., and Lees, A. C. (2015). Floristic impoverishment of Amazonian floodplain forests managed for açaí fruit production. Forest Ecology and Management, 351, 20-27.

[277] The species and the commodity are known as *Castanha do Pará* (Brazil), *Castaña de Amazonía* (Bolivia) and as *Nuez de Brasil or Castaña* (Peru).

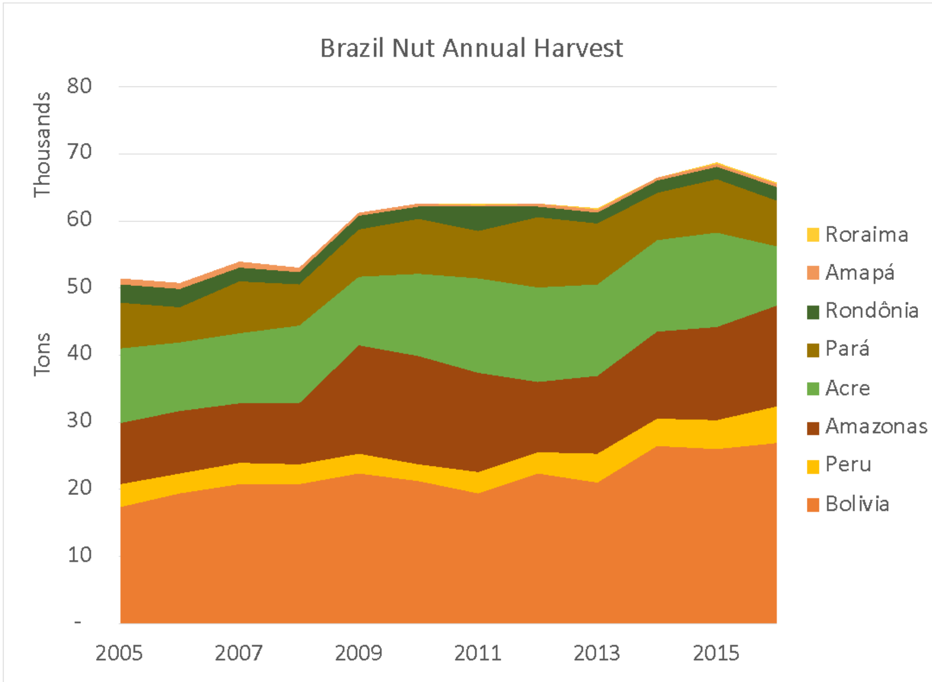
[278] Thomas, E. , Alcázar Caicedo, C. , Loo, J. , and Kindt, R. (2014). The distribution of the Brazil nut (Bertholletia excelsa) through time: from range contraction in glacial refugia, over human-mediated expansion, to anthropogenic climate change. Bol do Mus Para Emílio Goeldi Ciências Nat, 9, 267-291.

[279] Levis, C. , Costa, F. R. , Bongers, F. , Peña-Claros, M. , Clement, C. R. , Junqueira, A. B. , . and Castilho, C. V. (2017). Persistent effects of pre-Columbian plant domestication on Amazonian forest composition. *Science,* 355(6328), 925-931.

[280] EMBRAPA - Empresa Brasileira de Pesquisa Agropecuária (29/08/17) Pesquisa aponta queda de 70% na produção de castanha-da-amazônia, Ministério da Agricultura, Pecuária e Abastecimento

Bolivia displaced Brazil as the largest global supplier of Brazil nuts in the 1990s and Bolivian collectors have expanded their harvest by about 25% since 2010 (Figure 49). The Brazilian harvest is still about 25% greater than Bolivia's; however, about 60% is consumed domestically while Bolivian exports > 90% of its annual production. Harvest volumes have increased by about 3% annually over the last two decades, while total revenues increased by about 9%. The harvest in Brazil was severely impacted by several drought years.

Figure 49: Brazilian nut harvest



Total revenues for Bolivia, Peru and Brazil ranged between US$220 million in 2010 to almost US$500 million in 2016. Of this, it is estimated between 10% and 15% was paid to forest families with the majority of income being captured by middlemen and processing facilities.[281] The tradional livelihood for non-indigenous forest families at the base of the Brazil nuts industry was actually half of two-commodity NTFP harvest model that also depended on the collection of natural rubber. Demand for rubber collapsed in the 1980s when the Brazilian state ended price-supports. Acre attempted to maintain production via marketing initiatives and the establishment of manufacturing facilities to add value to local production (e.g., Amazonian condoms); that effort failed, unfortunately, and rubber production has essentially disappeared in the Amazon. That lost income and drought-induced poor harvest have motivated many (most) families to increase their reliance on [illegal] logging in Brazil Nut concessions, supplemented by shifting agriculture. Consequently, a Brazil nut production model will not be economically sustainable without significant subsidies, possibly from carbon, or innovations regarding forest enrichment and productivity as is already being piloted in Peru.

281 These values are based on export volumes from Bolivia and Peru from FAOSAT, production volumes reported by the IBGE and international prices derived from FAOSTAT and the Bolivian Export Institute (IBCE). Gross values were then compared to monetary value reported by the IBGE, which were 10 – 15% of the estimates based on international prices.

Proposed NTFP intervention based on value chain analysis of the Brazil nut

Value chain structure, yields and prices	*Production: maintenance and harvesting:* The average size of these concessions is 600 hectares, exhibiting an average density in the range of 0.5-0.8 trees per hectare. An important percentage of the concessions are undergoing a process of agricultural invasion and degradation, partly due to the low profitability of the chestnut activity and partly due to the motivation of some chestnut growers to engage in agriculture. The production range in each concession is between 100 and 300 barrels, with an average production of 150 barrels. Depending on the distance, topography, and tree density of the concession, production costs fluctuate between US$30 to US$60 per barrel. A minimum capital of US$5,000 – US$6,500 is needed to finance the campaign. The yield per barrel fluctuates between 20 and 25kg of peeled Brazil nuts and peeled Brazil nut prices fluctuate between US$3 and US$7.5/kg. There is a large natural variation in the inter-annual production, which affects these prices. The average price in the 2018/2019 season was US$4.6/kg. *Collection and transformation:* Collection and primary processing is carried out by companies and productive associations/cooperatives based in the city of Puerto Maldonado, Rurenabaque and Rio Branco. Both companies and associations tend to give credit for the campaign to their associates. RONAP, in Peru for example, gives US$30 per barrel. Aside from playing an enabling role, the associations play a role in helping with the paperwork and management plans for the concessions. The average transfer price to the local market and exporters in the 2018/2019 campaign was approx. US$7.6/kg. *Final distribution and export :* Exports are concentrated in six main players that account for 70% of the market. These are the companies El Bosque, Agrícolas y Forestales SAC, ManuTata, Agrofino Foods, La Nuez and CAPNTD. The RONAP and ASCART Associations have started their own export initiatives. In 2018 the total export volume was 5,833 tons with a total value of US$64.9 million, while in 2019 the total export volume was 4,985 tons with a total value of US$34.4 million. The average export price between 2018 and 2019 was US$9/kg. The local end market is small and dispersed, but there are new companies aiming to give it a high added value in the markets of the main cities, such as Shiwi SAC.
Technical services and best practices	Non-governmental conservation organizations have been supporting chestnut growers in recent decades in the management, formalization and monitoring of concessions, the agroforestry recovery of forest areas that have been degraded or lost to agriculture and the strengthening of productive associations. Approximately 20% of Brazil nut growers are members of a productive association, but most still work their concessions independently, which negatively influences the quality and consistency of the harvesting, drying and shelling processes. More recently, organizations such as the Peruvian Amazon Research Institute (IIAP) and the Peruvian Protected Area Fund (PROFONANPE) have been providing direct incentives for the enrichment of brazil nut forests in degraded areas. One of the initiatives, for example, is planting 100 brazil nut trees per hectare to achieve regeneration and greater productive density in the brazil nut groves. Current density of mature trees is 1-2 trees/ha.
Financial services	Concessionaires obtain their campaign capital from the company/association they work with or form local lenders. The local banks (Cajas Rurales and Financieras) tend to provide loans of only US$1,000-2,000, so the concessionaires turn to several Cajas to raise the necessary total capital of S/.15-20,000, and if they are unable to do so, they go to private lenders whose interest rates are much higher (10-12% per month). Local collection and processing companies generally access the cajas that provide credit at annual interest rates between 30-35%, using their properties as collateral for such loans, but if they can also social finance companies, that offer interest rates close to 10% per year.
Climate vulnerability and other risks	With more extended or intense periods of soil water deficit, large trees and those with low wood density may be at greatest risk of hydraulic failure due to cavitation. The ongoing increase in atmospheric carbon dioxide is also expected to cause changes in species composition as it is predicted to favor those trees that have greater competitive capacity to access light, consequently increasing the mean potential tree size within the community and to favour fast-growing trees, potentially leading to communities with lower wood density. If drought is increasingly affecting Amazonian forests, we

	might therefore expect concerted shifts in tree communities towards more dry-affiliated components[282].
Key Barriers and Enablers	As mentioned, there is a significant natural variation in the annual production of Brazil Nuts. This in turn generates volatility in sale prices, and in the profitability of the activity, with marked "good" years and "bad" years. Such variability should be considered in financing programs for the sector, potentially through a multi-year guarantee program or long / patient tenors.
Current extents and potential program adoption	Brazil Nut concessionaires and other NTFP producers are used to working and accessing credit through cooperatives and associations. Aim for 50% adoption by using this channel. Several of these associations work with more than 1 NTFP.
Proposed intervention	Concessionaires: US$5,545 financing for equipment and working capital to carry out an annual collection campaign following concession management best practices. Aggregators/ transformers: US$420,000 financing for improved aggregation, drying and selection facilities in order to improve product quality and volumes, and assist suppliers with working capital. Large: US$3.2 million for expansion of transformation/packaging/export facilities to meet international health (toxin levels) and quality standards and best practices. Proceed with concessional finance, technical assistance and incentives.
Mitigation activities and impacts	Enrichment and active adaptive management are potential responses to external ecosystem stressors that seem to already be manifesting themselves with climate change, and that could affect productivity of Brazil nut forests and other NTFPs. Modeling indicates that enrichment in Brazil Nut concessions, especially those that have been subjected to logging or agricultural induced degradation, could lead to increased carbon stocks equivalent to 5 tCO_2/ha/annum (Program Financial and Carbon Model).
Adaptation activities and impacts	In the Amazon, studies indicate that a warming, drying climate will reduce the mean net primary productivity, NPP, by approximately 52% by 2050 under a medium–high greenhouse gas emissions scenario. When the direct effects of CO_2 on plant physiology are included in the model, NPP still reduces but to a lesser extent of 33% due to the enhancement of photosynthesis by CO_2 fertilization.[283] These significant shifts will affect NTFP productivity, which is very significant for NTFPs with marginal economics. Enrichment and active management, as well as landscape level conservation approaches will be needed to maintain the adaptive capacity of the forest. In light of the many uncertainties, research and monitoring of forest conditions and composition are also an important part of the strategy to adequately adapt to the change processes at hand.
Financing aspects	NTFP management and extraction in most cases is a business with a yearly seasonal cycle. Finance is limited due to the inability of many producers to use their extraction areas as collateral. US%5,000-6,000 is also above typical micro-finance loan sizes in Amazon. May NTFP producers end up financing through informal financial services or through consumer credit, paying interest rates that easily exceed 30% annual. Lower interest rate (5-10% annual) and tenor 1 year are needed. Proceed with concessional loans, technical assistance and incentives.
Number and size of beneficiary and financial demand	Across all countries we estimate a total of 12,935 beneficiary entities (12,306 micro, 572 small and medium, and 57 large). Total potential financial demand in the order of US$528 million (micro: US$74 million, small and medium: US$261 million, and large: US$193 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[284]

282 Esquivel-Muelbert, A. et al. 2018. Compositional response of Amazon forests to climate change.

283 Harris et al. 2008 in Esquivel-Muelbert, A. et al. 2018. Compositional response of Amazon forests to climate change.

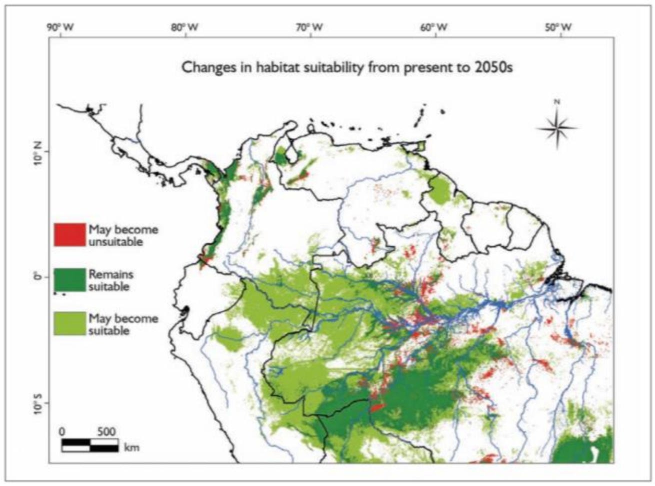
284 Miranda, J., Montaño, F., Zenteno, F., Nina, H. and J. Mercado, 2008. El Majo (Oenocarpus bataua): una Alternativa de Biocomercio en Bolivia. TRÓPICO - PNBS - FAN. Ediciones TRÓPICO. La Paz, Bolivia., ,Rainforest Alliance, 2015. Transformando la producción forestal no maderable a pequeña escala en una empresa competitiva: Un estudio de caso del trabajo con asociaciones de castañeros.

Potential beneficiary entity case study

Name of Entity	Ouro Verde Amazônia
Business Model & Value chain node	Creating sustainable businesses that use regional raw materials as a best way to protect the forest and generate income for local communities. The business focuses on processing and adding value to Brazil nuts.
Location	Mato Grosso, Sao Paolo; Brazil
Development Stage and Certifications	Scaling up, diversification of products and markets, certification (B-corp) Organic product certification of the entire product line. B-Corp since 2012.
Theory of Change & Impact Strategy	Sustainable model to add value to non-timber forest products, which brings added value to standing forest. Improving the quality of the raw materials collected by the communities, the logistics and storage of these products and diversification of products will provide added value and increase the price that Ouro Verde could pay for these products (40% over market price) and increasing income for the communities. Valuation of standing forest is a social incentive for conservation of the forest. With increasing market development and sales, more people will benefit and more forest can be preserved.
Innovation / R&D	Starting with whole Brazil nuts and raw material, now merchandizing 100% Brazil nut extra virgin oil; nut paste, nut semola. Other products (flour, pesto, liquor) under development. Support by research Escola Superiro Agricultura Luiz de Queiroz - Universidade de Sao Paolo.
Climate Change Nexus	
Spatial distribution and market	Brazil nut grows in south-eastern Peru, northern Bolivia, all across the Brazilian Amazon and in the Guianas and Venezuela. The nuts are harvested and comercialized in Brazil, Bolivia and Perú. At present, Bolivia dominates the global Brazil nut processing and export market. As of 2013, Bolivia produced 52 %, Brazil 42 % and Peru 6 %, according to FAOSTAT[285].
Mitigation benefits	Contribution to deforestation reduction: Para Nut extraction places added value to standig forest and therefore, contributes to forest conservation. In Brazil, NTFP concessions (conerved for Para nut recollection) cover approx. 22 million hectares, including extractive reserves. (Guariguata et al. 2017[286]) . Enrichment in Brazil Nut concessions, especially those that have been subjected to logging or agricultural induced degradation, could lead to increased carbon stocks equivalent to 5 tCO_2/ha/year.
Adaptation benefits	Brazil nut harvesting is an economic activity that depends on intact forests, and thus this investment provides additional incentives to maintain forest cover and support forest restoration. This will help strengthen the resilience of forest ecosystems, which otherwise experience high pressure for forest conversion (e.g. Chiriboga-Arroyo 2021; Guariguata et al. 2017). This will help to maintain or improve the provision of ecosystem services (Tscharntke et al. 2014 in Guariguata et al. 2017), including services that support climate and water regulation (helping to avoid the tipping point). Even though there is some climate vulnerability (see below) this is likely less than agriculture or pisciculture-based economic activities. In Brazil, smallholders living in extractive reserves rely on both Brazil nut harvesting as well as on non-forest uses (Duchelle et al. 2014a). Therefore, the promotion and increased revenue of Brazil nut implies a diversification and better income. The effort of

285 http://www.fao.org/faostat/en/#home

286 https://link.springer.com/article/10.1007/s10531-017-1355-3

	Ouro Verde to diversity production and search certification, increase resilience through improved income and fair-trade practices.
Climate vulnerability	Scientific and empirical evidence indicate how climate change can affect habitat suitability of the Brazil nut tree and create a spatial mismatch between the climate conditions and biotic needs (see below). Ecological niche models of Brazil Nut have demonstrated that temperature seasonality can be a good predictor for Brazil nut distribution.  Figure 7. Potential changes in Brazil nut habitat suitability from present to the period from 2040-2069. A warming, drying climate may reduce net primary productivity of trees, including Brazil Nut (WWF 2018) ; Due to inadequate growing conditions and pest and disease outbreaks, there can be a decrease in quality and availability Brazil nuts (Oxfam, 2020; Chavez Michaelsen et al. 2020).
Sustainable management practices & models	Enrichment and active management, as well as landscape level conservation approaches will be needed to maintain the adaptive capacity of the forest. In light of the many climate-related uncertainties, research and monitoring of forest conditions and composition are also an important part of the strategy to adequately adapt to the change processes at hand.
Beneficiaries	Brazil nut harvesters, communities, local producers
Co benefits	
Environmental co-benefits	Brazil nut management and harvesting supports maintaining standing forest. Most Brazil nut harvesting in done in designated forest concessions or Reservas Extractivistas. Therefore, it contributes to biodiversity conservation and environmental regulation (water, soils)
Social co-benefits	Most Brazil nut production managed by local communities. Even though in the past Brazil nut management was monopolized by oligarchic families, thanks to dedicated policies and certification schemes it is now mostly managed by traditional communities. Brazil nuts generate jobs and income for both women and man.

3.2.3 Timber concessions in natural forests

All countries in the Pan Amazon, except Ecuador have an official forest concession system in place. The status of timber natural forest concessions is dynamic and country specific, in response to changes of policies and markets, and pressures from stakeholders. Thus in Bolivia the 2000s saw a rapid decrease in forest concessions as land was allocated for indigenous community forestry and agricultural interests instead, while Brazil has seen a modest increase due to the startup of a new concessions program[287]. A review of forestry concessions in Latin America, including Bolivia, Brazil, Guyana, Peru and Suriname had the following recommendations for establishing a robust forestry concession program:

a) General
The granting of a particular area of forest to a private company by the federal government foments long-term investment by the concessionaire who knows that they will reap the benefits of capital improvements over an extended period. This runs counter to the normal attitude and perverse incentive of short term harvest permits and is crucial for building an economic constituency for standing forests. Time, lots of money and consistency are the unheralded and seldom mentioned harbingers of success for developing forest concessions. Given the multivariate nature of forestry, improvements in concession systems must be implemented at a large scale, with strong technical support, and a focus on the oftentimes forgotten social and financial aspects. Experienced professionals with production or private-sector experience should be involved and allowed to cross-disseminate ideas and methods with room for trial and error to adjust and apply proven techniques. Participation by local and international non-profit organizations to promote the good, expose the bad, and channel technical guidance and funds. When concession management is part of a broader strategy with a multi-pronged approach by the government, success is likely and impacts in stabilizing immigration, forest conversion and land-holdings are high.

b) Concession design
Transparent systems should be built that do not propagate the feeling that favoritism and under-the-table payments were the reasons someone received a particular concession. Pragmatic concession design with consistent and coherent governmental support that protects the right of the concessionaire. Determining the appropriate forest size should not be an arbitrary nor purely technical decision but rather must be based on a complete financial analysis with accurate cost and revenue information. Evidence shows the importance of resolving or minimizing conflicts between users prior to establishing concession boundaries; in the long run, it is much cheaper to establish a clean and low-conflict concession area up-front.

Since effective concession areas are seldom as large as one might think, it is useful to start with a large planning area to work within. Rather than being an afterthought, governments should include the management, harvest and trade of non-timber products as a complementary part of their programs. Simply allowing others to harvest such products, or not addressing in annual operating plans, is not sufficiently proactive. Given the desire and need to generate high revenues from concessions, governments should widely publicize concessions that are up for bid and ensure a competitive process that usually results in higher prices. Establishing concession fees based on area rather than volume is one way that governments can at least reduce the cost of harvesting low margin species and incentivize their commercialization.

[287] FAO (2016) Forest concessions: past, present and future, Forestry Policy and Institutions Working Paper 36

When it comes to concessions, simpler pricing approaches that do not allow for corruption by officials to obtain illegal payoffs seem better than more complex approaches that depend on lots of information that cannot be corroborated. At the same time, the price charged should be established via a clear method in order to rebuke charges that low prices were provided to favor large companies. Concession pricing mechanisms should incorporate real costs from similar operations that include all expenses related to a concessionaire and analyzed from a discounted cash flow approach rather than simply stumpage. Production-based fees should be based in part on prices paid for certain species of commercial interest, these should be derived on an individual species level (or similarly priced groupings). Fees based on market prices should ensure that the species are truly commercial and that the prices are from the specific region where the wood is commonly sold. Flexible contracts that allow for justifiable changes and for periods longer than the traditional 20-25 year cutting cycles would increase the appetite for companies to bid on concessions.

c) Technical

Forest inventories and censuses should focus on commercial species likely to be harvested rather than low value species or those with no market potential. Concessionaires should be able to visit forests and conduct their own supplemental inventories prior to bidding. Succinct management plans that clearly summarize inventory data, justify cutting cycles and harvest levels, offer realistic financial projections and present operational related information would be a dramatic improvement over the current situation of plans that do not provide practical information related to a concession's success. Concessions require more than management plans; successful programs develop clear technical guidelines, manuals, procedures and reports that foster both consistency in approaches, efficient monitoring and structured reporting.

d) Economic

Concessionaires must obtain sufficient profits to be able to compete with illegal and informal supplies of wood in the marketplace. Such profits must lead to visible and quantifiable benefits to locals in the form of direct and indirect jobs, sales to export and local markets, and tax revenues distributed to local governments from both the forestry and manufacturing. Vertically-integrated concessions linked to experienced manufacturing facilities are the most likely to succeed since a secure supply of wood allows the company to experiment with species, products and markets, and produce raw materials at a competitive cost.

The main incentive to any forest concession program would be the reduction in illegally produced wood with lower cost structures that do not allow concessions to compete well. Costs to concessionaires, in terms of time to approve permits or actual fees charged, must be reasonable in order for a concession program to work. At the same time, governments must show a willingness to modify procedures, payment structures and costs once they realize that they are onerous or expensive. Efficient processes are an incentive that governments can offer bidders.

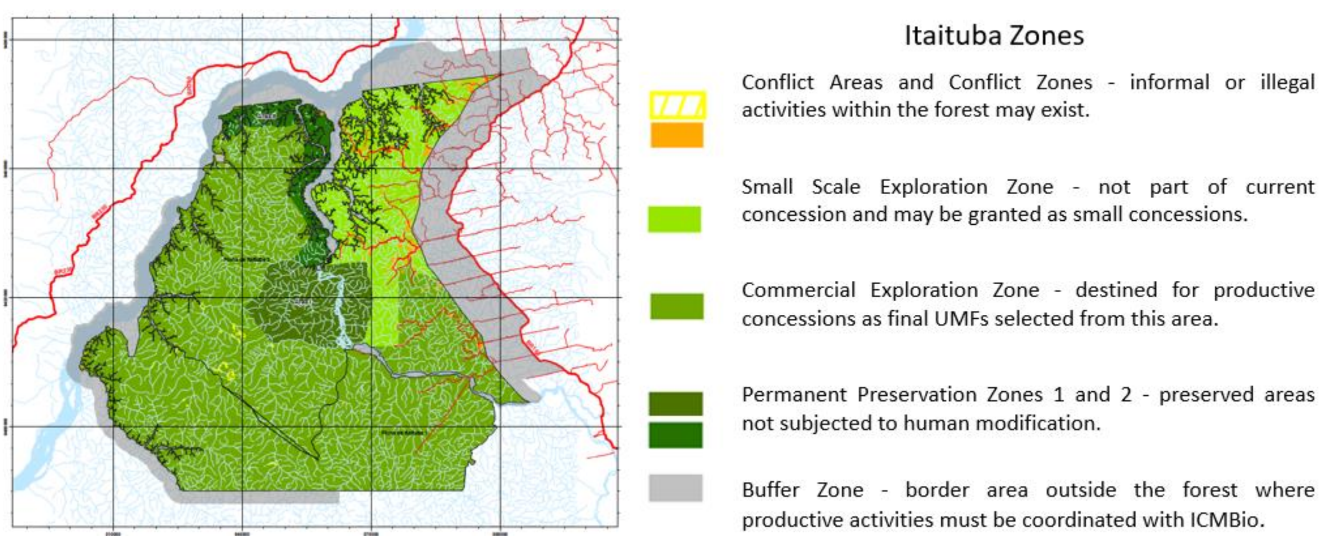
Incentives in the form of tax breaks, fee reductions and subsidies have been successful in reducing the cost of operating a concession and improving the likelihood of profitability. A pragmatic approach to stimulating investments in concessions would be for the government to share the costs of road-building which are the largest capital expenditure that a concessionaire needs to assume (and which in many cases represents a public infrastructure used by state officials and local communities).

e) Institutional

There have been varying degrees of success with local governments and their involvement in concession processes. For state, regional and municipal governments to be able to play a substantive role, clear and logical objectives and installed capacity must be built. Governments need to ensure adequate financial resources from not only concession rights and production taxes, but also from the general budget to cover the costs of running a concession program. Greater autonomy for agencies helps increase the rate of processing and granting concessions. In several cases, a relatively autonomous governmental body with new, motivated and politically strong leadership with the authority and budget to make significant changes was key to changing the way forest resources were managed.

The above principles were applied in an International Finance Corporation (IFC) project developed in 2014 with the Brazilian Forest Service (SFB): "*BR Amazon Forest: Improving the sustainable forestry concession model while advising the concession process of National Forests of Itaituba I and II*". It showed that targeted technical support and commercially-oriented financial analysis of large-scale timber concessions could lead to improved governmental implementation of sustainable strategies for the management of natural forests and contribute to the Amazonian bioeconomy, and is summarized in Case Study format in the following pages.

The Itaituba National Forests comprise 641,105 hectares in southwestern Pará State in the Brazilian Amazon. The General Management Plan of the forest defines its zoning and uses:



The project was conceived as a joint effort between SFB and IFC to enhance Brazil's concession system by improving the pricing model and legal instruments on a trial process for the Itaituba I and II Forests and lead to the consolidation and expansion of the country's future federal and state forest concessions. In short, SFB solicited IFC assistance in recognition of the fact that its federal concession program was not functioning as anticipated due largely to time-consuming and costly processes and a pricing system that did not adequately reflect actual operating conditions nor share risk among the private and public sectors. This was evidenced by the fact that despite 308 million hectares of registered Federal and State Public Forests in Brazil, between 2008 and 2013, only 508,000 hectares had been granted as 11 concessions in 5 federal public forests.

Early analysis by SFB and IFC noted the following obstacles to the concession program that essentially placed all of the risk on the concessionaire with little (if any) commitment by the public sector despite the government's recognition of the key role played by sustainable forestry in rural economic development, reduction of GHG emissions, and reduction of deforestation:

- Price- Concessionaires were legally required to offer bids based on price per species (BRL), effective productive area (net hectares), and expected productivity (m3/ha). This traditional approach did not adequately account for significant operational variables that affect profitability and long-term financial viability.

- Payments- Regardless of cash flow and actual conditions, concessionaires were required to pay a minimum amount on a quarterly basis, thus subjecting operators to increased risk without government sharing of responsibility. NOTE: Bonuses in the form of price discounts could be offered for bidders with the lowest environmental impact, highest direct social benefits, highest efficiency, and highest added value.

- Performance Bond- Concessionaires were required to provide performance bonds equivalent to 60% of the total reference value of contract (VRC) based on volume, area and pre-established prices per species as well as payment guarantees for the minimum amount of their contractual obligations. Such a high up-front guarantees, coupled with long approval processes, expensive data gathering processes, and formidable capital expenditure budgets to obtain raw material are further complicated by the long time period between start-up and sale of processed wood product, thus restricting access to concessions.

- Monitoring- Despite paying annual fees to the government, concessionaires were also required to pay for audits of their operations by the governments. NOTE: As an incentive, independently certified operations had reduced requirements as SFB could utilize the annual visits of auditors in place of its federal inspections.

Deep-dive analysis of the actual experiences of concessionaires and consultation with SFB's own staff resulted in the implementation of significant steps designed to improve the pricing, bidding process, and ultimate granting of the Itaituba concessions:

- Reliable background information- IFC led the elaboration of a realistic Management Plan and land tenure assessment of Itaituba. The first was approved by the government in record time while the second found no land limitations from a legal standpoint. This provided clarity to potential investors as to the legal, social, and biophysical landscape and what the government's specific intentions were on a particular area.

- Reliable inventory of raw material- IFC carried out a third-party analysis of the government's timber inventory, obtained additional information to increase reliability for the projection of commercial volumes, and tested market acceptance to inventory risk. This allowed bidders to have confidence in the amount of wood which they could extract and make the appropriate realistic financial calculations.

- Concession Price Methodology- Rather than relying on the simplistic reverse calculation to determine the price of standing timber (stumpage), IFC developed a discounted cash flow methodology to price the concession in more realistic commercial terms. This was a significant development that allowed for pricing per the realities of the market and private capital, and not a broad-brushed academic exercise assuming similar conditions for all species and areas.

- Concession Price Data and Financial Assessment- To reach a concession price based on actual site conditions, IFC, SFB and BNDES staff jointly visited the forest, and spoke on-stie with illegal gold miners and loggers, and local indigenous communities. This provided ground-truthing on risk from third-parties, costs of operations, quality of timber, and market demand, thus allowing for truly reliable financial analysis and an estimated risk-adjusted, Target Equity IRR of 18% per annum, including 60% debt and BNDES financing conditions.

- E&S Issues- IFC's well-known and stringent Performance Standards were incorporated into the Concession Agreement thus setting the stage for not only appropriate consideration of social and environmental aspects, but also allowing for institutional capital to be channeled to the concessionaires with lower risk.

- Independent Legal Due Diligence - To ensure complete alignment with conditions of the Federal Statute for Forest Concessions, Federal Statute for Bidding Process and Public Contracts and the Decree that regulates the normative content of the Statute for Forest, third party legal advisors monitored the process. This provided assurance to all parties that legal issues were addressed appropriately and reduced risk.

Despite all of the joint effort described above, and SFB approval of process and price, internal capacity and political obstacles in Brazil prevented the institution from bringing the Itaituba concessions to market. In Brazil, as in other Pan Amazon countries, significant challenges for the natural forests timber value chain remain, specifically with regards to timber traceability, land tenure in concessions, and the impacts of timber extraction roads on deforestation. The process and results of this exercise serve as guidance for subsequent development and technical assistance projects interested in improving the concession model. Due to these challenges, timber concessions in natural forests in not proposed as an intervention value chain for Component 1 of the Program.

3.3 The Wilderness Sector

3.3.1 Nature Tourism

This sector includes the design, development and sale of different tourist services, linked or not to the conservation of Protected Natural Areas, protection forests, communal forests, among others, with a vision of giving value to culture, biodiversity and the standing forest. The Amazon is both a travel destination and a tourism brand. The brand elicits a vision of vast forest landscapes traversed by powerful rivers, populated by charismatic wildlife and home to a diverse assemblage of indigenous peoples. Overall, the travel sector is a significant component of the regional economy, representing between 2 – 4% of the GDP of Amazonian jurisdictions.[288,289] The region's governments view nature and cultural tourism as important engines for growth.

Coomunity-based ecotourism is a subsector of nature tourism whose practitioners pro-actively support biodiversity conservation and share the economic benefits with indigenous and traditional communities[290]. Although nature and cultural tourism has enjoyed healthy growth over three decades, its potential to catalyze economic growth remains largely unrealized.

The limited growth of the Amazon tourist trade is the consequence of two structural attributes: Accessibility: International visitors must travel long and circuitous routes to arrive at their destination.[291] Brazil's domestic airline industry has only limited overseas connections, while international tourists visiting the Andean nations must pass through one or more airports prior to arriving at the starting point for an Amazonian expedition, which typically entails a long journey by road and/or fluvial transport. Air taxis are usually not available or are prohibitively expensive. Infrastructure: Most eco-lodges offer simplicity, which limits their appeal to less adventurous travelers who tend to be more affluent. The international travel industry is absent because returns are low and the potential for scale is limited. Consequently, nature and cultural tourism in the Amazon is a niche market dominated by small businesses with limited access to capital.

In Peru tourism is an important component of the national economy, generating more than US$8 billion and 500,000 jobs.[292] The most important destination is Cuzco and surrounding localities, which attracted 3.5 million tourists in 2017.[293] Most tourists organize their visit from an urban hotels, but complement their stay with nature hikes and nature viewing on indigenous lands. Peruvian tour operators have successfully leveraged this massive tourist asset to develop an ecotourism industry in the Amazonian lowlands. The most popular lowland destination is Madre de Dios where visitors can access more than 120 ecolodges located within or adjacent to the Tambopata Reserve and Manu National Parks. The next most popular option is Iquitos on the Amazon River where a similar number of lodges are located along the Amazon River. There are many lesser known destinations in the foothills of the Andes that provide affordable vacation offerings to budget travelers and the Peruvian middle class.

Ecuador has a similarly diverse and prosperous travel industry. Its stellar attraction, the Galapagos Islands, attracted 225,000 tourists in 2017 and many of these tourists also visit the Ecuadorian

[288] INEI - Instituo Nacional de Estadística (2016) https://www.inei.gob.pe/estadisticas/indice-tematico/producto-bruto-interno-por-departamentos-9089/0

[289] IBGE – Instituto Brasileiro de Geografia e Estatística (2017) PIB dos municípios , https://www.ibge.gov.br/estatisticas-novoportal/economicas/contas-nacionais/2036-np-produto-interno-bruto-dos-municipios/9088-produto-interno-bruto-dos-municipios.html?=&t=resultados

[290] The International Ecotourism Society (TIES) offer a certification scheme, as well as a variety of classes, workshops and resources to support its members. http://www.ecotourism.org/

[291] In 2018 there were only three daily flights from Manaus to Miami, Panama City or Lisbon and one daily flight between Belem and Miami; all other regional capitals are accessible only via São Paulo, Rio de Janeiro or Fortaleza.

[292] La Republica (25 Mar 2018) Turismo en Perú generó ingresos por más de US$8 mil millones

[293] There were more than 80 flights per day between Lima and Cuzco per day in 2017; in addition to overland from other parts of Peru and Bolivia. Source https://peru.com/noticias-de-dircetur-50974

Amazon. Entrepreneurs have developed dozens of ecolodges on two main landscapes: (1) the piedmont near Tena (Napo Province), most of which are located just beyond the agricultural frontier in coordination with *Kichwa* indigenous communities. (2) More remote venues adjacent to Yasuni National Park and the Cuyabeno Wildlife Reserve in association with the *Cofan* and *Woarani* communities. Other offerings include lodges directly managed by the *Schuar* and *Ashuar* people in Pastaza and Morona–Santiago provinces. As in Peru, there is a robust market of middle class urban families seeking a conventional vacation with swimming pools and other amenities.

Brazil's Amazonian travel industry is based largely out of Manaus. The most popular option are day trips provided to casual visitors, followed by multiday river trips on cruise ships with accommodations for up to 100 passengers and professional guides. There are also a few smaller, more intimate, vessels that cater to upscale tourists.[294] Manaus is the point of access to more remote locations upstream on the Rio Negro (Barcelos, Sao Gabriel da Cachoeira,) and further West on the Solimões (Mamiraua Sustainable Development Reserve).[295]

Nature and cultural tourism offerings in other regions of the Brazilian Amazon are surprisingly limited. Bird watchers visit Altafloresta (MT) and the Serra do Carajás (PA), but there is a dearth of ecolodges near other metropolitan areas (Belem, Amapá, Boa Vista, Porto Velho and Cuiabá) – in spite of public and private initiatives to promote ecotourism.[296,297,298] Moreover, there are a very limited number of ecotourism ventures that explicitly benefit indigenous communities, at least when compared to Peru and Ecuador.[299,300,301] In 2015, FUNAI, the federal agency charged with protecting the interest of indigenous people, finally promulgated a set of formal guidelines for both the community and the tour operator.[302]

Both Suriname and Guyana have several high quality ecolodges that cater to an international clientele from Europe and North America. Both countries received about 250,000 arrivals each in 2017, which

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294 Amazonas Viverde (11 Oct 2018) River Cruises. https://www.amazonastravel.com.br/river_cruises.html

295 TripAdivisor (12 Oct 2018) Sate of Amazonas https://www.tripadvisor.com/Tourism-g303226-State_of_Amazonas-Vacations.html

296 PROECOTUR (2000) Programa de Desenvolvimento do Ecoturismo na Amazonia legal, http://www.mma.gov.br/estruturas/sedr_proecotur/_publicacao/140_publicacao09062009023258.pdf

297 PROECOTUR - Programa para o Desenvolvimento do Ecoturismo na Amazônia Legal (2012) Pólos de Ecoturismo, MINAM – Ministerio do Meio Ambiente, http://www.mma.gov.br/informma/itemlist/category/79-turismo-sustentavel

298 Instituto EcoBrazil (1998) programa de desenvolvimento de ecoturismo em reservas extrativistas (RESEX) (1998), http://www.ecobrasil.org.br/home/3-secao-geral/categoria-projetos/905-projeto-ecoturismo-em-reservas-extrativistas

299 Instituto EcoBrasil (1998) Programa de Ecoturismo em Áreas Indígenas, http://www.ecobrasil.org.br/projetos/projetos-em-parceria

300 BBC (2015) Helping Brazil's tribal groups benefit more from tourism https://www.bbc.com/news/business-30897076

301 Nelson S.P. (2000) Ecotourism and Community Involvement in the Brazilian Amazon, Paper presented in the session "Ecotourism and Sustainability: Cooperation for a New Millennium," XXI International Congress of the Latin American Studies Association, http://lasa.international.pitt.edu/Lasa2000/Nelson.PDF

302 FUNAI – Fundação Nacional do Índio (8 Jul 2015) Funai normatiza Etno e Ecoturismo em Terras Indígenas, http://www.funai.gov.br/index.php/comunicacao/noticias/3334-funai-normatiza-etno-e-ecoturismo-em-terras-indigenas?highlight=WyJlY290dXJpc21vIl0=

includes businessmen and emigrants returning to visit family. Guyana reported that 60% arrive on a tourist visa, while Suriname reports that 25% are tourist on vacation.[303,304]

Another important destination in the heart of the Amazon is the trinational border area between Peru, Colombia and Brazil; most tourists arrive from Colombia for offerings similar to Manaus and Iquitos.[305] The rest of Colombian Amazon has very limited tourist activity; typically, small family-owned lodges located within or adjacent to towns that cater to a domestic clientele. Bolivia offers a range of offerings that appeal to international travelers, most are organized around Lake Titicaca and the Salar de Uyuni on the Altiplano; the Amazonian tourist industry includes family resorts in tropical Cochabamba and the Jesuit missions of Santa Cruz.

The revenues generated from nature and cultural tourism can be estimated by extrapolation from the statistics compiled by agencies that report revenues from the hospitality sector (lodging and meals). Overall, the sector defined as *lodging and meals* contributed US$4.2 billion in 2016, about 2.2% of Pan Amazon GDP. The proportion of establishments self-identified as ecotourist offerings can be identified by using a commercial web site that provides booking information to prospective clients. If revenues are evenly distributed across all enterprises, then establishments using the terms *eco* or *nature* in their marketing material would sum to US$319 million.[306]

Though tourism can be an empowering and supportive business for indigenous and rural communities, one that creates incentives for conservation, it can also undermine resilience when tourism falters because of economic shocks (Nepal 2020). COVID has made it clear how fragile tourism can be as a lever for economic development and conservation. Reports have come in from various parts of the Amazon, suggesting that the closing of ecolodges and hotels and the resulting drop in revenues and employment has led to illegal hunting, animal trafficking, illegal mining and extraction, and land seizures in and around protected areas (Butler 2020). Also, many NGOs have pulled out of field projects and related ecotourism and research operations, leaving local residents to stranded without support (Brown 2020).

The crisis led to reconsideration about how to make tourism more sustainable and resilient and how to ensure local communities are less vulnerable to the vicissitudes of the industry (Higgins 2020b). Some of the recommendations include a stronger commitment to goals that have long been the foundation of the paradigms of sustainable tourism and ecotourism. These include: limiting numbers of visitors and operations to be sure not to exceed the finite context of larger ecological systems (often referred to as social and ecological carrying capacity); ensuring local economies are diversified and not overly reliant on tourism alone to sustain entire segments; managing expectations for tourism can and should achieve (i.e., it can address certain goals of conservation, sustainable livelihoods, cultural

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303 Guyana Tourism Authority (2017) Guyana Tourism Statistical Digest, https://www.guyanatourism.com/

304 Suriname Tourism Foundation (2017) Visitor Exit Survey 2016-2017, https://www.surinametourism.sr/#!en&events-more&statistics

305 TripAdvisor (12 Oct 2018) Things to Do in Leticia, https://www.tripadvisor.com/Attractions-g317037-Activities-Leticia_Amazonas_Department.html

306 This definition would exclude most of the hotels in Cuzco and would not include meals in most restaurants that do not advertise as eco-anything.

revalorization, but not be a panacea for all). These are goals that depend on tourism operations and destination communities to achieve as they re-build after Covid. However, some of the responsibility for reform comes from governments. This includes acknowledging and registering the importance of their tourism industries to their economies, as a sector worth investing in for long-term recovery, and vital to mental and physical health and wellbeing of citizens and to the prosperity of their rural and coastal regions (Higgins 2020b).

Taking into consideration the preceding points and the current uncertainties, we recommend a intervention for the program that addresses the current COVID crisis in the Amazon tourism sector, taking into account as well the competitive advantages and the limitations that local Amazon populations face in this industry.

Model intervention: Community-led nature tourism

Value chain structure, yields and prices	*Community destination or lodging managers:* Communal nature tourism is mainly carried out at the level of associations or communities that articulate the contributions or family enterprises of several community members. Many of these associations or arrangements are quite new and are in the process of building the necessary social and economic capital for the successful execution of the enterprises. Many of them still do not have all the requirements to access finance (Public registry, bank accounts, internet, etc.). There are an estimated 100 community-based nature tourism ventures in Peru, several of the most successful are in communities near Natural Protected Areas, such as the Camino al Dorado venture in Pacaya Samiria, Loreto, the Tingana venture in San Martin, and the Posada Amazonas venture in Tambopata and Casa Matsiguenka in Manu, both in Madre de Dios. Charges per passenger range from US$40 to US$100 per day. *Managers, agencies and local urban lodgings:* Local travel agencies and lodges in nearby cities are a crucial link to the market for many community-based nature tourism ventures. Of the 454 Amazonian operators and agencies identified (Directorio Nacional Turismo-MINCETUR), we estimate that 20% work with community-based enterprises. Of these, we estimate that 50% are micro-enterprises and 50% are small enterprises. *Operators regional / national destination:* Several communal nature ventures have a development relationship in partnership with a destination operator active at the regional or national level. Successful destination operators working with communities include Rainforest Expeditions, Andean Lodges, Amazonas Explorer and Inkaterra. Similarly, there are national and international operators such as Lima Tours, Condor Travel, G Adventures and National Geographic Travel that have long-term partnerships to bring visitors to community-based tourism products in different parts of the country.
Technical services and best practices	Providers of services and inputs for community-based nature tourism are still underdeveloped. The main technical training processes have been provided by destination operators that are committed to community-based tourism, such as Rainforest Expeditions and Andean Lodges. At the national level, ProCompite Turismo para Asociaciones Comunitarias has supported 20 native communities over the past three years with non-refundable resources of up to S/. 200,000 soles each. There is also support from the national initiative Turismo Emprende, which is in its third year and has financed seven Native Communities with non-refundable resources with average amounts of S/.80,000.
Financial services	The development works of communal nature tourism services, both at the communal level and in the local urban enterprises that cooperate with them, have not been working with credit. This is due to what was mentioned above regarding the lack of credit conditions and track record, but also to the fact that several Communities do not trust the banking system and the credit system and prefer to work with their own capital. Regional and national destination operators have conventional credit profiles and access banking on a regular basis, both bank and non-bank entities. Such operators focused on nature-based tourism could act as anchor companies through which to finance the community-based tourism chain in specific geographic destinations.
Climate vulnerability and other risks	The nature tourism experience is to a large extent dependent on healthy nature. Climate change directly impacts the health of forests and biodiversity and so directly undermines the resource base on which community-led nature tourism depends. Volatile weather also increases operational complexity for a smooth running travel experience. Specifically, this manifests itself through damage to tourism hotspots (coastal mangrove and forest resources) and tourism infrastructure, creating higher operational costs e.g. insurance, evacuation, back-up systems) and trip cancellations, damages due to wildfires, reduced attractiveness of tourism in areas with increasing disease incidence (zika, malaria, dengue) and unpredictable climate (droughts, rainfall, temperature), damages to infrastructure from sea level rise and riverbank inundation, reduced attractiveness of key tourism features (waterfalls) due to precipitation variability, and others.
Key Barriers and Enablers	The tourism sector has been greatly affected by the COVID-19 crisis and the mobility and travel restrictions that have been implemented to try to mitigate the pandemic. As a result, not only community-led tourism and nature tourism enterprises, but the entire sector has shut down operations. The companies and experts consulted estimate that the recovery of the sector, starting in 2021, will be

	gradual and may effect structural changes that will profoundly affect inbound tourism in the Amazon. Although some of the larger anchor companies are in a position to apply for loans, financial support to the sector should include rescue grants and patient equity capital.
Current extents and potential program adoption	Extent based on estimates of eligible businesses and the assumption that each nature tourism operation has a sphere of influence/reliance of 10,000 hectares of forest. Due to the current crisis in the sector we expect a high adoption rate of 50%, as long as there is a high level of concessional financing.
Proposed intervention	Grant support to community-led businesses, based on their pre-COVID passenger volume and earnings. Cover maintenance, relaunch costs and, potentially, strategic reorientation of businesses, required US$12,400. Small and Medium operators: Grants, equity and concessional loans for infrastructure upgrades and marketing to reactivate operations, required US$96,000. Large operators: Equity and concessional loans for infrastructure upgrades and marketing to reactivate operations, required US$2,100,000. Proceed with concessional finance (grants, equity, loans), technical assistance and incentives
Mitigation activities and impacts	The establishment of nature tourism operations and the ensuing protection of forests and wildlife species for observation by visitors leads to habitat conservation and avoided deforestation. This avoided deforestation halo effect is estimated to lead to increased carbon stocks equivalent to 3 tCO_2/ha/annum (Program Financial and Carbon Model).
Adaptation activities and impacts	Well organized community-led nature tourism can lead to cultural revival and economic diversification of local and indigenous communities. It is inherently aligned with keeping natural forests and all their biodiversity in place, and so promotes ecosystem-based adaptation and resilience. Though, as the COVID pandemic has clearly demonstrated, nature tourism is vulnerable to outside shocks it is also one of the key areas that can have a quick recovery in high forest landscapes once the economic recovery is underway.
Financing aspects	Virtually all community-led nature tourism operations have ceased to function for the last 15 months. In this time they have still had to occur maintenance and other costs. We hazard a guess that 50% of them, across all countries, have already gone bankrupt and ceased to function permanently. The Program should proceed with grants to community enterprises and grants or equity to operators and destination managers, as well as technical assistance and other incentives
Number and size of beneficiaries and financial demand	Across all countries we estimate a total of 360 beneficiary entities (240 micro, 108 small and medium, and 12 large). Total potential financial demand in the order of US$44 million (micro: US$3 million, small and medium: US$11 million, and large: US$29 million). For details of beneficiaries, financial demand and intervention data refer to Annex 5 and sources[307].

Potential beneficiary entity case study

Name of Entity	Kapawi Ecolodge and Preserve
Business Model & Value Chain Node	Kapawi is a joint venture between a private tour agency (Canodros) and the entire federation of 5,000 Achuar Indigenous Peoples (Achuar Nation). The business model is an eco-lodge in Ecuador that honored nature while offering comfortable accommodation for tourists.
Location	Pastaza, Ecuador
Development Stage and Certifications	Fully developed and functional. In early years (1993-2008) the business was managed by Canodros who set up the lodge and trained local community members. The managing company paid a lease to use the space and charged a fee to every visitor. In 2008, management was transferred entirely to the Achuar Nation. In 2019, an 18-month renovation was initiated.

[307] Nycander et al. 2020. Community Tourism Enterprise Development in the Rupununi: A Blueprint.
MINCETUR, 2020. Base de datos Turismo Rural Comunitario -Turismo Emprende

Theory of Change & Impact Strategy	The Achuar's objective is to generate a source of local income, preserve their ancient traditions and customs, and protect the Amazon Rainforest. It's goal is to provide environmentally friendly, socially responsible, high-class tourism services that attract international and national visitors. This helps to create jobs for the Achuar villages. Thanks to the income from the lodge and visitor fees, the entire community benefits beyond the families directly working in the lodge, and values the sustainable business. With this additional income, value is added to the standing forest that helps the community to battle against encroachment of other (destructive) activities, particularly oil exploration. A positive authentic cultural and natural experience for the visitors could transform them into permanent allies of Amazon conservation.
Innovation / R&D	The most innovative aspect of the business is its 100% management by the Achuar Nation, including the distribution of revenues. The business received support from the Pachamama Alliance (www.pachamama.org) Kapawi has won several awards such as one of "50 Best Ecolodges" (2008, National Geographic) Equator Prize (2010, UNDP), Sustainable Standard-Setter Award (2013, Rainforest Alliance).
Climate Change Nexus	
Spatial distribution and market	It is mostly present in areas with a positive combination of natural and landscape beauty and accessibility. In Ecuador, tourism contributes to 1.8% of GDP, but employs 6% of economically active population. Kapawi is remote, accessible only by airplane and dugout canoe.
Mitigation benefits	The establishment of nature tourism operations and the ensuing protection of forests and wildlife species for observation by visitors leads to habitat conservation and avoided deforestation. This avoided deforestation ´halo´ effect is estimated to lead to increased carbon stocks equivalent to 3 tCO_2/ha/annum. The Achuar community manage 100,000 hectares where ecotourism has established as a key instrument supporting conservation and community development (300,000 tCO_2/annum). The total area of the Achuar Nation, which benefit from the ecotourism business, is approx. 7000 km^2. (6 M tCO_2/annum).
Adaptation benefits	Well-organized community-led nature tourism can lead to cultural revival and economic diversification of local and indigenous communities (Izurieta et al, 2021). It can lead to jobs, income and social inclusion (Hoefle, 2016). Nature tourism is inherently aligned with keeping natural forests and all their biodiversity in place, and promotes ecosystem-based adaptation and resilience. Although the climate vulnerability is relatively low, nature tourism is vulnerable to outside shocks (e.g., COVID) it is also one of the key areas that can have a quick recovery in high forest landscapes once the economic recovery is underway. In case of Kapawi, the successful ecotourism business helped the community to develop over the years other community enterprises, increasing their resilience.
Climate vulnerability	The general vulnerability of nature tourism includes damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) and trip cancellations; damage to forest resources (tourism hotspots) due to wildfires; reduced attractiveness of tourism in areas with increasing disease incidence (zika, malaria, dengue); risk of decreased attractiveness of key tourism features (wetlands, waterfalls) due to precipitation variability; reduced attractiveness of eco-tourism opportunities contingent on unique species (mammals, fish, etc.) that are vulnerable to climate change. In the case of Kapawi, the damage from wildfires is low because it is unlikely that this humid area will dry to such a degree that it becomes vulnerable to wildfires. The major particular vulnerability for Kapawi is the accessibility (depending on dirt airstrips and river navigability) and decreased attractiveness in periods that the surrounding wetlands dries.

Sustainable management practices & models (contributing both to adaptation and mitigation)	Agreement of the Achuar Nation to conserve the entire Achuar territory. Active involvement of as many Achuar peoples as possible in tourism improves knowledge on forest conservation. Association with international NGO and national university (San Francisco, Quito) helps to identify potential climate change impact and adaptive practices.
Beneficiaries	Entire Achuar Nation (5000 persons)
Co benefits	
Environmental co-benefits	Forest conservation is a general benefit to biodiversity and ecosystem services. Apart from the conservation effort of the entire Achuar territory, the communities also agreed to restrict hunting in the areas within the ecotourism zone.
Social co-benefits	Kapawi's economic impact has been significant. Sixteen of 52 Achuar communities base most of their income on ecotourism. In these communities, up to 45% of their total income comes from direct employment at the lodge. A rotating staff of 22 employees at Kapawi are from Achuar communities. A distinguishing characteristic is the fact Kapawi is not so much a community-based lodge (benefiting only the communities within the ecotourism area) as a federation-based lodge that incorporates over 58 Achuar communities living in 7,000 square kilometers of indigenous territory Direct labor at the lodge is more for man than women, among others because it implies leaving the family for longer periods. Nevertheless, there are female jobs created but women are more and activity involved in additional tourism activities such as community visits, handicraft production, wellness and yoga.
Risks	
Potential (social, environmental) risks	• Market (still) dependent on international tourism which is conjuncture-dependent. • Competition: increasing amount of tourism enterprises in the Amazon, may at lower prices (budget destinations like Cuyabeno) • Climate change can alter attractivity and accessibility (see vulnerability) which can affect income for communities. • Carbon footprint of visitors: international flights to travel to Ecuador and national flights to visit Kapawi. Increased number of tourists can cause more carbon footprint. • Leakage: additional income from tourism activities can potentially be used for unsustainable non-forest activities. • As a non-essential service, tourism is very sensitive to social, economic, political and public health shocks, as the COVID pandemic has so clearly shown • Negative impact of tourism on sites (use more than carrying capacity; destruction, wildlife disturbance • Inequality created by those who profit from direct job creation and those who do not
Potential risk mitigation strategies	• Marketing through international alliances and certifications • Competitive position: invest in quality and market unique features of Kapawi. • Climate vulnerability: ensure conservation of most of the watershed both through Achuar Nation conservation effort and collaboration with government agencies' planning (both watershed and conservation planning as well as in airstrip maintenance and flight services) • Carbon footprint: no specific strategy to mitigate (rather promotion to attract tourists) but awareness raising for tourists and others. Compensation by other sustainable practices (eg solar panels). • Leakage is managed by community planning and control. Little destructive practices take place by Achuar families who depend on subsistence agriculture. • A response to recent shocks (COVID) has been managed by focusing more on national market and reducing management costs

	● Negative impact of tourism on sites is managed by maintaining very low capacity (70 visitors/100,000 hectares) and carefully applying low impact activities. ● Inequality managed by federation who ensure fair benefit sharing.

3.4 Ecosystem services and habitat restoration value chains

3.4.1 Climate regulation and other ecosystem services

Natural ecosystems in the Pan Amazon region provide society with a wide range of ecosystem services at global, regional and local scales. Climate regulation, water provision, pollination services, recreational opportunities are of huge economic, social and health importance, while not yet adequately included in traditional economic accounting and policy decisions. In recognition of their importance, and in the face of the ongoing widespread degradation and loss of ecosystems providing them, progress has been made in the last two decades to assign monetary value to ecosystem services. These can be broadly divided into two categories:

1. Payments by users or beneficiaries of a specific service. These can be direct benefit payments or payments for the compensation of an environmental harm. Water services, pollination services and recreational services are the most common direct benefit services. There are good examples of local payments by water users for watershed conservation[308], and park fees are an example of payments for recreational use. However, these services are less developed in creating schemes where many financial transactions create a stable environment for private sector engagement at a significant scale. Carbon markets and biodiversity offsets, the most common examples of markets driven by the compensation of harm principle, do have this potential. These will be discussed in the next section.
2. Public payments per hectare for stewardship of land providing a certain quality of the full range of ecosystem services, i.e. undisturbed or somewhat disturbed land, or land under habitat restoration. Examples are Ecuador's SocioBosque Program and Costa Rica's FONAFIFO, the latter funded by a fuel tax. While such programs have shown to have significant impact, they will not be discussed further here for lack of clear opportunities for private sector engagement.

Carbon markets are by far the most developed, providing to some extent a template for other such markets, including biodiversity offsets (which are discussed in more detail in the following section on habitat restoration). In all countries of the Pan Amazon except Guyana and Suriname activities (projects) participating in carbon markets have already been developed, some since as far back as the

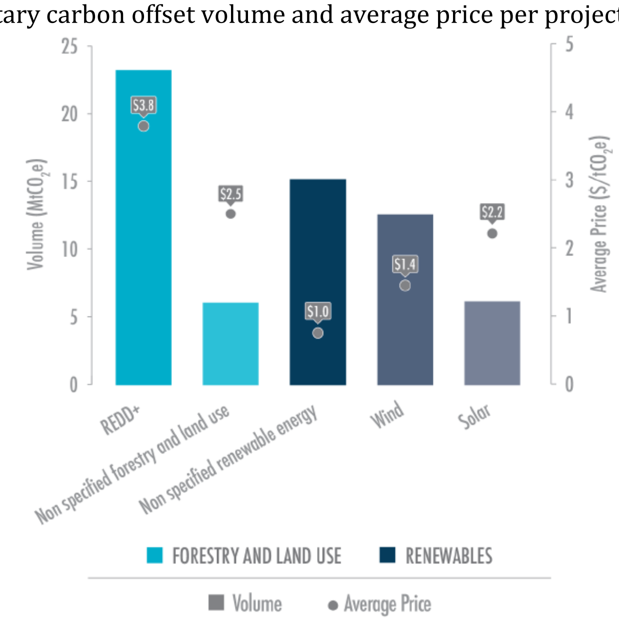
[308] However, these may work well in a geographically limited watershed, i.e. in a mountainous area, providing water services to a specific user, e.g. a city or drinks company. The vastness of the Amazon and Orinoco watersheds makes it next to impossible to link the impact of a project-scale intervention to changes in water quality or quantity downstream.

1990s.[309] This section discusses the status and the outlook on future potential of private sector involvement in carbon markets in the region.

The basic concept is that these projects must show that their actions reduce the emissions of CO_2 into the atmosphere (through preventing deforestation or forest degradation) or remove carbon from it (through tree growth), relative to what would have happened without their intervention (called the *baseline scenario*, which shows that the investment creates additional benefits). The baseline scenario is hypothetical, but the project intervention must be monitored over time to check if the forest is still there or how much the trees have grown. The project can thus quantify its performance, expressed in tons of CO_2 less in the atmosphere than without the investment, and this amount can be sold to offset that amount of emissions by the buyer. The rules, requirements, and methodological intricacies of how this is exactly done and independently verified are governed by a certification standard, of which there are a variety in existence, some specializing in different market segments. The largest such standard that certifies forest projects is the Verified Carbon Standard (VCS), administered by Verra[310].

Until recently, the only demand for carbon offsets from forest and other land use projects came from companies that voluntarily wish to neutralize all or part of their corporate greenhouse gas emissions. This voluntary market has been in existence since the late 1990s and has been fluctuating around a global demand of about 80m tCO_2 across all project sectors. In recent years, with renewable energy becoming financially competitive and widely adopted and thus no longer needing carbon market incentives, and with the increasing realizations that the world is facing an ecological crisis much wider than climate change, the voluntary market's focus has shifted to so-called *nature-based solutions* (NBS), i.e. forest conservation and tree planting, which made up around 60% of the value of global voluntary market transactions in 2019 (Figure 50).

Figure 50: Transacted voluntary carbon offset volume and average price per project type (Top 5), 2019.



309 International Database on REDD+ projects - countries (reddprojectsdatabase.org)

310 verra.org

Source: Forest Trends (2020)

There is a quickly growing international demand for NBS offsets, which will not be met initially as it takes several years to develop and implement NBS projects to the point they can deliver offsets into the market. The expectation is therefore that prices will (continue to) rise, providing further incentive to project developers and investors[311]. Furthermore, it is possible that regulated carbon markets, where offsetting is not voluntary but made obligatory through regulation, will accept NBS credits in the future and further fuel their demand.

Next to the voluntary market there are also carbon markets that are driven by government policy. The most relevant for this study is the Colombian carbon tax on fossil fuels, that since 2017 obliges the largest domestic users of such fuels (e.g. petrol companies, airlines) to pay a tax of $5.97 per tCO_2 emitted (this is the 2021 rate; it will rise every year along with inflation) or to show they have purchased the equivalent tons of CO_2 in offsets. The regulation allows offsets certified by a wide range of standards, but only from Colombian projects. It creates an annual demand of roughly 40 million tCO_2 in Colombia, with offsets selling at around 10-20% below the price ceiling[312]. However, with demand projected to outstrip supply for the foreseeable future (Table 17) it is likely the price differential will reduce or even approach zero. After all, buyers may also get the benefit of knowing exactly where their money is having impact (rather than it going to a generic fund, even if earmarked for environmental action) and may even get some marketing benefit out of it.

Table 17: Projected percentage of demand in Colombian domestic market that can be met in the next five years.

Supply and Demand	Base	2021	2022	2023	2024	2025
Pipeline Projects (gross tCO_2)	16,611,113	3,322,223	3,322,223	3,322,223	3,322,223	3,322,223
Registered Projects (gross tCO_2)	10,268,519	14,119,446	2,823,889	2,823,889	2,823,889	2,823,889
Estimate Supply of Verified (tCO_2)	8,394,992	14,991,160	27,698,661	30,240,162	32,781,662	35,323,162
Projected Demand (tCO_2)	42,211,825	43,478,180	44,782,525	46,126,001	47,509,781	48,935,074
% Supply of Demand	20%	34%	62%	66%	69%	72%

Source: Terra Global Capital 2021

It is not clear whether Colombia will allow domestic projects to sell internationally in view of price dynamics in the international voluntary market, which are already rising above the Colombian ceiling price, or whether it will adapt its internal price accordingly, or neither.

None of the other Pan Amazon countries have an internally regulated carbon market. Bolivia and Ecuador do not allow any participation by private entities in carbon markets, as their constitutions do not treat ecosystem services as private property but as public goods. While Bolivia rejects any kind of commercial ecosystem services transaction, Ecuador does participate as a country in the international REDD+ scheme (see below). Peru does explicitly allow landowners or holders of land lease contracts to commercialize the ecosystem services generated from that land and it encourages project development for the voluntary market. Brazil has in the past adopted conflicting messaging towards

[311] Forest Trends' Ecosystem Marketplace, Voluntary Carbon and the Post-Pandemic Recovery. State of Voluntary Carbon Markets Report, Special Climate Week NYC 2020 Installment. Washington DC: Forest Trends Association, 21 September 2020.

[312] Terra Global Capital, 2021. Colombia's carbon market revolutionizing rural development. New Paper: Colombia's Carbon Market Revolutionizing Rural Development | Terra Global Capital

project development for international carbon markets but has never actually disallowed it. The country seems to have realized, that it is missing out on private investment into voluntary market projects that effectively help it to achieve its Nationally Determined Contribution (NDC) under the Paris Climate Agreement[313] without in return having to transfer any emission reductions to other Parties to the Agreement under its Article 6[314]. Its new regulation, Floresta+, explicitly encourages any initiatives in the country that feed into the voluntary carbon market, though without providing further regulatory detail. Similarly, its recent National Policy of Payments for Environmental Services (PNPSA) is explicitly encouraging such payments schemes and confirms their legal basis, again without providing specific regulation[315].

Guyana and Suriname are both countries with a high forest cover and low deforestation rates. The service they provide to the global community of keeping the carbon stored in their forest out of the atmosphere must be recognized. Norway (in the case of Guyana) and the World Bank are assisting them on a trajectory to receive international payments for this (the aforementioned REDD+, see below). However, the potential for development of individual offsetting projects along the principle of additionality as applied by most carbon standards is negligible in these countries, due to the low threat of deforestation. Any private-sector investment and the development of business opportunities is thus unlikely. Pilot projects/investments may be warranted if future deforestation scenarios change in view of economic or social changes occurring in both countries.

The international REDD+ scheme that is part of the Paris Agreement promises financial rewards to developing countries that Reduce Emissions from Deforestation and forest Degradation (REDD+) against a national baseline, the Forest Reference Emissions Level (FREL). All Pan Amazon countries are participating in a trajectory assisted by either Norway[316], the World Bank[317] and/or the UNREDD[318] program to put in place the systems (readiness) to finance, implement, monitor, account for and transact climate benefits from REDD+ activities. While in Bolivia, Ecuador, Guyana and Suriname, REDD+ participation does not enable private sector opportunities, in Brazil, Colombia and Peru it is a supporting factor, as REDD+ readiness and implementation contributes to creating the enabling environment for private sector investment (e.g. low policy risk, human capacity, pilot experiences).

Significantly, jurisdictional or sub-national approaches to implementing forest carbon initiatives are emerging. These are a hybrid approach between a project and a national program. Like national action, it is government that manages and regulates the initiative, and, if done properly and financed properly (through REDD+ payments and/or credit purchases, which can come from both public and private

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[313] Brazilian REDD+ Alliance, 2020. Programa Floresta+ and Voluntary Carbon Markets – Article 6, voluntary markets and the new Brazilian REDD+ Programme.

[314] As would be the case if Brazil would sell emission reductions to another Party. These would then count towards the other Party's NDC, not Brazil's. This is not the case with voluntary transactions for offsets, which do (for now) not get claimed by any other country.

[315] globalcompliancenews.com

[316] https://www.nicfi.no

[317] Forest Carbon Partnership Facility

[318] UN-REDD Programme (un-redd.org)

buyers), a government has the power to effect impact that can be many times that of a collection of projects. Currently, 18 jurisdictions in the Pan Amazon are developing REDD+ initiatives (1 in Colombia, 1 in Ecuador, 5 in Peru, and 11 in Brazil). Jurisdictional programs have been given strong signals that they may be the most eligible and acceptable NBS credits to sell into international emissions trading schemes that are not voluntary but where compliance is mandated by an authority, e.g. a government or industry association. The most likely first scheme to open to jurisdictional credits (see below) is the one by the International Civil Aviation Organization.[319] These markets have the promise to unlock a much larger and more reliable demand for carbon credits than the voluntary market, and they have long been the prime target for the NBS sector.

An approach that seeks to give room for both governmental action and privately financed projects is being developed in Peru and Colombia, and is called *nesting*. While Brazil would be the third country in the region that could follow a nesting approach, it is not currently doing so. Essentially, every five years the government will set a spatially explicit FREL of deforestation and (possibly) forest degradation, against which it will formulate its internal reduction target in its NDC. All projects that want to develop within the jurisdiction must use the FREL set for their particular area, expressed tCO_2/ha/yr emitted, as their baseline scenario. If they can reduce emissions below that, they may be in business and be registered. However, as projects have an investment horizon of several years, sometimes decades, there must be assurance that projects can safely operate for a sufficiently long period without being disqualified by future regulation.

In summary, there is potential for direct private sector involvement in Colombia, Peru and Brazil, with a less supportive regulatory environment and hence potential in Bolivia, Ecuador, Guyana and Suriname. Due to the ongoing transition from project-based to jurisdictional/national level schemes for climate ecosystem services valuation[320], climate regulation ecosystem services projects are not proposed as an intervention value chain for Component 1 of the Program. Technical assistance should be included to help countries working with the Amazon Bioeconomy Fund to further clarify how public-private cooperation can go forward in this value chain.

Table 18: Status of carbon market participation and NBS project activity in the Pan Amazon countries

Country	National REDD+	Juris-dictional programs	Nesting policy	Confirmed ongoing REDD projects	Confirmed ongoing reforestation projects
Bolivia				3	1
Brazil	yes	11		27	18
Colombia	yes	1	yes	30	18
Ecuador	yes	1		2	3
Guyana	yes			0	0
Peru	yes	5	Process	12	10

[319] Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) (icao.int)

[320] Forest Trends' Ecosystem Marketplace. 2021. State of Forest Carbon Finance 2021. Washington DC: Forest Trends Association.

Suriname	yes	0	0

Source: study team

3.4.2 Habitat restoration on degraded areas

Land degradation is a global problem. Pledges have been made internationally by many countries to restore millions of hectares of degraded lands. Of the Pan Amazon countries, Bolivia, Brazil, Colombia, Ecuador and Peru have set targets for forest restoration in their National Plans for Forest Restoration or their (Intended) Nationally Determined Contributions (INDCs) to the Paris Agreement (Table 19). The targets add up to millions of hectares, which indicates there is both a large potential and a political willingness for habitat restoration efforts.

Table 19: National forest restoration targets of the Pan Amazon countries.

Country	National forest restoration plan	Restoration area target (ha)	Target date	Source
Bolivia		6,000,000	2030	Bolivia INDC 2016
Brazil	yes	12,000,000	2030	Brazil INDC
Colombia	yes	1,000,000	2020	20x20 Initiative, Plan Nacional de Restauracion
Ecuador	yes	4,500,000	2030	Plan Nacional de Restauracion Forestal 2019-2030
Guyana		0		
Peru	yes	3,200,000		Plan Nacional de Restauracion, SERFOR
Suriname		0		

Note: Not all the areas in the targets will be within the Amazon region.

Regulatory instruments for habitat restoration are those that oblige the actors of habitat degradation or destruction to take remedial or compensatory action. Every Pan Amazonian country has legislation that covers the rehabilitation of areas of extraction of minerals and fossil fuels, though these are often not well-enforced. If at all, remedial action is often managed in-house by the extraction company and is not done professionally. Often there is also the question whether the restorative action will succeed due to the lack of organic matter and/or toxicity of the soil, resulting in failure and abandonment of the effort.

Some countries, for example Colombia[321], Brazil[322] and Peru[323], also regulate the destructive impact of other sectors, mainly infrastructure projects in the energy and transport sectors (highways, airports, ports, dams, power lines, etc.). However, since the areas where this infrastructure is established are deemed to be permanently lost any restorative action necessarily needs to take place elsewhere. This

[321] Murcia C, Guariguata MR, Quintero-Vallejo E y Ramírez W. 2017. La restauración ecológica en el marco de las compensaciones por pérdida de biodiversidad en Colombia: Un análisis crítico. Documentos Ocasionales 176. Bogor, Indonesia: CIFOR

[322] A Brief Tour of Brazilian Payments for Ecosystem Services - Ecosystem Marketplace

[323] MINAM, 2015. Lineamientos para la Compensación Ambiental en el marco del Sistema Nacional de Evaluación de Impacto Ambiental (SEIA).

then becomes a compensation, or offsetting activity, which is also to be used by extractive industries. The basic principle for environmental offsetting is also being applied in carbon markets. It requires that an environmental damage be remedied by doing at least an equivalent amount of environmental good elsewhere. Naturally, with the offsetting of habitat destruction there are difficult questions regarding equivalence, quantification and timing[324]. While these questions seem impossible to answer academically, it is possible to design a conceptual framework that directs the compensation of habitat loss in a direction where it is reasonable to assume that, overall, a net environmental gain has been achieved[325]. Governments can regulate such a framework and can make it mandatory. Colombia set a step in that direction in 2017 by adopting guidelines towards mandatory *biodiversity offsetting*, as it is also called. Colombia had already developed a manual on biodiversity offsetting in 2012, and Peru did so in 2015, though further work is needed before offsetting can become mandatory there. In Brazil, biodiversity offsetting is mandatory for mining operations, but only if habitat loss occurs within protected areas. Ecuador is in an exploratory phase of a compensation framework and in Guyana it is voluntary. Bolivia and Suriname do not have any specific regulation in place[326,327,328].

In the Brazilian Amazon, the *Código Florestal* (Forest Code) requires landholders to maintain 80% of the natural forest cover on their land. Hundreds of thousands of landholders have violated the Forest Code over several decades to create cattle ranches, oil palm plantations and soybean industrial farms. Although no meaningful attempt has been made to enforce the law, landholders have multiple incentives to come into compliance by reforesting part of their property. These include the prospect of eventually paying environmental fines and improving the valuation of their property at time of sale or when seeking financial credit. Many landholders lack clear legal title to their land and noncompliance impedes their ability to complete the land tenure process. Producers who wish to commercialize their production via supply chains that are closely monitored by international entities dedicated to sustainable production (e.g. RTRS, GRSB[329]), must show they are in compliance or have taken measures to come into compliance with the law.

Restoration could become economically attractive as a stand-alone business model, because lawmakers incorporated a provision into the 2012 version of the Forest Code that at least 50% of the "reforested" area must be natural forest, i.e. not commercial reforestation[330]. However, leaving the

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324 Can the loss of an intact and highly biodiverse habitat be compensated by the restoration of degraded land? How long will it take for this restoration to reach the same status and value (in species richness, providing habitat for endangered species, and ecosystem services provision) as the habitat lost? How are they equivalent if they are not exactly equal in type of ecosystem, geography, species composition, and services provided?

325 BBOP (2013), "To No Net Loss and Beyond: An Overview of the Business and Biodiversity Offsets Programme (BBOP)", Washington D.C.

326 GIBOP (Global Inventory of Biodiversity Offset Policies) (2019), "Global inventory of biodiversity offset policies" https://portals.iucn.org/offsetpolicy/

327 Murcia C, Guariguata MR, Quintero-Vallejo E y Ramírez W. 2017. La restauración ecológica en el marco de las compensaciones por pérdida de biodiversidad en Colombia: Un análisis crítico. Documentos Ocasionales 176. Bogor, Indonesia: CIFOR

328 V. Alonso, M. Ayala y P. Chamas, "Compensaciones por pérdida de biodiversidad y su aplicación en la minería: los casos de la Argentina, Bolivia (Estado Plurinacional de), Chile, Colombia y el Perú", serie Medio Ambiente y Desarrollo, N° 167 (LC/TS.2019/125), Santiago, Comisión Económica para América Latina y el Caribe (CEPAL), 2019.

329 Round Table for Responsible Soy; Global Roundtable for Sustainable Beef

330 Covre, J., Clemente, F., and Lirio, V. S. (2015). New Brazilian forest code: changes and prospects (No. 1008-2016-80333). http://ageconsearch.umn.edu/bitstream/183043/2/New_Brazilian_forest_code_final.pdf

land to regenerate at its own speed seems to be the favored manner of complying: since 2008, 695 ha have been restored by planting native species in the Brazilian Amazon (by NGOs), whereas 9.6 million ha of natural regeneration have been observed.[331] There is also potential for assisted natural regeneration, whereby the natural succession is accelerated by sowing or planting targeted tree species.

Incentives: Private owners of degraded lands may wish to restore these lands but have no reason to do so without public incentives. These can range from direct restoration grants to fiscal incentives, such as tax rebates. Other incentive schemes are payments for ecosystem services (primarily carbon) or a biodiversity offsetting market, i.e. offsetting regulation as discussed above linked with a marketplace where suppliers and buyers of biodiversity offsets can trade.

Direct implementation: Public bodies may wish to spend public funds on habitat restoration, for example to restore connectivity between protected areas or to safeguard ecosystem services, e.g. water provision. While such efforts would be likely to take place on public lands there is much potential to engage the private sector in Public-Private Partnerships (PPPs), for example with local companies that use water resources or that wish to be seen to engage in habitat restoration. Implementation of such initiatives may also be contracted out to private sector restoration service providers.

The extractive industry is required by law to mitigate, avoid, remediate or compensate for the impacts that are caused by their operations. This may include the restoration the natural vegetation that was removed or damaged during the exploration and exploitation of oil fields or the operations of an industrial mine. For example, the oil and gas companies will typically drill numerous exploration wells prior to discovering a commercially viable oil field that is then exploited via production platforms. Most exploration wells are “dry holes” and are not converted into production platforms; these facilities are restored to native vegetation.

The mining industry has a similar obligation and, although it is literally impossible to restore a modern open-pit mine, companies are compelled to remediate the environmental liabilities associated with the waste rock left behind as “tailings.” Tailings contain dangerous mineral elements and a specialized service industry has grown up to develop and implement environmental management plans, which include a component to stabilize mine tailings with some type of vegetation cover. In the Amazon, responsible companies are electing to restore these areas into something that approximates a natural habitat.

An important case is underway at the bauxite mine operated by the company *Mineração Rio do Norte* (MRN) near the Río Trombetas in Western Pará. Bauxite occurs as a layer of rock ten to twenty meters below the soil surface which is exploited by a “strip mine,” where the soil and rock situated above the ore, known as an overburden, is used to backfill the excavation made by previous operations. Before the imposition of environmental laws, operators of strip mines made no effort to restore or revegetate

[331] Observatorio da Restauração e Reflorestamento, 2021.

the landscapes modified by strip mines, which is why the abandoned bauxite mines in Guyana (15,000 hectares) and Suriname (20,000 hectares) are essentially devoid of life.

The operators of the Trombetas bauxite mine are implementing restoration protocols that include separating and reusing topsoil, spreading forest detritus on the soil surface in order to reintroduce soil fungi, and planting trees using seed from locally collected native species. Epiphytes are reintroduced using living collections that were established prior to initiating operations, while assisting recolonization my insects and small mammals.[332] More than 5,750 hectares have been incorporated into the restoration process out of a total of 8,600 hectares mined since initiating operations in 1979.

These protocols can be replicated at other bauxite mines in Brazil (Juruti and Paragominas), as well as at tailing piles at iron ore mines at Carajás, kaolinite near Amapá, cassiterite [tin] mines in Amazonas and Rondônia, and industrial-scale gold mines operating in Brazil, Guyana and Suriname. Potentially, the abandoned mine sites in Suriname and Guyana could be restored by the governments that assumed the environmental liabilities of these facilities when they assumed operations following the departure of the original mining corporation.

Placer gold mining is the term used to refer to a mining technology that is widely used in Amazonian countries to exploit gold deposits located in sub surface soil horizons on river floodplains. In its simplest manifestation, a placer gold mine is nothing more than a pick, shovel and gold-pan, but more often includes specialized equipment to collect and separate gold from the sand and gravel that characterize placer formations. The term "small-scale" is deceptive, however, and many operations have considerable capital invested in trucks, backhoes, bulldozers, pumps, water cannons, dredges, sluice boxes, augers and other forms of specialized equipment. A placer mine is not unlike an unregulated strip mine, because it churns across a landscape leaving behind a sterile soil surface incapable of supporting life. Placer mines tend to occupy a floodplain in its entirety, extending from terrace to terrace and expanding upstream and downstream over dozens of kilometers. Placer mines deforest floodplains, a uniquely productive forest community, while destroying dozens of specialized aquatic habitats, block fish migration and interrupt the flow of ecosystem services along the riparian corridor and between aquatic and terrestrial biomes.

Placer mines are also a source of mercury toxicity. Elemental mercury is noxious, but microbes transform mercury into an organic compound, methylmercury, which is 100-times more likely to be absorbed by an animals and plants. Mercury accumulates over time and becomes concentrated in long-lived carnivores situated near the top of food webs.[333] Elevated levels of mercury have been documented in migratory fish populations far removed from mining areas, as well as in urban

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332 Mineracao Rio do Norte – MNR (accessed 17 July 29017) Reforestation. http://www.mrn.com.br/en-US/Sustentabilidade/Gestao-Ambiental/Reabilitacao-de-Areas-Mineradas/Pages/Reflorestamento.aspx

333 Machado, N. G., Silva, M. E. P. D., Bastos, W. R., Miranda, M. R., Carvalho, D. P. D., ... and Fulan, J. Â. (2016). Bioaccumulation of methylmercury in fish tissue from the Roosevelt River, Southwestern Amazon basin. *Revista Ambiente and Água*, *11*(3), 508-518

populations that consume fish.[334,335] In humans it is transported freely throughout the body and can cross the placenta where it will impact the development of a fetus. In adults, it causes neurological disorders, including clumsiness, difficulties in speaking, hearing impairment, blindness and death.[336] Placer miners, known as *garimpeiros* in Brazil, seldom pay royalties and make no effort to conform to the social and environmental standards adopted by the formal mining sector.[337] Regulation of the informal mining is ineffective because governmental agencies do not have the resources to impose effective control, while elected officials lack the political will to confront a numerous constituency accustomed to operating outside the confines of the law.

Amazonian governments are finally beginning to assert control over these lawless landscapes, motivated by fiscal exigencies and the opportunity to collect the taxes from a prosperous sector of their national economy. Hopefully, the imposition of the law will extend to environmental regulations, which should reduce the dimensions of future impacts by requiring operators to remediate the impacts of their operations. Eventually, governments will have to address the massive environmental liabilities that have been created by the placer mining sector, which have been created with the collusion of governmental authorities. Civil society groups and academics have initiated research to elaborate protocols for restoring the basic structural and compositional attributes of wetland habitats on floodplains.

Financial incentives for habitat restoration are likely also to come from carbon markets (see Section 3.4.1). International demand for carbon offsets from nature-based sequestration projects has risen sharply in the last two years. Prices are rising and there is currently even a price differential with forest conservation offsets, with sequestration offsets sold at a premium. This will get more forest restoration projects to move forward. The main cash flow problem that such projects have is that costs are front-loaded (project design, tree planting, etc.) while carbon value is accrued as trees grow. There is therefore a need for upfront investment that is willing to engage purely on the basis of carbon value, since additional income streams are limited to NTFPs and tourism. Sometimes these are of commercial importance, but in projects designed for habitat restoration usually less so.

While the carbon market outlook for sequestration projects is better than ever before, private investment in the carbon value of habitat restoration will remain limited unless the investment risk is shared or carbon prices rise much higher and acceptable investment returns can be achieved in a relatively short time horizon. The current Colombian market, for example, does not give a sufficiently high price signal to stimulate investment into habitat restoration. Thus, grant funding and public funding will remain critical and should cover investment risks (e.g. through guarantees or bonds), in order to get this type of project off the ground. Many financial instruments have already been

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[334] Marshall, B. G., Forsberg, B. R., Thomé-Souza, M., Peleja, R., Moreira, M. Z., and Freitas, C. E. C. (2016). Evidence of mercury biomagnification in the food chain of the cardinal tetra Paracheirodon axelrodi (Osteichthyes: Characidae) in the Rio Negro, central Amazon, Brazil. Journal of fish biology, 89(1), 220-240

[335] Anjos, M. R. D., Machado, N. G., Silva, M. E. P. D., Bastos, W. R., Miranda, M. R., Carvalho, D. P. D., ... and Fulan, J. Â. (2016). Bioaccumulation of methylmercury in fish tissue from the Roosevelt River, Southwestern Amazon basin. Revista Ambiente and Água, 11(3), 508-518.

[336] Goyer, R. A. and Clarkson, T. W. Toxic effects of metals. In: Klaassen, C. D. (Ed.). Casarett and Doull's toxicology: the basic science of poisons. 6. ed. New York: McGraw-Hill, 2001. p. 834-837

[337] Heck, C., and Tranca, J. (2011). La realidad de la minería ilegal en países amazónicos. Sociedad Peruana de Derecho Ambiental.

developed in carbon markets that blend public and private investment, though usually this is facilitated by projects delivering on other income streams, with public investors taking on most of the carbon risk. Governments could also guarantee offtake of carbon offsets at a floor price and sell the credits in the open market, thus taking over the market risk. This solution could be facilitated by the UNFCCC's mechanisms of REDD+ payments for performance (through the Green Climate Fund or bilateral public payments), or through future government-level trading or payment agreements under Article 6 of the Paris Agreement.

4.0 FINANCIAL CONTEXT AND FINANCE DEMAND

4.1 Financial context and interest rates

Different types of financial institutions (FI) are present in the Amazon. Certain FI focus on certain business types, while others focus on certain value chains or sectors. Understanding the positioning of these FI with regards to the different bio-businesses will be important for selecting appropriate delivery channels for the proposed financial interventions. As a general categorization we have:

Banks and state institutions: the backbone of national financial system and 1st tier lenders to the other actors in the system. Both public-backed and private banking institutions also lend directly to agricultural and forestry businesses, mainly in the medium and large categories.

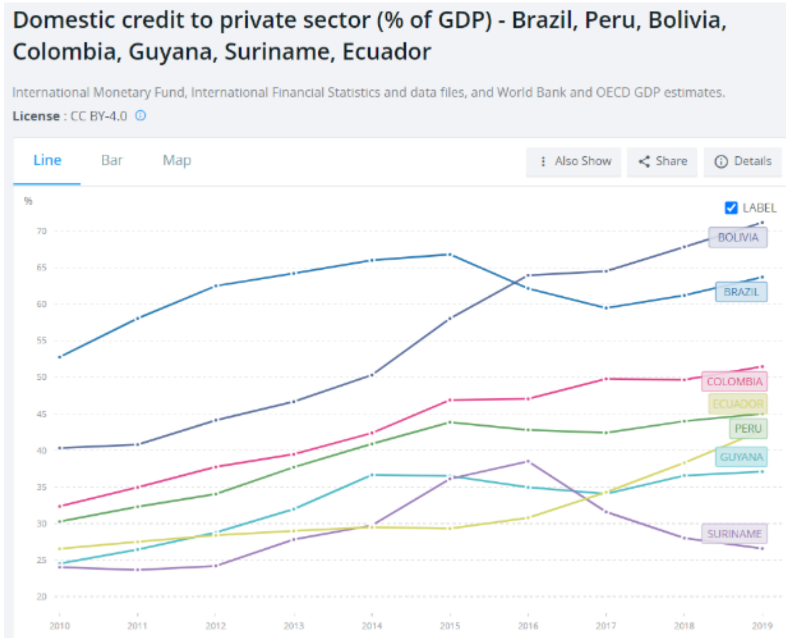
Municipal and state/county level financial institutions: they are in general supervised by the same financial authorities and have the same attributes and services as private national and international banks. Most of them cover the full spectrum of finance (from microfinance to corporate loans) and due to their local focus and willingness to work with clients with limited financial track record (credit rating) they have interest rates a few percent higher than 1st tier banks.

Cooperative and micro-finance institutions: smaller financial institutions often circumscribed to a specific location or membership, with a limited number of financial services. Their membership focused services and their small size make them important actors in rural environments and agricultural lending. On the whole they deal with small loan sizes and relatively high interest rates.

International social finance and impact investors: On the whole these are impact driven financial institutions based in Europe or US, that operate locally through non-financial companies formally registered in local public registries, but their credit operations are managed from their head offices in Europe or the United States. Interest rates vary greatly from standard to highly concessional. There are about a dozen finance institutions of this type operating in Latin America, including Incofin, Rural Finance and Rabobank.

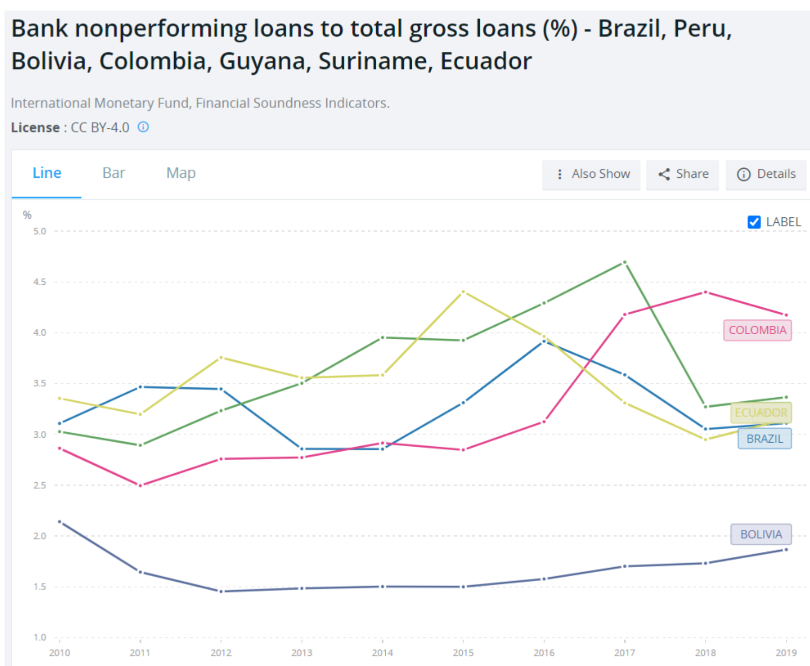
Across all Amazon countries there has been a progressive financialization of the economy in the last 10 years. The steady, gradual increase of domestic credit to the private sector follows the global trend and is also a reflection of a maturing financial sector, as shown in Figure 51.

Figure 51: Domestic credit to private sector (% of GPD)



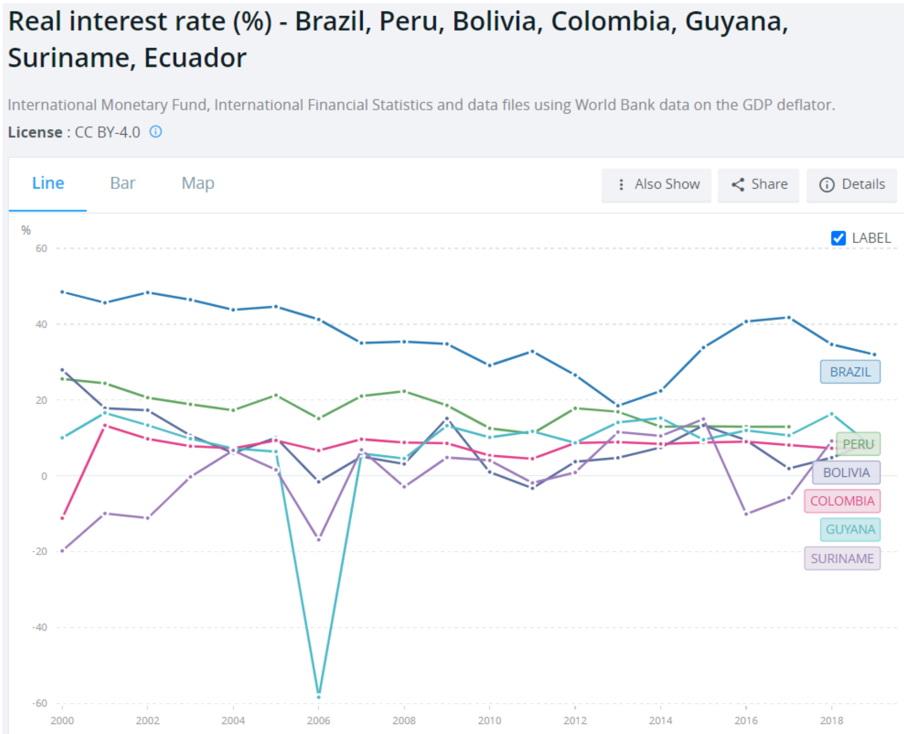
Non-performing loans are falling and are within acceptable levels of 3-4%, after rising slightly in the period 2015-2017 (Figure 52). Our data, however, do not include 2020 in order to take account of the COVID-19 shock.

Figure 52: Bank nonperforming loans to total gross loans (%)



Real economy wide average interest rates have also remained stable over the last decade in all countries, with the exception of Guyana in the year 2006, and the long term outlier Brazil, which aligned with other countries interest rates in 2012-2014, but has since risen to its 30-40% range (Figure 53).

Figure 53: Real interest rate (%)



Business owners and managers in different countries and sectors will have different strategies to access capital. Accessing finance in rural Amazon locations where most bio-businesses are located is not easy. Most smallholder and indigenous business managers do not have access to the larger, more formal banking institutions, present in the different regional and national capitals. Due to these access considerations, but also because they accept higher risk profile clients, local regulated and non-regulated financial institutions (Cajas Rurales, Cajas Municipales) and Saving and Credit Cooperatives (Cooperativas de Ahorro y Credito) play an important role in the Amazon economy. In Peru, interest rates of these local financial institutions active in bioeconomy value chains are in the range 25-40% per annum, and puts many bio-businesses at a serious disadvantage versus other business endeavors. For a comparison of interest rates across business sizes and financial institution type see Table 20.

In the Peruvian Amazon only between 20 and 30% of small producers access capital through financial institutions, and in the case of indigenous and community organizations uptake is even lower[338]. An undetermined number source capital through their immediate networks (family), whilst others rely on informal money providers, known as *habilitadores*, with annual interest rates in the range 60-180%

338 *Hajek et al, 2017. El potencial para incentivar inversiones agrícolas y forestales libres de deforestación en la Amazonía peruana. Solidaridad, Nature Services Peru and SEED. Lima.*

per annum. On the other hand, bioeconomy corporate actors are well versed in accessing different forms of capital (through equity, loans, factoring, etc.) through financial institutions in capital cities, with loans rates at present in the range 8-25% per annum. Considering the current low international interest rate environment, there is a significant opportunity to support the development of the bioeconomy in the Pan Amazon by improving access and terms of finance (interest rate, repayment periods, etc.).

Table 20: Interest rates spread and tenor ranges in the Peruvian Amazon

Type financial institution	**Example institutions**	**Real lending interest rate by business size (%/PEN)**			**Tenor for rural primary production (Range maximum tenor available)**[9]
		Micro[6]	Small[7]	Med and Large[8]	
National level banks and state institutions[1]	BBVA, BCP, Scotiabank, Banco Nación, Agrobanco	---	10-15	5-10	3-10 year
Municipal and rural financial institutions[2]	CM Cusco, CM Maynas, CR Los Andes, CR Del Centro, COOPAC NorAndino, COOPAC La Florida	15-30	15-30	10-20	1-3 year
Local, Cooperative and micro finance institutions[3]	Inversiones La Cruz, Credinka, Proempresa, Progreso, Compartamos	25-40	25-40	---	0.5-1 year
International social and impact finance[4]	Oikocredit, RaboFund, Responsability, Root Capital, NESST	---	10-15	5-10[10]	1-3 year
Nonprofit supporting Community banking[5]	ADRA, Manuela Ramos, Arariwa, Promujer	25-40	---	---	0.5-2 year

[1] National level banks and state institutions are main lenders to large companies and 1st tier to the rest of the financial system
[2] Municipal and rural financial institutions are key actors in urban amazon areas, lending to the whole spectrum of businesses.
[3] Local, Cooperative and micro finance institutions focus on lending to micro and small businesses, mainly working capital
[4] International social and impact finance focus on novel sectors and purpose driven businesses. Also act as 1st tier to 2,3 and 5.
[5] Nonprofit supporting Community banking includes communities, micro-businesses and vulnerable demographics.
[6] Micro enterprise: as defined by tax authority SUNAT annual revenue up to US$190,000
[7] Small enterprise: annual revenue up to US$2,150,000
[8] Medium and large enterprise: above US$2,150,000
[9] Primary bioeconomy activities in the Amazon are categorized by financial institutions in the categories Agricultura and pesquerías or servicios. There is to date not a sophisticated management of tenor across business types. For example, shorter term for agriculture vs. Forestry. International social and impact finance actors, are the exception, but these are as yet a niche Group. Only the larger FI are in a capacity to consider longer term 5-10 year financing needed for activities like agroforestry and forestry. These tenors do not necessarily apply to businesses in the transformation, distribution and export nodes of bioeconomy value chains. which, independent of their location, have other collaterals (real estate assets, export contracts, etc.).
[10] These rates are lower when international social and impact finance institutions act as 1st tier lenders to level 2, 3 and 5 institutions

4.2 Potential Finance demand

Based on the different value chains presented in Section 3 of this report, beneficiary sizing, distribution and potential finance demand estimates over the timeframe of the Amazon Bioeconomy Fund program (currently planned for 7 years) were developed[339]. The calculations and detailed results are presented separately in database Annex 2b of the Full Proposal. We here present a summary of these findings and estimates for the six target countries.

Table 21: Number of bio-businesses by size and sector in Brazil

Sector	Number by business Size			
	Micro*	Small & Medium**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	45,098	966	47	46,111
Forestry: Timber & Non Timber Products	12,132	4,226	43	16,401
Wilderness: Traditional use & nature tourism	80	36	4	120
Restoration & Regulation ecosystem services	NM	12	5	17
TOTAL	**57,310**	**5,240**	**99**	**62,650**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present

Table 22: Potential finance demand for bio-businesses in Brazil

Sector	Total financial demand by business size (US$)			
	Micro	Small & Medium	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	286,528,000	141,465,918	132,643,481	560,637,399
Forestry: Timber & Non Timber Products	113,180,896	229,158,055	156,996,613	499,335,564
Wilderness: Traditional use & nature tourism	992,000	3,456,000	8,400,000	12,848,000
Restoration & Regulation ecosystem services	NM	6,064,593	9,703,349	15,767,943
TOTAL	**400,700,896**	**380,144,566**	**307,743,444**	**1,088,588,905**

[339] Agriculture and forestry sector activity extent (hectares) and participant numbers are obtained from the most recent agriculture, livestock and forestry census data of each country. Tourism data has been collated from the websites of the Tourism Ministries of the respective countries, while ecosystem services data has been obtained from the Ecosystem Marketplace, REDD Project database and Verra Registry, as well as the sources stated in the intervention tables in Section 3 of this study

Table 23: Number of bio-businesses by size and sector in Colombia

Sector	Number by business Size			
	Micro*	Small & Medium**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	13,820	162	7	13,989
Forestry: Timber & Non Timber Products	1,227	60	2	1,289
Wilderness: Traditional use & nature tourism	40	18	2	60
Restoration & Regulation ecosystem services	NM	11	4	15
TOTAL	**15,086**	**251**	**16**	**15,353**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present

Table 24: Potential finance demand for bio-businesses in Colombia

Sector	Total financial demand by business size (US$)			
	Micro	Small & Medium	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	59,473,600	27,698,597	18,544,598	105,716,795
Forestry: Timber & Non Timber Products	18,278,667	22,008,293	11,600,000	51,886,960
Wilderness: Traditional use & nature tourism	496,000	1,728,000	4,200,000	6,424,000
Restoration & Regulation ecosystem services	NM	5,421,053	8,673,684	14,094,737
TOTAL	**78,248,267**	**56,855,943**	**43,018,282**	**178,122,491**

Table 25: Number of bio-businesses by size and sector in Ecuador

Sector	Number by business Size			
	Micro*	Small & Medium**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	14,335	131	8	14,473
Forestry: Timber & Non Timber Products	1,227	60	2	1,289
Wilderness: Traditional use & nature tourism	40	18	2	60
Restoration & Regulation ecosystem services	NM	NM	NM	-
TOTAL	**15,602**	**209**	**12**	**15,823**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present. Commercialization of ecosystem services not permitted in private sector.

Table 26: Potential finance demand for bio-businesses in Ecuador

Sector	Total financial demand by business size (US$)			
	Micro	Small & Medium	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	59,911,800	21,844,525	19,487,117	101,243,442
Forestry: Timber & Non Timber Products	18,278,667	22,008,293	11,600,000	51,886,960
Wilderness: Traditional use & nature tourism	496,000	1,728,000	4,200,000	6,424,000
Restoration & Regulation ecosystem services	NM	NM	NM	-
TOTAL	**78,686,467**	**45,580,818**	**35,287,117**	**159,554,402**

Table 27: Number of bio-businesses by size and sector in Guyana

Sector	Number by business Size			
	Micro*	Small & Medium**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	235	34	2	271
Forestry: Timber & Non Timber Products	747	36	2	785
Wilderness: Traditional use & nature tourism	10	4	1	15
Restoration & Regulation ecosystem services	NM	1	1	2
TOTAL	**992**	**75**	**6**	**1,073**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present

Table 28: Potential finance demand for bio-businesses in Guyana

Sector	Total financial demand by business size (US$)			
	Micro	Small & Medium	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	5,551,800	4,200,500	6,960,000	16,712,300
Forestry: Timber & Non Timber Products	9,878,667	13,608,293	8,820,000	32,306,960
Wilderness: Traditional use & nature tourism	124,000	384,000	2,100,000	2,608,000
Restoration & Regulation ecosystem services	NM	500,000	2,000,000	2,500,000
TOTAL	**15,554,467**	**18,692,793**	**19,880,000**	**54,127,260**

Table 29: Number of bio-businesses by size and sector in Peru

Sector	Number by business Size			
	Micro*	Small & Medium**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	45,588	319	16	45,923
Forestry: Timber & Non Timber Products	1,820	88	5	1,913
Wilderness: Traditional use & nature tourism	40	18	2	60
Restoration & Regulation ecosystem services	NM	5	2	7
TOTAL	**47,448**	**430**	**25**	**47,903**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present

Table 30: Potential finance demand for bio-businesses in Peru

Sector	Total financial demand by business size (US$)			
	Micro	Small & Medium	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	190,755,920	62,008,000	37,196,000	289,959,920
Forestry: Timber & Non Timber Products	21,569,624	33,600,000	29,600,000	84,769,624
Wilderness: Traditional use & nature tourism	496,000	1,728,000	4,200,000	6,424,000
Restoration & Regulation ecosystem services	NM	2,500,000	4,000,000	6,500,000
TOTAL	**212,821,544**	**99,836,000**	**74,996,000**	**387,653,544**

Table 31: Number of bio-businesses by size and sector in Suriname

Sector	Number by business Size			
	Micro*	Small & Med**	Large***	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	235	34	2	271
Forestry: Timber & Non Timber Products	NM	NM	481	481
Wilderness: Traditional use & nature tourism	10	4	1	15
Restoration & Regulation ecosystem services	NM	1	1	2
TOTAL	**245**	**39**	**485**	**769**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

***Large enterprise: above US$4,000,000

NM: Not material at present

Table 32: Potential finance demand for bio-businesses in Suriname

Sector	Total financial demand by business size (US$)			
	Micro	Small & Med	Large	TOTAL
Ag: Perennial, Agroforestry & Aquaculture	5,551,800	4,200,500	6,960,000	16,712,300
Forestry: Timber & Non Timber Products	NM	NM	11,600,000	11,600,000
Wilderness: Traditional use & nature tourism	124,000	384,000	2,100,000	2,608,000
Restoration & Regulation ecosystem services	NM	500,000	2,000,000	2,500,000
TOTAL	**5,675,800**	**5,084,500**	**22,660,000**	**33,420,300**

5.0 COOPERATION, RESEARCH AND EXTENSION PROGRAMS

Perhaps the most influential research institution in the Pan Amazon is the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), one of the most successful of all Brazilian government institutions when measured by the economic impact of the technological innovations that have emerged from its laboratories and field stations, which include eight decentralized research laboratories located within the Legal Amazon.[340] The research themes include discovering the commercial potential of medicinal plants, aromatic herbs and palm products. Much emphasis is placed on improving options for family production systems via agroforestry and aquaculture, while research in industrial systems now focuses on integrated crop-livestock-forestry systems, restoration of degraded areas and low-carbon agriculture. Key to EMBRAPA's success is the integration of high-quality research with effective extension programs via collaborative relationships with academic institutions and state and municipal agencies.

The largest biodiversity research institution in the Amazon is the Instituto Nacional de Pesquisas da Amazônia (INPA), which is home to more than 250 senior researchers organized into 64 working groups distributed across four divisions: Biodiversity, Innovation and Technology, Environmental Dynamics, and Society, Environment and Health.[341] In addition to its main campus in Manaus, it operates satellite facilities in Belem (PA), Porto Velho (RO), Boa Vista (RR), Rio Branco (AC) and Santarem (PA), as well as several research stations and floating labs on the Amazon river and its tributaries.

INPA pursues research in partnership with scientists from across the globe, including all major Brazilian universities and research institutes, as well as international entities such as NASA, the European Space Agency, the National Science Foundation and dozens of prestigious universities in North America and Europe. INPA pursues an ambitious long-term research agenda that include interactions between the biosphere and atmosphere, experiments that monitor the impact of forest fragmentation on biodiversity, and carbon emissions generated by human activities and climate change.[342] INPA mission is to discover a pathway to economic growth and development that is compatible with the conservation of the Pan Amazon. This combination of basic and applied research makes it the premier scientific institution in the Pan Amazon and the global leader in research on the Amazon.

The Brazilian university system has also materially contributed to the generation and diffusion of scientific information about the Amazon. Chief among these are the Federal Universities, large multi-

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340 Amapá (Macapá), Eastern Amazon (Belem, PA), Western Amazon (Manaus, AM), Acre (Rio Branco), Agrosilvopastoral (Sinop, MT), Rondônia (Porto Velho, RO), Roraima (Boa Vista) Fisheries and Aquacuture (Palmas TO); there are a total 43 decentralized facilities many of which address issues that are also relevant to Amazonian production systems. Source: https://www.embrapa.br/en/embrapa-in-brazil

341 http://repositorio.inpa.gov.br/

342 Mesquita, R. (2018) The role of research institutions in Amazonia in fostering development in the region - INPA´s contribution, Instituto Nacional de Pesquisas da Amazônia, Seminar presented at The Scientific, Social, and Economic Dimensions of Development in the Amazon The Wilson Center, 24 Sep 2018. https://www.wilsoncenter.org/event/the-scientific-social-and-economic-dimensions-development-the-amazon

campus institutions offering graduate and post-graduate programs in a broad range of disciplines.[343] States support a parallel university system with greater emphasis on undergraduate education, as well as Facultades and Centros Universitarios which provide educational opportunities in mid-level cities.[344] Finally, there is a network of technical schools (Instituto Federal de Educação, Ciência e Tecnologia) that provide vocational training and advanced degrees in specialized subjects.[345]

The first institution dedicated to Amazonian science in the Andean nations was the Instituto de Investigaciones de la Amazonía Peruana (IIAP). Established in 1981, it has two primary objectives: (1) Develop sustainable production systems based on the biological resources of the Amazon and the knowledge of its indigenous and traditional peoples. (2) Provide technical proposals to government agencies to support the conservation and sustainable use of natural resources. In addition to its main campus in Iquitos, IIAP operates offices in Pucallpa, Tarapoto, Puerto Maldonado, Chachapoyas and Tingo María. Its scientist and technical staff have focused most of their research and extension activities on understanding the life histories of species with economic potential and using that knowledge to develop technologies for family production systems, particularly aquaculture and agroforestry.[346] IIAP provides extension service to Peruvian communities and has contributed to the successful programs promoting aquaculture of *paiche* (*Arapaima gigas*), as well as the cultivation, harvest and marketing of camu *camu* (*Myrciaria dubia*) and *aguaje* (*Mauritia flexuosa*).

Colombia created an Amazonian research institution in 1991 with the foundation of the Instituto Amazónico de Investigaciones Científicas Sinchi, a modern-day natural history museum with biological collections, ecological laboratories and long-term field studies. Its multi-disciplinary research agenda focuses on development options, scenarios modeling, impact assessment and policy development. The Instituto Sinchi is linked to Ministry of Environment and Sustainable Development.

The university systems in the Andean Amazon are considerably lacking the structure that characterizes the Brazilian system. Higher education in these countries is largely concentrated in institutions in the Andean highlands or on the coast. There are only three universities in Amazonian Ecuador, five in Colombia, eight in Peru and fifteen in Bolivia.

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[343] Pará (UFPA) 40,000 students; Amazonas (UFAM) 30,000 students; Mato Grosso (UFMT) 22,000 students; Amapá (UNIFAP) 11,000 students; Sul e Sudeste do Pará (UNIFESSPA) 11,000 students; Tocantins (UFT) with 10,000; Rondônia (UNIR) with 7,600 students; Rondonópolis (UFR) 5,000 students; Acre (UFAC) 6,000 students; Oeste do Pará (UFOPA) 5,000 students; Rural de Amazônia (UFRA) 5,000 students; Roraima (UFRR) 5000 students 4.

[344] A *Facultad* is similar to a College in a US-based system (e.g. College of Agriculture). Similarly, a *Universidad*e is an institution that combines multiple *Facultades*, but also must conduct research and provide extension services. Almost all of the smaller *Universidade*s started their existence as *Facultades,* expanded their offerings over time and were recategorized as *Universidades* by the State or federal authorities.

[345] http://redefederal.mec.gov.br/historico.

[346] International support has been provided by Switzerland, Finland, Germany, Spain, France, Netherland, USA, UNDP, UNESCO, FAO, CIAT.

6.0 ENABLERS, BARRIERS AND RISKS FOR THE BIOECONOMY

The Program, its partners and its beneficiaries will not be able to address by themselves the inherent landscape and climate related risks for the interventions, as well as those risks arising from the interventions themselves. Broad articulation and interdependence with national and international stakeholders will be inherent to this Program. However, we list here the key proximate enablers, barriers and risks identified in order to ensure the positive impacts of the Program materializing, and the risks being adequately managed.

6.1 Enablers and barriers for bio-businesses

The barriers to bio-business are idiosyncratic to each productive system and business model, but there are many shared characteristics. First and foremost is limited technical capacity and know-how at the producer level. This is true for both the perennial (palms, agroforestry, timber plantations forestry), animal production productions systems (aquaculture) and services (nature tourism) The most successful producers, small or large, are those that manage to develop technologies, knowledge and know-how.

For example, the cultivation of native palms (açaí, macauba, and others) requires species-specific expertise and specialized knowledge linked to nursery management, harvest procedures, irrigation and replanting cycles. Aquaculture is the most demanding because it requires precise water quality control that spans a multiple-stage life-cycle characterized by unique nutritional inputs. Low technology or remote management are likely to fail, perhaps catastrophically (aquaculture) or by low yields and marginal returns (palm cultivation). Post-harvest processing of fruits and seeds is a constraint for many agroforestry crops, and is absolutely essential for palm plantations. Processing facilities require a technological package and capital expenditure that are out of the range of all smallholders and most medium-sized, family-owned operations.

Farmers tend to be culturally averse to risk and any novel production models entails at least some level of economic risk. Subsistence farmers have little margin for error and, even if they grow their own food, most cultivate cash crops to generate revenue for essential goods and services. Medium-sized family farmers are only marginally less risk averse and corporate producers are unwilling to be guinea pigs. Promotional material will not suffice, they must see successful examples of novel production systems "with their own eyes."

Most of the proposed bio-business models require a significant outlay in fixed capital. Most landholders do not have free cash flow or an investment portfolio that can be converted to cash. Their capital is tied up in their land, their production systems or livestock. Consequently, they would have to borrow money to diversify or switch production models. Lending institutions require a mortgage or another guarantee, particularly for a producer without a proven track record in the new production system. Culturally-averse producers will not risk their land to take on credit. Even if the technology is proven, the potential for a weather-induced crop failure is often sufficient risk to impede an investment.

In the travel industry, the major constraint is access. To arrive at most remote ecolodges require multiple air connections, land transport and, usually, a voyage by river. Some of this can be packaged as part of the adventure tour (river transport), but other parts are boring and expensive. More tourists would visit Amazon ecolodges if the voyage was less complicated, had fewer connections and more compressed timelines.

A second constraint to an expanded nature tourism industry is a lack of variety in offerings with a surplus of overly rustic accommodations. Many tourists actively seek a backwoods experience, but many more would prefer comfortable lodgings with modern amenities, including ventilation (or even AC), hot water, access to the internet and, most importantly, a limited exposure to biting insects.

A third problem is poor service, a widespread defect of the hospitality sector across Latin America. Urban tourists expect prompt attention. Part of this is cultural. For example, Latin tourists want their coffee served with their breakfast, but visitors from North America want their coffee while they wait for breakfast. The disconnect between expectation and delivery is most evident in ecolodges operated by self-taught, home-grown entrepreneurs that do not understand their clientele.

Indigenous communities are almost completely absent from the ecolodge sub-sector due to the historical legacy derived from their social status and lack of educational opportunities. There are some notable exceptions detailed in this report, but all too often indigenous and traditional communities participate as junior partners or, worse, as "curiosities" exploited by tour operators that use them to attract tourists.

Enabling solutions for improving the technical capacity of producers and potential producers are well known. In Brazil, the extension services of EMBRAPA are of very high quality and there are explicit institutional linkages between university research services and publicly funded extension services. Even municipal governments tend to have an extension office and these public knowledge networks are fortified by grower associations and private companies that share [sell] expertise.

The public-funded research-extension ecosystem is less well-developed in the Andean republics, or exceedingly underfunded, or beset with mediocrity linked to political patronage. The failure, or inadequacy, of public extension services has given rise to a proliferation of programs managed by civil society groups (NGOs). Although this practice is understandable, given the need and urgency, publicly funded extension services provide a more permanent and sustainable solution.

Extension services must operate via successful field programs. Promotional material will not suffice to convince landholders to modify their production strategies. Most will want tangible evidence the proposed production system is both feasible and appropriate for their landholding and livelihood. This means seeing an example "with their own eyes," either in a field station or, even better, on their neighbor's farm. Extension agents and private-sector service providers would be well-advised to subsidize demonstration plots on farmer-owned land.

Credit should be linked to crop insurance, such that the lender is compensated for a failed crop and the producer is not penalized for a weather-linked or pathogen-caused crop failure beyond his or her control. Crop insurance should be part of a package of policies that motivated (obligated) borrowers to participate in extension field trials and purchase crop insurance with part of their credit package.

Investment in regional airport infrastructure could expand the ability of remote communities to participate in the ecotourism and adventure tourism market. This investment would only succeed, however, if air service to remote parts of the Amazon was radically improved. Current air taxi services are unsafe and expensive. The war on drugs has restricted investment in air taxi services, because they are viewed as being complicit in the illegal drug trade. A subsidized air taxi service would improve health care of remote indigenous communities. There is ample evidence for this business model in Alaska, where tourism and service to remote indigenous communities support a robust private sector air taxi service.

6.2 Risks for and arising from bio-businesses

6.2.1 Risks for bio-businesses

Apart from risks germane to all sectors of the economy (e.g., conflicts from unresolved and/or insecure land tenure, political unrest, currency fluctuations, downturns in the global economic cycle), bio-business investments are subject to specific risks, which we describe below.

Risks of lending to bio-businesses, including those in areas exposed to environmental climate risks: Despite their adaptation and mitigation benefits, bio-businesses are riskier and more costly compared to other land-uses, especially at the early stages of development and in low-income, vulnerable areas. Adopting sustainable resilient and low carbon production practices imposes incremental costs on businesses and producers, requiring capital that is generally unavailable or only available at significantly high costs. Bio-businesses in general lack the scale needed to attract conventional investors. They are mostly not big enough for large investors but not small enough for microfinancing. In addition, they lack traditional types of collateral as required by financial institutions. Anchor firms are dependent on small enterprises or producers along their value chain with limited or no funding of their own, and must also work together with dispersed communities. Bio-businesses generally require longer payback periods, too, since their financial returns cannot normally be expected in the short run. In addition, many bio-businesses operate in markets with high volatility in the volumes and prices of the inputs and products they offer, which negatively impacts their ability to be competitive, especially since the climate benefits and environmental value of their product is not usually reflected in a price premium. Bio-businesses also have limited or no track record that would inform potential investors about profitability, and biodiversity impacts, and contributing factors to exposure to climate and environmental risks. In general, financiers and investors avoid riskier projects, and their lack of familiarity with lending to bio-businesses exacerbates their perception of risks. Thus, the sector risk profile causes funds to flow towards other directions, leading to an overall lack of resources to invest, which in turn limits their possibilities for development and expansion.

Immature capital and financial markets which limits supply of funding for bio-businesses: In LAC, the problem goes beyond the characteristics inherent to bio-businesses. Although initial capital needs may not be very high, bio-businesses in the region do not have access to sources of venture capital, angel investors or other financing mechanisms, mostly due to their difficulty to bring their businesses to scale. The region's banking sector lacks depth, with around 88% of total financing demand unmet. About half of formal small and medium firms do not have access to formal credit and the gap is much larger when micro and informal enterprises are taken into account. Capital markets are quite underdeveloped in most of the Amazon countries, leading to a marginal number of large companies using it as a financing source, with no mechanisms available for smaller firms to access them. Other traditional sources of finance (e.g., bank credit) are often not available to these ventures, partly because of lack of information that results in high collateral requirements and interest rates, and lending policies that favour short-term loans with low risks. The COVID-19 crisis has exacerbated these constraints, as lending strategies have been readjusted to address weaker operating conditions and increased risks. The crisis has also affected the financial health of firms, which are at higher risk and facing liquidity constraints. These trends affect bio-businesses, as Micro and Small Enterprises (MSE) represent the majority of these businesses and their value chains. In the Amazon, this is compounded by a general absence of financial institutions in the region.

Weak institutional environment for bio-business development: The lack of national systems and tools for the valuation of assets that produce carbon sequestration and, or GHG-emission reduction or reduce exposure to environmental vulnerability to climate risks, diminishes the capacity to attract private investment to activities that protect natural capital. In all target countries, existing legal frameworks and governance tend to distort the true costs of unsustainable activity activities in forest and land-use, without assigning a tangible value to conservation, climate mitigation, or increased climate resilience. Changes are needed to address the absence of policies that support the shift to more sustainable resilient and low-carbon production practices and technologies, including long-term strategies to access markets that offer premium prices for sustainable products. In addition, better articulation among actors in the business ecosystem such as investors, financial institutions, risk capital, businesses, incubators, and accelerators, is needed in order to create financial paths for scale and to link actors to value chains. Targeted mechanisms and incentives can be developed so that the private sector will invest more in sustainable activities, either directly or indirectly through capital markets or via well-structured partnerships.

Lack of standardized frameworks to monitor biodiversity and climate vulnerability impacts: Lack of data, measurement systems, taxonomies, and natural capital and forest asset value accounting systems lead to insufficient awareness on the value associated to bio-businesses for climate mitigation and adaptation. As a result, the costs of destruction relative to the benefits of sustainable use that supports GHG-emission reduction and positive biodiversity outcomes and climate resilience are not properly understood, nor is it taken into account in decision-making by either public or private actors. Reliable data is also essential to build credibility. Investors require transparency on the biodiversity and climate exposure impacts of the ventures they support. Measuring and reporting systems, metrics and indicators are key to build credibility.

Knowledge and capacity gaps for qualitative and quantitative assessment of contributing factors to and benefits of sustainable intensification and expansion practices in targeted value chains: Insufficient awareness on the bio-business market opportunity is compounded by other capacity issues, such as a general lack of specialized knowledge (about production and marketing of innovative products or potential business models), low levels of social organization, insufficient alignment with international standards and norms, inadequate access to markets, insufficient logistic capacity, and limited use of certifications. These factors combined critically limit the capacity of firms, micro and small in particular, to formulate successful growth strategies and to translate ideas for conservation into bankable/investable projects. Local availability of professionals that combine technical conservation/mitigation and financial skills is limited in target countries. Financial institutions are generally not familiar with traditional agriculture models, let alone bio-businesses.

The value chains recommended for investment in this study also have specific risks:

Perennial agriculture:

Like any monoculture based on genetically identical cloned plants, the risk from plant pathogens and pests in cacao is high. This risk can be mitigated by planting a mixture of varieties, particular traditional fine cacao varieties that are planted from seeds rather than cloned from cuttings. Land tenure security is an issue in all potential, production landscapes. The traditional method for establishing cocoa plantation was to clear the understory of a natural forest and plant cacao seedlings. Over time the forest canopy is removed to maintain yield, making cacao a significant driver of deforestation; due to this process new production paradigms seek to channel expansion of cacao into deforested lands through deforestation free agriculture models (DFA).

The yields reported by agronomic field trials for native palms like Macauba and Morete (*Mauritia sp.*) have been obtained under ideal conditions that reflect optimum levels of water management and soil fertility, conditions that are not likely to be reproduced in commercial production. Macaúba palms will produce a type of palm oil that may be confused with palm oil produced by the African oil palm, which has a well-earned reputation as a driver of deforestation and a source of GHG emissions. It is different, but if the development is not managed carefully it could also drive deforestation and land-use change in the Cerrado, Chiquitano, Chaco and Caatinga biomes that are part of the Pan Amazon.

NTFPs:

Over harvest of açaí is impacting natural açaí tree populations in some areas and causing broader ecosystem degradation in others, while a shift to cultivation could lead to a price collapse paid to traditional producers. Cultivation in floodplains could lead to habitat loss and even further deforestation, while a shift to upland cultivation could, eventually, marginalize the traditional NTFP production model. The most productive Brazil nut forests in Acre, Pando (Bolivia) and Madre de Dios (Peru) are all at risk of deforestation and illegal logging. The most productive Brazil nut forests in Acre, Pando and Madre de Dios are suffering periodic and more severe droughts and tree mortality due to climate change; wildfire may become more common in the future.

Native species aquaculture:

Producing fish successfully requires a technological sophistication that is poorly appreciated on frontier landscapes, where many landholders assume one merely has to build a pond and stock it with fish. A successful operation requires on-sight management to control water quality and supply feed, while guard from predation from wildlife and people. Aquaculture must compete with commercial fishing of wild stocks locally, and nationally with marine fisheries. Most operations will discharged effluent rich in fish waste into adjacent streams, which is acceptable for small operations on larger water courses, but not acceptable in streams in peri-urban environments.

Nature tourism:

As a non-essential service, tourism is very sensitive to social, economic, political and public health shocks, as the COVID pandemic has so clearly shown. Upheaval and political unrest can easily interrupt the travel industry. Tourism has many well-documented risks associated with the damage to archeological sites and the degradation of natural resources, although these risks are minimized in low volume nature tourism.

6.2.2 Risks arising from bio-businesses

Like other businesses, bio-business investments impact their surroundings and measures must be taken to maximize positive impacts and avoid environmental and social damage from their implementation. In the case of bio-businesses in the Amazon of particular concern are:

1. the displacement of environmentally degrading activities to other deforestation/degradation frontiers and/or the clearing of secondary forests rich in carbon and biodiversity;
2. loss of biodiversity due to intensification of production methods;
3. risks to local people's rights (e.g. land conflicts, lack of free, prior and informed consent); and
4. increased corruption and illegal activities due to the influx of new economic resources.

Effective strategies to date to formalize and reduce deforestation and degradation in the Amazon, and thus contain these risks, have been:

1. Support the establishment of national, regional and private protected areas, which provide water, pollination and local climate regulation services to agricultural areas of the landscape, and contribute to the strengthening of other sectors of the local economy.
2. Address land use planning processes and indigenous/local land claims, implementing complementary measures to ensure that indigenous communities maintain a culture that continues to value and sustainably manage forests, in order to halt the increase in land rentals and deforestation that has been occurring on some indigenous lands.
3. Land titling and land management for small farmers and migrants at the landscape level. This should be implemented sequentially, in whole districts or jurisdictions, in contrast to the current segmented approach to land titling that increases the risk of preferential treatment

and land speculation. Implementation level synergies should be sought with programs for sustainable jurisdictions[347].

Given the potential impact of bioeconomy financing, the monitoring of its impacts must be integrated into development programs and public monitoring initiatives, respecting the UNFCCC Cancun safeguards and other safeguard standards. There are also several systems for the certification of good agricultural practices that go beyond the general safeguard requirements. It is critical to note that the implementation of the national legal frameworks around social and environmental rights would go a long way towards ensuring compliance with the safeguards, but an in-depth analysis of these linkages is needed. Key areas for this analysis include:

- Addressing land tenure and land rights issues.
- Guidelines and model contracts to help ensure equitable agreements between communities and companies, and within associations and cooperatives.
- The role of capacity building within cooperatives/associations, indigenous organizations and other grass-roots entities as a means to help improve social and environmental outcomes.
- The inclusion mechanisms to ensure positive social outcomes for small independent farmers who are often excluded from social protection systems.

[347] For example, the Produce-Conserve-Include (PCI) framework is already being applied with initial success in Jurisdictions like Mato Grosso, in Brazil, and San Martin in Peru, and Caqueta in Colombia. In different countries the PCI strategy is materializing in contextually appropriate forms: Brazil: Produzir, Conservar e Incluir (http://pci.mt.gov.br/), Peru: Produce-Protege-Incluye. Colombia: Caqueta Sustentable. This framework is possibly also the best mechanism through which to link to Deforestation Free Production (DFP) commitments made by national and international value chain actors represented in fora like the New York Declaration on Forests and the Tropical Forest Alliance (TFA).

7.0 SUMMARY AND RECOMMENDATIONS

To summarize the findings of the study and provide recommendations, we return to the guiding questions stated in the study objectives: a) Which are key bioeconomy value chains interventions that can deliver natural capital and climate benefits in the seven target countries of the Amazon Bioeconomy Fund ?, b) What is the potential private sector financial demand that the Fund could attend in order to support products and services with climate mitigation and adaptation benefits in these value chains ?, and c) What is the intervention portfolio structure for the Fund to achieve transformational change in reducing emissions, increasing human wellbeing and ecosystems resilience in the Amazon ?

<u>Key bioeconomy value chains</u>
The value chains evaluated by the study are:
1) Perennial agriculture with acaí a (*Euterpe oleracea*) or other native palms including morete (*Mauritia flexuosa*) & pijuayo (*Bactris gasipaes*),
2) Perennial agriculture or Agroforestry Cacao (*Theobroma cacao*) with native timber species,
3) Agroforestry Coffee (*Coffea arabica*) with native timber species,
4) Native species aquaculture with *Colosomma macropomum* & *Piaractus brachypomus,*
5) Native species forestry plantations including *Shizolubium* sp., *Ochroma* sp., *Guazuma* sp. & others,
6) Non-timber forest products including Brazil nuts (*Bertholettia excelsa*), acai (*Euterpe oleracea*) & others,
7) Sustainable Forest Management in Natural Forest Concessions
8) Community-led nature tourism with indigenous and local peoples
9) Climate regulation ecosystem services
10) Habitat restoration services
Upon evaluation of the current status of these ten value chains, detailed model interventions have been developed for seven of them, and these model interventions have been used to develop the quantitative financial and climate modelling of the Program (presented in Annexes 3 and 22 of the Full Proposal). The list of value chains evaluated is indicative and not exhaustive, within the timeframe of the study only a subset of material bioeconomy value chains could be analyzed. The Amazon´s natural capital will undoubtedly be the source of new economically significant value chains in the near future, and the Program should remain flexible to investments in new value chains that maximize climate benefits.

<u>Potential Finance Demand</u>
On the basis of the evaluated value chains, this study estimates current bioeconomy finance demand in the order of US$1,901 million. This estimate should be considered a minimum, that should be revised as the Program moves to implementation. Addressing this financial demand would support and improve the economic profitability of over 143,000 businesses, of which 95.2% are vulnerable smallholder producers and micro-enterprises (Table 33).

Table 33: Distribution of number of potential businesses by sector and size

Sector	Number by business Size			TOTAL
	Micro*	Small & Med**	Large***	
Ag: Perennial, Agroforestry, Aquaculture	119,311	1,647	82	121,039
Forestry: Timber & Non Timber Products	17,152	4,471	536	22,159
Wilderness: Traditional use, nature tourism & cultural services	220	98	12	330
Restoration & Regulation ecosystem services	-	30	13	43
TOTAL	**136,683**	**6,245**	**643**	**143,571**

* Micro enterprise: annual revenue approx. upto US$200,000

**Small enterprise: annual revenue upto US$2,000,000. Medium enterprise: annual revenue upto US$4,000,000

Average financing for micro-businesses ranges from US$5,094 to 12,400, while for small and medium bio-businesses it ranges from US$71,661 to 500,000, and for large companies it ranges from US$429,860 to US$2.7 million, as can be seen in Table 34.

Table 34: Average financing for potential businesses by sector and size

Sector	Average financing by business size (US$)		
	Micro	Small & Medium	Large
Ag: Perennial, Agroforestry, Aquaculture	5,094	158,757	2,704,331
Forestry: Timber & Non Timber Products	10,563	71,661	429,860
Wilderness: Traditional use, nature tourism & cultural services	12,400	96,000	2,100,000
Restoration & Regulation ecosystem services	-	500,000	2,000,000

At the sector level (Table 35), perennial agriculture, agroforestry and aquaculture have the largest finance demand with US$1,090 million, closely followed by timber and non-timber forestry with US$732 million. Wilderness management and ecosystem services value chains are equally important because they are fundamental for the economic sustainability and conservation of large tracts of forest, but identified financial demand volumes are smaller, at US$37 and US$41 million respectively. This study has focused on determining current finance demand potential. Bioeconomy investment opportunities are evolving rapidly, sectorial finance demand should be reassessed at regular intervals.

Table 35: Total financial demand of potential businesses by sector and size

Sector	Total financial demand by business size (US$)			TOTAL
	Micro	Small & Medium	Large	
Ag: Perennial, Agroforestry, Aquaculture	607,772,920	261,418,040	221,791,197	1,090,982,156
Forestry: Timber & Non Timber Products	181,186,520	320,382,934	230,216,613	731,786,067
Wilderness: Traditional use, nature tourism & cultural services	2,728,000	9,408,000	25,200,000	37,336,000
Restoration & Regulation ecosystem services	-	14,985,646	26,377,033	41,362,679
TOTAL	**791,687,440**	**606,194,619**	**503,584,843**	**1,901,466,903**

At a country level (Table 36), the biggest financial need identified is, unsurprisingly, Brazil with a total estimated bioeconomy finance demand of US$1,089 million, followed by Peru, and Colombia with US$388, and US$178 million respectively.

Table 36: Estimated finance demand per sector and country (million US$)

Sector	Brazil	Colombia	Ecuador	Guyana	Peru	Suriname	TOTAL
Ag	560,637,399	105,716,795	101,243,442	16,712,300	289,959,920	16,712,300	1,090,982,156
Forestry	499,335,564	51,886,960	51,886,960	32,306,960	84,769,624	11,600,000	731,786,067
Wilderness	12,848,000	6,424,000	6,424,000	2,608,000	6,424,000	2,608,000	37,336,000
Eco services	15,767,943	14,094,737	-	2,500,000	6,500,000	2,500,000	41,362,679
TOTAL	**1,088,588,905**	**178,122,491**	**159,554,402**	**54,127,260**	**387,653,544**	**33,420,300**	**1,901,466,903**

Note: In line with the regulatory frameworks, in Ecuador ecosystem restoration and ecosystem services provision are governed and managed through public mechanisms and systems, limited or null private participation foreseen in the near future.

Amazon Fund Portfolio Structure

In order to avoid further deforestation, degradation, generalized ecosystem services losses, and a potentially catastrophic, irreversible tipping point in environmental conditions in the region, production systems in the Amazon should more closely resemble Amazon ecosystems, from a structural, functional and productive standpoint. Towards this aim, the Fund should encourage a regional economic transition from extensive cattle ranching and annual monocultures (e.g., soy, maize) towards integrated landscape production systems based, amongst others, on the value chains presented in this report.

The value chain analysis carried out, and the accompanying financial and carbon modelling of the prioritised value chain interventions, indicate that in order to maximize mitigation and adaptation benefits and most effectively catalyze the transition towards a tree-based bioeconomy, the Amazon Bioeconomy Fund should support a diverse portfolio of sustainable intensification and extensive ecosystem conservation bio-businesses. The reason for this is that sustainable intensification business models are more effective at generating higher revenues and in creating employment opportunities (adaptation impact), while extensive ecosystem conservation business models are more effective at delivering emission reductions and enhancing ecosystem resilience (mitigation and adaptation impact), as exemplified in Table 37.

Table 37: Comparing the results of sustainable intensification vs. extensive ecosystem conservation in the seven prioritized value chain interventions of the Program

Sub-sector	**Value chain**	**Intervention Type**	**Annual Sales Range** (US$/ hectare)	**Mitigation Impact** (Result area: Forestry and land-use) tCO2eq reduced/US$ invested)	**Adaptation Impact** (Result area: vulnerable people, communities, regions) jobs created/US$ invested	**Adaptation Impact** (Result area: Ecosystem and ecosystem services) Hectares protected or restored/US$ invested
Perennial Agriculture	Native palms (*Euterpe, Bactris sp., etc.)*	Sustainable Intensification	2,000-5,000	Low-Medium	Medium-High	Low
Agroforestry	Cacao, coffee with native trees	Sustainable Intensification	1,000-4,000			

Aquaculture	Native species (*Collosoma, Piaractus sp, etc.*)	Sustainable Intensification	15,000-20,000			
Forestry Plantations	Native timbers (*Shizolobium, Ochroma sp., etc.*)	Sustainable Intensification	1,000-2,000			
Non-Timber Forest Products	Brazil nut (*Bertholletia, euterpe sp., etc)*	Extensive ecosystem conservation	20-40	Medium-High	Low-Medium	High
Nature Tourism	Community-led nature tourism	Extensive ecosystem conservation	2-4			

Though this study has presented the extensive ecosystem conservation interventions independently, management models that integrate NTFP, nature tourism, ecosystem services and habitat restoration revenue streams may be necessary to increase the economic competitiveness of ´standing forest´ business models. Sustainable intensification interventions, like perennial palm agriculture and aquaculture, are less prone to combination on a single site, but can be combined at the landscape level (for example, pulp and seed residues from palm agriculture as input for feed for native species aquaculture).

Technology and innovative production practices also have to play their role. It is important to note that the growing success of the açaí is mainly due to its adoption as a perennial crop: of the current annual açaí production of 1,630,000 tons, approximately 230,000 tons (14.1%) comes from NTFP managed natural forest areas and the remainder, approximately 1,400,000 tons (85.9%), comes from 198,000 hectares of managed plantations. The evolution of other NTFPs into perennial agriculture systems, could be one of the keys for both the jurisdictional level sustainability of standing forests, and the scaling of perennial, climate smart agriculture in the Pan Amazon bioeconomy. If we are to avert catastrophic climate change and a potential amazon tipping point, countries and businesses should learn from the innovations of their neighbors. There is no fundamental impediment for the success of açaí to be replicated with other native palms, or the high plantation yields of exotic timber species obtained with native species plantations.

Targeted patient capital at scale is now needed to help other bioeconomy value chains compete in national and international markets and realize the full potential of the Amazon's biodiversity.

APPENDICES

Appendix 1 – Leticia Pact for the Amazon Region

The Heads of State and Heads of Delegation of the Plurinational State of Bolivia, the Federative Republic of Brazil, the Republic of Colombia, the Republic of Ecuador, the Republic of Guyana, the Republic of Peru and Republic of Suriname gathered in Leticia, Colombia, on 6 September 2019:

Reaffirming the sovereign rights of the countries of the Amazon region over their territories and their natural resources, including the development and sustainable use of those resources, as recognized by international law;

Aware of the value of the Amazon for the conservation and sustainable use of the biodiversity, as well as its tropical rainforest, which is the source of 20% of the planet's fresh water and a climate regulator, providing essential ecosystem services to support the sustainable development of Amazonian populations;

Having in mind that 34 million people inhabit the Amazon region, including indigenous and tribal peoples, and peoples in voluntary isolation and initial contact, possessing ancestral knowledge, traditional knowledge, and cultural and linguistic diversity, which must be considered and protected;

Reaffirming all the principles of the Rio Declaration on Environment and Development, and taking into account the United Nations Framework Convention on Climate Change, including the principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances, the Convention on Biological Diversity, the Convention to Combat Desertification and Land Degradation, the Convention on International Trade in Endangered Species of Wild Fauna and Flora; the Minamata Convention on Mercury; as well as regional agreements, such as the principles and purposes of Amazon Cooperation Treaty Organization (ACTO) and other relevant international agreements for the sustainable development of the Amazon region and global ecosystems;

Aware of the importance for the implementation and generation of synergies between the 2030 Agenda and its Sustainable Development Goals, the Paris Agreement, and the process of building a global framework for biodiversity after 2020;

Reaffirming that for the conservation and sustainable development of the Amazon the efforts of the Amazon countries are required, and expressing their concern about the deforestation and forest degradation that is occurring by different causes in each of the countries, bearing in mind their respective regulatory frameworks, including those causes of deforestation that, according to necessary evidence, could be linked to climate change and its structural causes, and expressing their commitment to increase national and regional efforts to tackle this problem in a comprehensive and urgent way;

Reaffirming that the cooperation among Amazonian countries is an important condition for the conservation of the Amazon region, to generate opportunities for sustainable development and well-being of its populations;

Considering that, even though there are mechanisms and financial programs established, including multilateral banks, that complement the efforts of Amazonian countries and that contribute to the solution of these challenges, the provision and mobilization of financial resources must be increased to achieve the commitments established within the framework of these mechanisms in order to obtain this objective;

Encouraging the international community to cooperate for the conservation and sustainable development of the Amazon region, on the basis of respect for their respective national sovereignty, priorities, and national interests, we decide to sign the following:

LETICIA PACT FOR THE AMAZON REGION

1. Strengthen coordinated action for forest and biodiversity assessment, as well as to fight against deforestation and forest degradation, based on national policies and their respective regulatory frameworks.
2. Establish regional cooperation mechanisms and the exchange of information allowing to combat illegal activities threatening the conservation of the Amazon region.
3. Create the Amazon Network for Natural Disaster Cooperation among the region´s Emergency Operations Centers to coordinate and articulate national systems of disaster prevention and management in order to effectively address emergencies of regional impact, such as large forest fires scale.
4. Exchange and implement experiences to the comprehensive management of fires, encouraging the development of policies, instruments and technical actions, based on the prevention of forest fires, the promotion of alternatives to the use of fires in the rural areas and the strengthen of technical, scientific and institutional capabilities.
5. Specify accelerated restoration, rehabilitation, and reforestation initiatives in areas degraded by forest fires illegal activities, including, illegal extraction of minerals, with the goal of impact mitigation, recovery of species, and ecosystem functionality.
6. Increase efforts associated with monitoring forest cover and other strategic ecosystems in the region in order to have periodic reports, in particular, regarding the generation of an early deforestation and degradation alert system to act with a preventive approach.
7. Exchange information to improve the monitoring capabilities of climate, biodiversity, water, and hydrobiological resources of the region under a watershed approach, and based in communities.
8. Promote initiatives for connectivity of priority ecosystems and mechanisms for biodiversity conservation through sustainable use, restoration, and landscape management, respecting national sovereignty.
9. Exchange and implement experiences in the management of the systems of protected areas of the Amazon countries at regional, national and subnational levels for their effective management and for the benefit of the local populations, through the promotion of the development of conservation and sustainable use of programs and projects.
10. Strengthen the mechanisms that support and promote the sustainable use of forests, sustainable productive systems, responsible consumption and production patterns that promote value chains and other sustainable production approaches, including, those based on biodiversity.

11. Promote joint action aimed to the empowerment of women inhabiting the amazon region to encourage their active participation in the conservation and sustainable development of the Amazon region.
12. Strengthen the capacities and participation of indigenous and tribal peoples, and local communities in the sustainable development of the Amazon region, acknowledging their fundamental role in the conservation of the region.
13. Promote research, technological development, technology transfer, and knowledge management processes with the purpose of guiding the adequate decision-making and promoting the development of sustainable environmental, social and economic entrepreneurship.
14. Develop and articulate between the Amazon countries education and awareness-raising activities on the role and function of the Amazon, the main challenges and threats it faces for its conservation, the sustainable use of forests, the protection of traditional knowledge of the communities that inhabit it, and disaster risk scenarios for strengthening the resilience of Amazonian populations.
15. Work together to strengthen the programs and financial mechanisms, reiterate the commitments made by countries in these scenarios, mobilize public and private resources, including the multilateral banks, as appropriate, for the implementation of this Pact.
16. Promptly move forward in the formulation of the second phase of the Amazon Sustainable Landscapes Program under the Global Environmental Facility.

WE DECLARE

- Our willingness to adhere to this Leticia Pact for the Amazon Region.
- Our commitment to coordinate, through the Ministries of Foreign Affairs and the competent authorities, the formulation of a plan of action for the development of the actions adopted, as well as the convening of follow-up meetings to evaluate the progress in the formulation and implementation of the said plan.
- Our intention to cooperate with and our call to other interested States, to the Amazon Cooperation Treaty Organization (ACTO) and to other regional and international organizations to cooperate for the attainment of the actions here agreed, building in harmony with national efforts and in response to the national requests made by the Amazon countries that signed this Pact, and with full respect of their sovereignty.

Appendix 2 – Land Use Planning and Land Rights

The Pan Amazon nations have instituted numerous policy initiatives to reform rural land markets to encourage sustainable development; however, most still have legal mechanisms for transferring public land to private individuals that explicitly allow—or even require—deforestation. Local and regional governments, with the support of multilateral development agencies, build roads in wilderness landscapes, where it is implicitly understood that land speculation will invariably lead to deforestation. These policies enjoy the support of the economic interests of construction companies, landholders, and agribusinesses, as well as the electoral power of landless peasants seeking a pathway out of poverty.

The Pan Amazon nations have used land-use planning methodologies to identify landscapes that should be set aside for protection or zoned for some type of economic activity, including forest management, livestock, perennial crops, and intensive agriculture. There are two basic approaches*:* *Zonificación agro-ecológica* (ZAE) and *Zonificación ecológica económica* (ZEE).[348] The ZAE method uses climate and soil data to differentiate land-use categories, while the ZEE approach essentially uses the ZAE output as a baseline but incorporates social and economic criteria to arrive at a land-use plan that, theoretically, will be accepted and used by society. A ZEE includes a consultation process that engages all stakeholder groups, including indigenous and traditional communities, academics, and civil society, as well as migrants and agroindustry.[349] The effectiveness of these studies and their implementation as land use policy is mixed. Settlement, colonization, and deforestation have occurred and continue to occur via processes influenced largely by social and market forces. Nonetheless, the ZEE process has supported the establishment and management of protected area systems and institutionalized the claims and rights of indigenous communities and other vulnerable groups. Governments, NGOs, and multilateral institutions continue to invest in these approaches as a path towards truly sustainable development.

Land-use zoning is most relevant on frontier landscapes undergoing land-use change. In some instances, these recommendations have provided sound information and supported expanding agricultural production systems. However, highway infrastructure and the cost of land are more important factors when predicting future expansion of the agricultural sector. For example, the *Plan de Uso de Suelos* (PLUS) of Santa Cruz, Bolivia, correctly identified the productive capacity of the alluvial plain located east of the Río Grande. This landscape was deforested over the next decade to create a soybean production landscape, known as the *eastern expansion zone*. That is now a mainstay of the national economy.[350] That same document, however, classified a similarly flat alluvial landscape located to the north and west of the Río Grande as inappropriate for intensive agriculture due to poor drainage. Nonetheless, this seasonally flooded wetland was settled by farmers who drained the marshes to create another soy production district known as the *northern expansion zone*.

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[348] This methodology had its roots in the USDA system known as Land Capability Classification (LCC), which in Latin America was promoted as *Capacidad de Uso Mayor de la Tierra,* by USAID and the Instituto Interamericano de Cooperación para la Agricultura (IICA).

[349] Bolivia: Plan de Uso del Suelo (PLUS); Brazil: *Zoneamento Eecológico e Econômico* (ZEE*);* Colombia: *Plan de Ordenamiento Territorial* (POT); Ecuador; *Planes de Desarrollo Ordenamiento Territorial* (PDOT); Guyana: National Land Use Plan (NLUP); Peru: *Zonificación Ecológica Económica (ZEE);* Suriname: *Land use Plan* (LUP); Venezuela: *Plan Nacional de Ordenación del Territorio* (PNOT).

[350] CORDECRUZ-Corporacion Regional de Desarrollo de Santa Cruz (1995)-Plan de Uso de Suelos (PLUS)

Laws enacted in the 1990s obligated Bolivian municipalities to conduct ZEE-like studies, known as a *Plan Municipal de Ordenamiento Territorial* (PMOT); however, most of these were ignored or abandoned prior to completion due to the high turnover of elected authorities.[351] The regulatory system enacted in the 1990s also required land-use planning for individual properties greater than 100 hectares. Known as a *Plan de Ordenamiento Predial* (POP), these were designed to foster the conservation of forest corridors along river margins, as well as to legalize private reserves and ensure that properties complied with the PMOT. More importantly to the landholder, however, is the requirement to present a POP in order to formalize land tenure and obtain a permit to clear forest. In 2015, the Bolivian forest authority approved POPs covering 850,000 hectares and issued forest clearing permits for 154,000 hectares. The agency in charge of approving these studies had approved an additional 4.7 million hectares of deforestation by 2020.[352] Ironically, this land-planning instrument, which was intended to foster forest conservation, seems to have been used to promote deforestation as part of a strategy to expand agricultural production in the Bolivian Amazon.

The ZEE concept was first adopted as a policy by the Peruvian government in 1997, but methodological guidelines were not approved until 2004. Implementation has been slow and only nine of 24 regional governments had completed a draft ZEE by 2017. Fortunately, these include three Amazonian regions: Madre de Dios,[353] San Martin, and Amazonas, while Loreto focused its effort on Alto Amazonas Province, which has the highest rates of deforestation and land on the landscapes surrounding Yurimaguas. ZEEs are still lacking for frontier landscapes near Ucayali, where the regional government is actively promoting the expansion of secondary road networks and agricultural expansion.

The Peruvian system treats the ZEE as a technical document that provides information and recommendations, but it is only the first step of a labyrinthine process to develop a legally binding land-use plan. This requires seven additional special studies: (1) risk analysis from disasters and climate change, (2) land-use change, (3) ecosystems and coastal habitat, (4) land tenure, (5) regional economic dynamic, (6) ecosystem services, and (7) institutional capacity.[354] Due to this complexity, only the region of San Martin within the Peruvian Amazon has produced a legally binding zoning regime. The Ministry of the Environment has legal authority to stop a mineral concession made by the Ministry of Energy and Mines but rarely exercises that authority, nor has it been able to halt initiatives backed by local authorities and the Ministry of Agriculture to expand the agricultural frontier. Ironically, stakeholders seeking to clear land and expand agriculture can use a parallel ZAE-type of land-use classification system, which is still part of the regulatory system, to legalize deforestation, except in protected areas, permanent production forests, indigenous reserves, and lands classified as F

[351] Fundacion para la Conservacion del Bosque Chiquitano (12 March 2018) – Gestion Integral del Territorio y Areas Protegidas.

[352] NOTIBOLIVIARURAL.COM (26 Abril 2016) En 2015 autorizaron 1 millon de hectáreas para POP y Planes de Desmontes

[353] The first Madre de Dios ZEE was compiled in 2001 by the Instituto de Investigation de la Amazonia Peruana (IIAP), with support from the Interamerican Development Bank (IADB) and USAID

[354] MINAM - Ministerio del Ambiente - Perú (2015). *Orientaciones básicas sobre el Ordenamiento Territorial en el Perú / Dirección General de Ordenamiento Territorial. 2 ed.*-- Lima: Ministerio del Ambiente, 2015. http://www.minam.gob.pe/ordenamientoterritorial/wp-content/uploads/sites/129/2017/02/Orientaciones-basicas-OT-1.pdf

(Forestry) or X (Protection) in the ZAE. This loophole was used by Peru's largest palm oil producer to double the area under cultivation via deforestation between 2005 and 2015.

In Ecuador, the *Plan de Desarrollo y Ordenamiento Territorial* (PDyOT) is part of the National Development Plan (PND), a constitutionally mandated framework for decentralizing administrative functions. The PDyOT is a process rather than a study, and is both participatory and multi-sectoral; theoretically, it will create a legally binding framework that will promote [or constrain] the economic activities within autonomous regional governments. The PDyOT incorporates three main elements: (1) a diagnosis, which is an analysis using biophysical and socioeconomic information (essentially a ZEE); (2) a proposal, which will organize land use according to land capacity categories and productive systems; and (3) a management model, which details how the proposed model will be executed via programs and projects.[355] The scheme empowers local and regional jurisdictions but reserves a strong role for the central government, which has established a uniform set of rules and will function as repository for the information compiled by regional governments.[356]

Colombia adopted a national land-use planning strategy in 1997, when all of its municipalities were charged by law to develop a *Plan de Ordenamiento Territorial* (POT) by 2003; most complied with the requirement to produce a document. Changes to this regulatory regime were implemented between 2011 and 2015 in a renewed effort to incorporate land-use planning to foster sustainable development.[357] The reformed system differs from a standard ZEE by including a risk analysis for earthquakes, floods, and landslides, as well as a focus on the discrepancy between the inherent capacity of a landscape and its actual use. The Colombian method includes a protocol for improving land-use efficiency, such as in the previously deforested lands in Caquetá and Putumayo that are covered by low-productivity pastures. The POT process is focused at the municipal level, with an emphasis on urban planning, while the regional-scale process is the domain of environmental regulatory agencies, known as *Corporación Autónoma Regional* (CAR).

In Brazil, the legal basis for developing a ZEE began in 1981, when the Congress passed the National Environmental Policy Act, which recognized environmental zoning as a regulatory tool for promoting the rational use of soil and the protection of ecosystems. The responsibility for conducting a ZEE was transferred to the states in 1994 and was formalized as a regulatory procedure via presidential decree in 2002, when the government established a federal commission to coordinate the process (CCZEE).[358] Shortly thereafter, the ZEE was incorporated into the constitutionally mandated four-year, state-level, strategic planning process (PPA). In 2010, the Ministry of the Environment published a Macro ZEE of the Legal Amazon, which was derived from preliminary state-level studies and provided the first

[355] SENPLADES-Secretaria Nacional de planificación y Desarrollo (2014)-Lineamientos y directrices para la planificación y ordenamiento territorial.

[356] Cabezas, J., 2017. La planificación nacional en Ecuador: planes de desarrollo y ordenamiento territorial, y el sistema de seguimiento y evaluación SIGAD.

[357] Departamento Nacional de Planificación (7 junio 2016). A partir de hoy 100 municipios y 25 departamentos apuestan a ser territorios modernos.

[358] CCZEE (*Comissão Coordenadora do Zoneamento Ecológico-Econômico do Território Nacional*) is composed of twelve cabinet ministries. See: http://www.mma.gov.br/informma/item/7596
Consórcio ZEE Brasil (*Grupo de Trabalho Permanente para a Execução do Zoneamento Ecológico-Econômico)* is composed of two ministries and fifteen autonomous agencies and technical institutes. see: http://www.mma.gov.br/informma/item/10407

official vision of the future of the Legal Amazon. The ZEE methodology will eventually be applied at the municipal scale.[359]

The importance of the ZEE was enhanced by the Forest Code of 2012, which recognized the ZEE as an official information resource for regulatory purposes and obligated each state to produce a more detailed version (1:250,000). As of January 2018, only Acre and Rondônia had completed a detailed ZEE, although Pará, Amazonas, Tocantins, and Amapá had made partial progress (Table A1). Maranhão and Roraima had executed zoning studies, but they did not conform to federal guidelines. The case of Mato Grosso is unique because it completed a ZEE in 2008, which was rejected by the CCZEE in 2012. In 2016, the Mato Grosso government initiated a process to bring its planning into compliance with federal regulations.

Table A1: Status of ecological–economic zoning (ZEE) studies in the Legal Amazon

State	start		Macro ZEE (1:1,000,000)		ZEE (1:250,000)			Observations
			Year	**CCZEE Valid.**	**Year**	**% Cover**	**CCZEE Valid.**	
LA	2002		2010	Y				Compiled by the MINAM based on Macro ZEEs provided by the states (where available)
AC	1999		2000	N	2007	100%	Y	Considered to be the most effective ZEE and is used in numerous initiatives by the state government
AP	1991				2000	17%	N	Completed only for the populated landscapes of the Southern Sector; it was updated in 2007
AM	2003		2009	Y	2011	16%	Y	Only the Purus sub-region is complete (16%); the Lower Amazon (7%) and Madeira (14%) and under development
MA	1991		2014	Y				The state contracted EMBRAPA to prepare a ZEE in 2000-2002, but it was not concluded; the effort was renewed in 2009
MT	1995		1992	N	2008	100%	N	The ZEE MT was completed in 2008, but modified by the legislature in 2011; it was, ruled invalid by CCZEE; a new effort was started in 2016
PA	2002		2005	Y	2010	93%	Y	The work was subdivided into 4 sub-regions: East, West and North are complete, but Coast is under development in 2017
RO	1996		1991	N	2005	100%	Y	The 1991 Macro ZEE was a legacy of the PLANOFLORO project; the 2005 ZEE was a draft that was updated in 2007.
RR	2015		2002	N				A ZEE was prepared in 2002 by the national geological service (CPRM), but did not meet the CCZEE guidelines; a new version was under development in 2017

[359] Ministerio do Meio Ambiente (21 Mar 2018). Histórico do ZEE. http://mma.gov.br/gestao-territorial/zoneamento-territorial

TO	1992		1999	N	2005	12%	Y	A ZAE was completed in 1999 by EMBRAPA; a standardized ZEE was completed for 42 northern municipalities in 200
		Source: http://www.mma.gov.br/images/arquivo/80253/Estados/Informacoes%20ZEE%202017.pdf						

In spite of the patchwork nature of its implementation, the ZEE process is viewed as a success in Brazil. It has imposed scientific criteria on both federal and state planning processes and is used as a reference point during the environmental reviews supervised by *Instituto Brasileiro do Meio Ambiente e dos Recursos Natureis* (IBAMA) and relevant state agencies. Public sector financial entities, such as the *Banco do Brasil* and BNDES, are obligated to review investment projects and ensure they are in compliance with the state ZEE.

Moving forward, the ZEE process faces several challenges. One unfulfilled objective is to facilitate the land regularization process at *Instituto Nacional de Colonização e Reforma Agrária* (INCRA). In part, this is due to the coarse scale of existing ZEE studies, as farmers and ranchers require fine-scale information on soil attributes to inform their decisions on land use, particularly as it concerns the Forest Code, one of the most important and conflictive aspects of land use regulation in Brazil.

There have been three iterations of the Brazilian Forest Code: 1936, 1965, and 2012. The first version declared the forest to be a public good and recognized its essential functions, which justified the role of the state in forest management. It provided guidelines for establishing protected area categories and stipulated that forest on private property must be managed according to the rules outlined by the law.

The Forest Code of 1965 increased the power of the state in regulating forest landscapes and the commercialization of forest products. Of particular importance was the introduction of two different types of forest reserves on private property: (1) *Area de Protección Permanente* (APP), which are deemed essential for maintaining ecosystem function, such as riparian corridors, lakesides, steep slopes, and hilltops, and (2) *Reserva Legal* (RL), an additional area of native forest that must be protected to ensure the conservation of natural habitats at the landscape scale. The area allocate as APP is dependent on topography and hydrology, but the dimensions of the RL were stipulated by the law, which established minimum proportional areas. In the Amazon biome, landholders were required to set aside 80% of the natural forest cover, plus whatever area was required by the APP.[360] Within the RL, landholders were allowed to pursue forest management options based on timber and non-timber forest products.

The Forest Code of 2012 retains the basic tenants of the previous version but introduced several significant changes. The calculation of the total area to be included within the RL was modified to include areas that were identified as the APP. Previously, these two units were accounted for separately; in addition, provisions were included to reduce the RL and to make the restoration requirements less onerous:

- Properties < 400 ha are exempt from restoring land cleared prior to 2008, but landholdings are not allowed to exceed the legal limit with new deforestation.

[360] This value was originally set at 20% in the 1934 law but was increased to 50% for Amazonian properties in 1965 and 80% via presidential decree in 2001; see: http://www.planalto.gov.br/ccivil_03/mpv/2166-67impressao.htm.

- Smallholders in consolidated [long-settled] areas in Rondônia have a RL of 50% (rather than 80%), because that was the policy when they obtained their properties.
- Landholders only have to restore deforested area until their RL equals 50% of their property, if they are located in municipalities where more than 50% of their total area is set aside as a conservation unit or indigenous territory.
- Landholders only have to restore deforested area until their RL equals 50% of their property, if they are located in states that have set aside more than 65% of their total area as a conservation unit or indigenous territory.
- Up to 50% of the land that must be reforested can be planted in commercial species, a provision that includes plantation forestry using exotic species.
- Land swapping within a biome is an option for meeting RL requirements.

Agrarian reform and land tenure registry

The rural landscapes of the Pan Amazon have been settled and transformed by pioneer families and corporate farms. Landholdings appreciate in value over time as their productive assets grow by additional forest clearing and investments in plantations, pastures, and basic infrastructure. Landholders monetize this wealth when they sell their property or realize its value when it is transferred to a younger generation. All of the nations in the Pan Amazon have elected to create a national land registry (*cadaster*) to manage properties. Brazil and the Andean countries chose to organize this effort using the agrarian reform institutions that distributed land during the colonization boom of the 1970s and 1980s. For reasons of expediency, these agencies issued temporary titles with the promise of "formalizing" them at a later date; this led to a massive backlog of claims that has contributed to the informality and illegality of rural real estate markets. Starting in the late 1990s, agencies began programs to create digital databases and to finalize the process of issuing legal titles. None have completed this process.

In Brazil, INCRA has been charged with creating and maintaining the *Sistema Nacional de Cadastro Rural* (SNCR)[361] The government has launched periodic initiatives to populate the SNCR with data with increasing levels of electronic sophistication. Currently, two different systems contribute data to the SNCR: the first is the *Sistema Nacional de Certifcação de Imóveis* (SNCI), which was created in 2003, and the second is the *Sistema de Gestão Fundiária* (SIGEF), established in 2013. The systems have not been digitally merged, but the SIGEF has supplanted the SNCI as the data entry portal. A landholding that has passed through the due diligence of SNRC issues a *Certificado de Cadastro de Imóvel Rural* (CCIR), which functions as a legal title in Brazil.

In December of 2017, only 12% of the landowners registered within the SNRC had obtained a CCIR; however, this relatively small fraction of landholders owned approximately 60% of the private properties registered within the SNCC. Most were medium- and large-scale producers who self-financed the CCIR registration process, which requires the services of a professional surveyor and legal counsel. In contrast, the vast majority of smallholders lacked clear legal title to their properties.

There are therefore two distinct levels of land tenure: ownership and possession. A landholder without a CCIR is a possessor of land (*poseiduero*), while one who has obtained a CCIR is a landowner

[361] National Rural Cadaster System (SNCR); note: Cadaster is a technical term for land registry.

(*proprietário*). Clear legal title confers many more rights than possession, but the possessor is not devoid of legal protection. They cannot be evicted from the property if they are using it according to principles referred to as a "social and economic function." Nonetheless, the lack of a clear legal title restricts the ability to sell the land or access some forms of credit, and consequently, has a negative impact on its value in real estate transactions. The majority of smallholders, including those who reside inside INCRA-sponsored settlement projects, lack clear legal title to their properties, which is almost always their most significant financial asset.

The lack of a comprehensive land tenure registry motivated the Brazilian government to create the *Cadastro Ambiental Rural* (CAR), a parallel land registry that allows landholders, including both *poseiduero* and *proprietário*, to "regularize" their status with respect to the Forest Code. [362] The CAR, which is managed by the Brazilian Forest Service, functions as a mechanism to facilitate the commercialization of farm commodities, particularly soy, maize, and beef. It was developed during the crisis caused by a global boycott of Brazilian commodities, which motivated stakeholders to develop a system for monitoring deforestation on rural properties in the Brazilian Amazon.[363]

Registration in the CAR is not obligatory, but authorities have created positive incentives for registration, including facilitating farmers' and ranchers' ability to commercialize their production, but also by providing access to credit and creating options for complying with environmental regulation. The CAR has avoided the pitfalls of the national land registry system (SNCR) by adopting lenient standards regarding land tenure, such as allowing registration of holdings regardless of their legal status or the existence of conflicting land claims. The CAR provides a relatively accurate depiction of the number and location of all land claims and provides a mechanism for monitoring the compliance with the Forest Code, while leaving the legal formalization to INCRA. As such, it provides the best estimate of the number and distribution of private land holdings in Brazil, particularly for the Legal Amazon where the history of settlement is recent and land tenure data is poorly organized.[364]

The creation of the CAR has not resolved land tenure insecurity, however. Administrative disorder fosters corruption, which has been an operative part of INCRA from the outset of its existence. The most common malfeasance is the payment of small bribes to functionaries to facilitate the legalization of documents.[365] Although individually small, over tens [hundreds] of thousands of transactions, they represent a large sum of money. Even more serious is the appropriation of public land by politically connected or professional land grabbers.

In 2016, the *Tribunal de Contas da União* (TCU), the national audit agency, estimated that a third of all historical land grants made by INCRA via its settlement program were fraudulent and estimated the cost to the nation at more than R$41 billion.[366] Evidence of malfeasance was obtained by comparing

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362 MINAM – Ministério da Agroicultura, Pecuaria e Abastecimento (5 jan 2021) O que é o Cadastro Ambiental Rural (CAR), https://www.florestal.gov.br/o-que-e-o-car

363 Laskos, A.A., Cazella, A.A. and Rebollar, P.B.M., 2016. O Sistema Nacional de Cadastro Rural: história, limitações atuais e perspectivas para a conservação ambiental e segurança fundiária. Desenvolvimento e Meio Ambiente, 36.

364 See http://www.car.gov.br/#/

365 METROPÓLIE (22/08/2017) PF prende servidoras do Incra por corrupção com propina de R$ 12 mil https://www.metropoles.com/brasil/pf-prende-servidoras-do-incra-por-corrupcao-com-propina-de-r-12-mil

366 The calculation is based on a conservative estimate of the value of the land that was fraudulently distributed and the real value could be many times greater since land values vary among regions and appreciate in value over time. Source: Tribunal de Contas da União (2016) Relatório de TC 000.517/2016-0

national identification numbers of the individuals who had received land with other information sources. The audit identified more than a thousand politicians and 140,000 civil servants who had improperly received public lands; at least 37,000 land grants were made to individuals who were dead at the time of their application.[367] The auditors estimated that at least R$2.5 billion had been misappropriated via the technical assistance programs and as much as R$92 million was at risk in 2015.[368] Not surprisingly, the TCU identified that land fraud was most prevalent in the Legal Amazon.

The Andean republics have a similar history of agrarian reform and land tenure chaos, due to administrative inefficiency and deliberate malfeasance. In Bolivia, the *Instituto Nacional de Reforma Agraria* (INRA) is charged with providing legal title for all rural landholdings. The agrarian reform and land law was modified by legislative action in 1996 to provide better legal security for landowners as part of the structural adjustment programs that were being imposed on the country by multilateral agencies. This included an effort to regularize the national land registry and fortify the private land market, but it also included efforts to recognize the land rights of indigenous communities. Following the election of 2005, INRA's mandate was modified, with the express purpose of limiting the concentration of land in the Amazon lowlands. As of 2019, INRA had validated the tenure of approximately 78 million hectares: about 29% of this area is held collectively by indigenous and peasant organizations, while another 21% is owned by small farmers, and 23% is controlled by commercial farmers and ranchers. About 30 million hectares are held by the state, either as protected area or forest reserves, while another 30 million hectares remain to be reviewed.[369]

In spite of the progress in creating a national land registry, the private sector continues to complain about the lack of legal security. Their major complaint is the requirement to review tenure every five years; tenure is never permanent and may be revoked if the landholding does not meet the criteria of having an economic or social function. The government continues to use INRA as a vehicle to validate new land titles, particularly on landscapes where the government has rescinded long-term contracts with timber companies. Between 2013 and 2019, the government of Bolivia approved five laws facilitating access to public lands and legalizing landholdings appropriated during previous administrations.[370]

In Peru, the government created the *Proyecto Especial de Titulacion de Tierras y Catastro Rural* (PETT), with the specific goal of providing legal title to all Peruvian landholders and creating a national land tenure database.[371] The management of the PETT project has been subject to several administrative reforms, including a decentralization decree in 2003; an anti-corruption drive in 2007; a renewed

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367 TCU - Tribunal de Contas da União (2016) Relatório de TC 000.517/2016-0, http://portal.tcu.gov.br/lumis/portal/file/fileDownload.jsp?fileId=8A8182A253D4239E0153F24D7BAC2406&inline=1

368 The findings of the audit obligated the TCU to block the emission of new land titles and freeze credits to an estimated 400,000 rural smallholders participating in the INCRA settlement program; the moratorium was ended in November of 2016 after INCRA following a series of reforms. Source: INCRA Noticias.

369 Fundación Tierra (09 Octubre 2015) El saneamiento no acabó con la gran propiedad agraria ni redujo el minifundio, Reforma Agraria y Titulación de Tierras, http://www.ftierra.org/index.php/reforma-agraria-y-titulacion-de-tierras

370 Ley 337, de Apoyo a la Producción de Alimentos y Restitución de Bosques (2013). Ley 741, "Ley de Autorización de Desmonte hasta 20 hectáreas (2015). Ley 1098, de Aditivos de Origen Vegetal (2018). la Ley 1171 de Uso y Manejo Racional de Quemas (2019). Decreto Supremo N° 3973 (2019). A

371 Peruvian governments have leveraged their investments in PETT with loans of approximately equal amounts from the via the Land Titling and Registration Projects: PTRT I in 1996 @ US$22 million total (PE0037); PTRT II in 2001 @ US$23.3 million (PE0107) and PTRT III in 2014 @ $us 40 million (PE-L1026); see https://www.minagri.gob.pe/portal/664-catastro-rural

effort at decentralization in 2010; and finally, a return to the Ministry of Agriculture in 2013. Currently, the program is managed by regional offices that organize field campaigns where all properties on a shared landscape simultaneously resolve land title issues. Corruption within these entities is widespread, where officials and citizens use counterfeit and cloned documents to appropriate state lands.[372] Unlike in other countries in the region, Peruvian legislation does not condition long-term tenure based on a demonstration of social and economic function. Landholders have property rights typical of a market-oriented liberal democracy.[373]

The National Agricultural Census of 2012 counted about 5.2 million properties nationally, of which less than 30% enjoyed legal title.[374] In the lowlands, the census registered more than 646,000 smallholdings; although there is no information on the legal status of these properties, registry presumably progress tracks the rest of the country. Fortunately, efforts to provide legal title for communal lands advanced significantly due to the assistance of civil society organizations.[375]

In Ecuador, a military government created the *Instituto Ecuatoriano de Reforma Agraria y Colonización (IERAC),* which distributed about five million hectares of land between 1967 and 1996. About 67% of these properties were located in the eastern lowlands, where land was distributed in 40-hectare plots to approximately 80,000 families.[376] Unfortunately, IERAC did not provide homesteaders with legal land titles, nor did the regional offices incorporate the data into a national archive. In 1994, IERAC was replaced by the *Instituto Nacional de Desarrollo Agrario (INDA)* as part of a 'structural readjustment' policy intended to foster a market-based economy and reinforce property rights. That law centralized the land titling process in Quito and was supported by an IDB-financed initiative to create a digital database.[377] This initiative had limited success, however, and by 2010 there were a total of 700,000 'folders' waiting to be processed when INDA transferred its functions to the *Subsecretaria para Tierras y la Reforma Agraria* at the Ministry for Agriculture.[378] The land titling process was modified by the

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[372] Sierra Praeli, Y. (13 Dec 2018) Tráfico de tierras en Ucayali: funcionarios detenidos por pertenecer a mafia, https://es.mongabay.com/2018/12/trafico-tierras-ucayali-bosques-desaparecen/

[373] Fort, R. (2007) Property rights after market liberalization reforms: land titling and investments in rural Peru. PhD Thesis. Wageningen: Wageningen Academic Publisher. 113 p. http://www.grade.org.pe/publicaciones/buscar/PETT

[374] IIPDRS - Instituto para el Desarrollo Rural de Sudamérica (2014) Perú: Conversatorio "Titulación Rural y Agricultura Familiar" http://www.sudamericarural.org/noticias-peru/que-pasa/2941-peru-conversatorio-titulacion-rural-y-agricultura-familiar; Carlos Zecenarro Monge (2014) Retos normativos para la consolidación de la titulación de predios rurales y la gestión del catastro rural en el Perú, Gestión Pública y Desarrollo, https://works.bepress.com/czecenarro/5/; IADB – Interamerican Development Bank (2014) Proyecto de Catastro, Titulación y Registro De Tierras Rurales en el Perú – Tercera Etapa (Pe-L1026), Perfil De Proyecto, http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=39045138

[375] IBC / CEPES (2016) Directorio 2016 Comunidades Campesinas Del Perú, SICCAM - Sistema de Información sobre Comunidades Campesinas del Perú, Instituto del Bien Común and Centro Peruano de Estudios Sociales (CEPES), Lima; IBC (2016) DIRECTORIO 2016, COMUNIDADES NATIVAS DEL PERÚ, SICNA - Sistema de Información sobre Comunidades Nativas de la Amazonía Peruana, Instituto del Bien Común Lima.

[376] Pierre Gondard, Hubert Mazurek (2001) 30 años de reforma agraria y colonización en el Ecuador (1964-1994) - Dinámicas espaciales, Estudios de Geografía, vol. 70, 0 CEN, CGE, IRD, PUCE, 2007, http://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_7/carton01/010026095.pdf

[377] IADB: Project EC-0191: Land Titling and Registration in 2001 @ US$15 million.

[378] El Universo (01/11/2010) Conflictos de tierra pasarán del INDA a Secretaría a fin de mes http://www.eluniverso.com/2010/11/01/1/1355/conflictos-tierra-pasaran-inda-secretaria-fin-mes.html

Constitution of 2008 which devolved administrative authority back to the municipalities.[379] In spite of the change in jurisdictional authority, the law tasked the national government to create and maintain a digital database. Known as SIGTIERRAS, this initiative was supported by another IDB project, which presumably incorporated the experiences of the previous decade's pilot project.[380]

The land tenure process in Ecuador is now managed by the *Autoridad Agraria Nacional (AAN),* apparently a new name for the same entity within Ministry for Agriculture. Among its regulatory features, the law establishes limits on the maximum dimensions for properties: 200 hectares for the highlands, 500 hectares for the coast, and 1000 hectares for the Amazon. the law also provides the ANN with the power to confiscate properties that are larger than these dimensions or do not meet criteria regarding social and economic function.[381] As of October 2017, the AAN had registered a total of 31,000 rural properties in three Amazonian municipalities (Orellana, Nueva Loja, and Succumbios), which together included 15% of the population and about 40% of agriculture's spatial footprint in the region. There are probably more than 100,000 landholdings in Amazonian Ecuador, which implies that the ANN had completed perhaps 35% of the task as of 2017. Fortunately, the effort to formalize land tenure for indigenous communities is well advanced.

The unequal distribution of land in Colombia is a root cause of this nation's rural development challenges and has fueled decades of conflict. The problem has motivated multiple policy initiatives, starting in 1936 with the first agrarian reform law, followed by a renewed attempt in 1961 with the creation of the *Instituto Colombiano de la Reforma Agraria* (INCORA). A third agrarian reform in 1994 was based on a market-based approach for redistributing land by providing subsidies to tenants seeking to negotiate a land purchase from landowners. This reform followed the precepts of the Constitutional of 1991 and coincided with the legal decrees that recognized the rights of indigenous and traditional people in 1995. INCORA was replaced in 2003 by INDECORA,[382] which remained responsible for promoting access to rural property but diversified its mission by promoting the sustainable development of peasant, indigenous, and black communities. These and other initiatives failed to resolve the long-standing issues related to land tenure and rural poverty, a task that was essentially impossible due to the violence that consumed the country for another 25 years.[383]

One of the most conspicuous legacies of Colombia's long civil war is the massive number of displaced people, including an estimated 7.5 million family farmers.[384] The legacy of land also plagues the private sector, because investors are unwilling to commit resources to a productive enterprise if there is a risk of forfeiture due to an illegitimate title. This legacy is now being addressed via a component of the

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379 In Ecuador, the equivalent to a municipality is referred to as a "canton."

380 IADB: EC-L1071: National System for Rural Land Information and Management and Technology in 2010 @ US$90 million.

381 Milton Yulán Morán (18 mayo 2017) LEY Y REGLAMENTO DE TIERRAS: LA CLAUSURA DE LA REDISTRIBUCIÓN, https://lalineadefuego.info/2017/05/18/ley-y-reglamento-de-tierras-la-clausura-de-la-redistribucion-por-milton-yulan-moran/

382 Instituto Nacional de Desarrollo Rural y Reforma Agraria

383 Berry, A. (2006). Has Colombia finally found an agrarian reform that works. Human Development in the Era of Globalization: Essays in Honor of Keith B. Griffin. Book News Inc, Portland, OR.

384 IDMC - Internal Displacement Monitoring Center (31 October 2017) Colombia, http://www.internal-displacement.org/countries/colombia; Richani, N. (2013) Systems of Violence: The Political Economy of War and Peace in Colombia. New York: Suny Press.

Peace Process known as the *Reforma Rural Integral*,[385] which will be the responsibilities of two institutions: the *Agencia Nacional de Tierras* (ANT), as the clearing house for all issues related to land tenure, and (2) the *Agencia de Desarrollo Rural* (ADR), to foster investments and provide technical support.[386] An estimated 3.5 million rural properties exist in Colombia, and less than 15% have clear legal title; 59% are in some stage of tenure review, and an estimated 26% have yet to be incorporated into the national land registry system.

[385] Barthel, K, Cespedes, V., Salazar, B., Torres, R. Varón, M. (2016) Land and Rural Development Policy Reforms in Colombia: The Path to Peace, USAID/Colombia Land and Rural Development Program (LRDP), https://www.globalcommunities.org/publications/2016-Colombia-Rural-Development-Policy.pdf

[386] See http://www.adr.gov.co/index.php and http://www.agenciadetierras.gov.co/

Appendix 3 – Ecoregions of the Pan Amazon

The Pan Amazon integrates an enormous diversity of landscapes and ecosystems, making the region the most biodiverse on the planet. A characterization of all ecosystems is beyond the scope of this report. However, we can consider the classification of global vegetation types and ecoregions developed by WWF and TNC (2008) as a useful framework to outline the biodiversity of the region and identify those ecoregions that are suffering from land use change, deforestation and degradation, in order to detect the extent of habitat loss and monitor ecosystem persistence over time. The Pan Amazon has seven distinct vegetation types and 5I distinct ecoregions. In Figure A1 we can see the spatial distribution of each ecoregion of the Pan Amazon, while in Table A2 we can see its extent and the vegetation type to which each ecoregion corresponds.

Figure A1: Ecoregions in the Pan Amazon

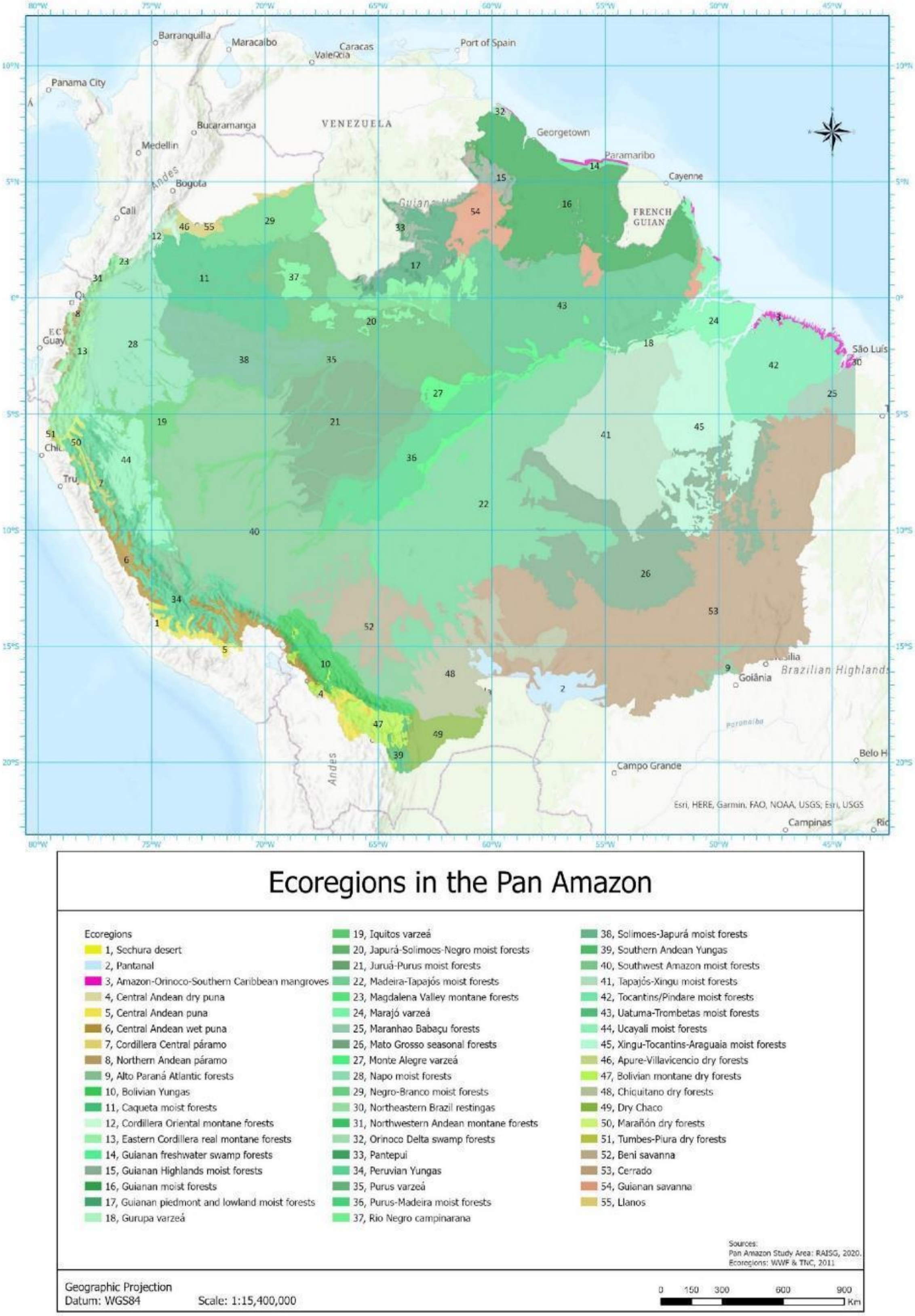

Table A2. Ecoregions in the Pan Amazon, by vegetation type

Ecorregion	Vegetation Type	Extension (ha)
Sechura desert	Xeric Shrublands	50.759
Pantanal	Flooded Grasslands and Savannas	5.925.239
Amazon-Orinoco-Southern Caribbean mangroves	Mangroves	1.923.118
Central Andean dry puna	Montane Grasslands and Shrublands	242.159
Central Andean puna	Montane Grasslands and Shrublands	3.866.812
Central Andean wet puna	Montane Grasslands and Shrublands	6.269.079
Cordillera Central páramo	Montane Grasslands and Shrublands	908.439
Northern Andean páramo	Montane Grasslands and Shrublands	1.072.359
Alto Paraná Atlantic forests	Tropical & Subtropical Moist Broadleaf Forests	1.308.482
Bolivian Yungas	Tropical & Subtropical Moist Broadleaf Forests	9.430.085
Caqueta moist forests	Tropical & Subtropical Moist Broadleaf Forests	18.465.443
Cordillera Oriental montane forests	Tropical & Subtropical Moist Broadleaf Forests	1.950.890
Eastern Cordillera real montane forests	Tropical & Subtropical Moist Broadleaf Forests	8.248.673
Guianan freshwater swamp forests	Tropical & Subtropical Moist Broadleaf Forests	778.022
Guianan Highlands moist forests	Tropical & Subtropical Moist Broadleaf Forests	5.642.266
Guianan moist forests	Tropical & Subtropical Moist Broadleaf Forests	36.620.234
Guianan piedmont and lowland moist forests	Tropical & Subtropical Moist Broadleaf Forests	8.582.443
Gurupa varzeá	Tropical & Subtropical Moist Broadleaf Forests	995.408
Iquitos varzeá	Tropical & Subtropical Moist Broadleaf Forests	11.603.023
Japurá-Solimoes-Negro moist forests	Tropical & Subtropical Moist Broadleaf Forests	27.034.516
Juruá-Purus moist forests	Tropical & Subtropical Moist Broadleaf Forests	24.425.151
Madeira-Tapajós moist forests	Tropical & Subtropical Moist Broadleaf Forests	73.113.004
Magdalena Valley montane forests	Tropical & Subtropical Moist Broadleaf Forests	102.584
Marajó varzeá	Tropical & Subtropical Moist Broadleaf Forests	8.837.716
Maranhao Babaçu forests	Tropical & Subtropical Moist Broadleaf Forests	5.982.934
Mato Grosso seasonal forests	Tropical & Subtropical Moist Broadleaf Forests	42.185.725
Monte Alegre varzeá	Tropical & Subtropical Moist Broadleaf Forests	6.719.815
Napo moist forests	Tropical & Subtropical Moist Broadleaf Forests	25.255.568
Negro-Branco moist forests	Tropical & Subtropical Moist Broadleaf Forests	14.696.362
Northeastern Brazil restingas	Tropical & Subtropical Moist Broadleaf Forests	3.998
Northwestern Andean montane forests	Tropical & Subtropical Moist Broadleaf Forests	83.503
Orinoco Delta swamp forests	Tropical & Subtropical Moist Broadleaf Forests	390.044
Pantepui	Tropical & Subtropical Moist Broadleaf Forests	666.663
Peruvian Yungas	Tropical & Subtropical Moist Broadleaf Forests	18.530.821
Purus varzeá	Tropical & Subtropical Moist Broadleaf Forests	17.858.457
Purus-Madeira moist forests	Tropical & Subtropical Moist Broadleaf Forests	17.575.429
Rio Negro campinarana	Tropical & Subtropical Moist Broadleaf Forests	8.412.363
Solimoes-Japurá moist forests	Tropical & Subtropical Moist Broadleaf Forests	16.820.586
Southern Andean Yungas	Tropical & Subtropical Moist Broadleaf Forests	1.297.203
Southwest Amazon moist forests	Tropical & Subtropical Moist Broadleaf Forests	76.323.636
Tapajós-Xingu moist forests	Tropical & Subtropical Moist Broadleaf Forests	33.932.288
Tocantins/Pindare moist forests	Tropical & Subtropical Moist Broadleaf Forests	19.437.159
Uatuma-Trombetas moist forests	Tropical & Subtropical Moist Broadleaf Forests	47.336.768
Ucayali moist forests	Tropical & Subtropical Moist Broadleaf Forests	11.624.653
Xingu-Tocantins-Araguaia moist forests	Tropical & Subtropical Moist Broadleaf Forests	26.830.061
Apure-Villavicencio dry forests	Tropical and Subtropical Dry Broadleaf Forests	741.870
Bolivian montane dry forests	Tropical and Subtropical Dry Broadleaf Forests	5.036.576
Chiquitano dry forests	Tropical and Subtropical Dry Broadleaf Forests	19.210.734
Dry Chaco	Tropical and Subtropical Dry Broadleaf Forests	5.862.731
Marañón dry forests	Tropical and Subtropical Dry Broadleaf Forests	1.144.684
Tumbes-Piura dry forests	Tropical and Subtropical Dry Broadleaf Forests	88.133
Beni savanna	Tropical and Subtropical Grasslands, Savannas and Shrublands	13.005.705
Cerrado	Tropical and Subtropical Grasslands, Savannas and Shrublands	95.745.056
Guianan savanna	Tropical and Subtropical Grasslands, Savannas and Shrublands	9.235.518
Llanos	Tropical and Subtropical Grasslands, Savannas and Shrublands	1.558.494

Tropical humid broadleaf forests

In the Pan Amazon the most predominant vegetation type is tropical rainforests, with 78% of the representative area. The tropical rainforests, in addition to having the largest extension, also have the greatest biodiversity, containing more species than any other vegetation type on Earth. They are generally found in extensive patches and are characterized by low annual temperature variability and high levels of precipitation. The world's most biologically diverse tropical rainforest, its forests and soils contain the largest terrestrial carbon stocks and are home to the largest amount of freshwater in the world. They also provide other associated services, such as climate regulation, biodiversity protection, as well as contributing to food security through fisheries and other inputs from the various existing ecosystems.

Tropical grasslands, savannahs and scrublands

Tropical grasslands, savannas and scrublands are found in a smaller area, generally associated with mountains, covering 15% of the Pan-Amazonian territory. They are characterized by low levels of precipitation, with a high predominance of grasses. In the Pan-Amazon we find emblematic ecoregions such as the Cerrado in Brazil, or the Llanos in Colombia, or El Beni in Bolivia, which are characterized by high levels of endemism and diversity.

Dry tropical broadleaf forests

Tropical dry forests are characterized by a landscape with sparse trees that allows thick undergrowth. Their level of endemism is not comparable to tropical rainforests, however, they provide high biological diversity in harsh climatic environments, such as desert ecoregions, providing valuable ecosystem services. Here we locate ecoregions of high representative value such as the Chiquitano Dry Forest and the Chaco in Bolivia, and the dry forests of the Marañón in Peru.

Grasslands and montane shrublands

Here we find extensive grasslands and shrublands at high altitude, where species are adapted to climatic conditions of high humidity and intense radiation. They provide multiple ecosystem services such as water regulation, due to their presence in headwaters where multiple water sources abound. They are also a great source of endemic biodiversity, due to their difficult accessibility. The most distinctive ecoregions are the puna and páramo (wet puna) of the Andes located between Ecuador, Peru and Bolivia.

Flooded grasslands and savannas

Flood grasslands and savannas are characterized by atypical hydrological regimes due to a long flooding season, with variations in water availability, where species have adapted to this environment. Although they are not ecoregions with high endemism, they are habitats of many transient bird species, so their natural importance is significant. In the Pan Amazon we find the Pantanal ecoregion, located between Bolivia and Brazil.

Mangroves

Mangroves are subject to the ebb and flow of ocean tides and seasonal climatic fluctuations, so they are found on salty and waterlogged soils of tropical coasts, and feature salt-tolerant tree species. Mangroves are breeding habitats for a wide range of animal species, so their importance for the survival of terrestrial and aquatic species is fundamental.

Threats

In the Pan Amazon, the most affected vegetation types in terms of percent area loss due to land use change (principally to agricultural and livestock use) are the tropical and subtropical grasslands, savannas and shrublands (30.43% loss, totalling over 36 million hectares), and tropical and subtropical dry broadleaf forests (22.98% loss, totalling over 7 million hectares). However, the vegetation type with the greatest absolute extent loss is tropical moist broadleaf forests with over 69 million hectares, representing just over 11% cover of this vegetation type. The extent of loss for all vegetation types is shown in Table A3.

Table A3. Agriculture extent by vegetation type in the Pan Amazon

Vegetation Type	Extension (ha)	Agriculture extension (ha)	Percentage (%)
Tropical & Subtropical Moist Broadleaf Forests	629.101.976	69.437.625	11,04
Tropical and Subtropical Grasslands, Savannas and Shrublands	119.544.773	36.379.945	30,43
Tropical and Subtropical Dry Broadleaf Forests	32.084.728	7.374.368	22,98
Montane Grasslands and Shrublands	12.358.848	678.649	5,49
Flooded Grasslands and Savannas	5.925.239	945.754	15,96
Mangroves	1.923.118	253.121	13,16
Xeric Shrublands	50.759	544	1,07
Total	**800.989.441**	**115.070.006**	**14**

The most affected ecoregions are shown in Table A4.

Table A4. Pan-Amazonian ecoregions most affected by change in agricultural use

Ecorregion	Vegetation Type	Ecorregion extension (ha)	Agriculture extension (ha)	%
Alto Paraná Atlantic forests	Tropical & Subtropical Moist Broadleaf Forests	1.308.469	1.000.464	76%
Maranhao Babaçu forests	Tropical & Subtropical Moist Broadleaf Forests	5.982.916	3.060.849	51%
Tocantins/Pindare moist forests	Tropical & Subtropical Moist Broadleaf Forests	19.437.150	8.681.669	45%
Xingu-Tocantins-Araguaia moist forests	Tropical & Subtropical Moist Broadleaf Forests	26.830.061	9.081.997	34%
Mato Grosso seasonal forests	Tropical & Subtropical Moist Broadleaf Forests	42.185.725	14.188.029	34%
Apure-Villavicencio dry forests	Tropical and Subtropical Dry Broadleaf Forests	741.870	330.995	45%
Chiquitano dry forests	Tropical and Subtropical Dry Broadleaf Forests	19.211.490	5.914.394	31%
Cerrado	Tropical and Subtropical Grasslands, Savannas and Shrublands	95.744.834	35.695.708	37%

Among the ecoregions most affected are the Atlantic Forests of Alto Paraná, the Maranhao Babaçu Forests, the Humid Forests of Tocantins/Pindare, the Xingu-Tocantins-Araguaia Humid Forests, and the Seasonal Forests of Mato Grosso, all located in Brazil, where the loss amounts to more than 30% of their total extent, being the Atlantic Forests of Alto Paraná the most devastated with a loss of 76% of their territory.

In the case of grasslands and shrublands, the most important threat to this habitat is plowing and overgrazing by domestic livestock. For these activities, fire is the most widely used tool because of its low cost, but under poor management or excessive use it can rapidly degrade and alter the natural communities. Although fire is a part of grasslands and shrubland ecosystem dynamics, under increased habitation and climate change conditions more stringent management is required to mitigate its more deleterious impacts, as in the case of the Cerrado ecoregion in Brazil, which has already lost more than 37% of its original extent.

Dry forests are also very sensitive to fire pressure, and are also greatly being affected by agricultural land use change. Large ecoregions are being affected by these processes, such as the Chiquitano dry forest and the Apure-Villavicencio dry forest, with the latter already having lost 45% of its extent.

Appendix 4 – Brazil Bioeconomy Context

Overview of policy, regulations and norms

The Federative Republic of Brazil is the largest country in South America, with a total area of 8,514,876 km^2. The Amazon rainforest covers almost 50% of Brazil's territory (or 4,2000,000 km2). The Legal Amazon encompasses the states of Acre, Amapá, Amazonas, Pará and Roraima, as well as parts of the Rondônia (98.8%), Mato Grosso (54%), Maranhão (34%) and Tocantins (9%)[387]. The Amazon region´s governance structure and land management legal framework evolved in response to, and a driver for, Brazil´s economic and population growth.

In 1967, the Brazilian government, under president Castello Branco, signed decree 288, which created incentives and mechanisms to operate the Manaus Free Trade Zone (MFTZ), in the state of Amazonas[388]. The MFTZ was implemented to promote settlement and financial development in the remote region of the Amazon. Interestingly enough, by concentrating roughly 50% of the state's population in the capital of Manaus, anthropogenic pressure was shifted away from the rainforest, maintaining a surprising 98% of its forest cover[389]. Neighboring states, nevertheless, pursued an intensive agricultural expansion and deforestation of the rainforest.

It was during these times of economic growth and development that Brazil participated of the 1972 United Nations Convention on the Human Environment in Stockholm. The Convention recognized the need for regulations and guiding principles for all participating countries to reach a harmonious relationship between humans and nature. Brazil and other participating countries enacted 26 guiding principles aimed to inspire legislation across the globe.

Brazilian environmental legislation, first developed in 1981 with law 6938, institutes a progressive and 'holistic' National Policy of the Environment (PNMA for its acronym in Portuguese). PNMA recognizes the environment to be a set of conditions and interactions of the biological, chemical and physical order, which allow, host and rule life in all of its forms (art 3, I). The law was instrumental in developing the National System for the Environment (SISNAMA), instituted to preserve and restore environmental quality suitable for a socio-economic development that fosters human dignity at the federal, state and municipal level (Art. 2 and Art. 6). The main legal tool used by SISNAMA's executing entities is law 12.651/2012, known as the Forest Code.

The Brazilian Forest Code (BFC), is the world's most ambitious regulation for forest conservation on private property. In the Legal Amazon (Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia, Roraima and Tocantins), landholders are required to maintain 80% of their land as natural forest habitat within the Amazon forest biome and 35% within the Cerrado biome. Outside of the Legal

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387 MCTI, 2020. Fourth National Communications to the UNFCCC. Ministry of Science, Technology and Innovations, Brazil. https://unfccc.int/sites/default/files/resource/4a%20Comunicacao%20Nacional.pdf

388 Branco, H. Castello. "Das Finalidades E Localizacao Da Zona Franca De Manaus." Ed. Brazil, Governo do. Brasilia1967. Vol. 288. Print.

389 SDS, Governo do Estado do Amazonas. "Amazonas Initiative on Climate Change, Forest Conservation and Sustainable Development." Ed. (SDS), Secretariat for Environment and Sustainable Development. Manaus2007. Print.

Amazon, 20% of each property must remain as native woodland/savanna cover. This legal reserve requirement (*Reserva Legal - RL*) is complimentary with other requirements of the BFC including the mandatory conservation of native vegetation in riparian zones, steep slopes, and hilltops (*Area de Proteção Permanente - APP*)[390] [391].

The BFC is an essential piece of the tropical forest conservation agenda in Brazil because of its mandates regarding land-use options that impact the value of rural properties and over the widespread perception among Brazilian farmers that they are held to a different standard than their counterparts in the US or Europe. The Forest Code was not enforced by the government agencies for several decades (1970 – 2005), which has created a legacy of hundreds of thousands of landholders who are in violation of the law. When the government finally developed the political will, the inter-agency coordination, and the tools, both legal and technological, to implement the BFC in 2005, a new phase in the tropical forest conservation agenda began[392].

Many of the sustainability initiatives put into practice in the Brazilian Amazon feature standards or rules that include legal compliance. An important assumption behind the inclusion of legal compliance in sustainability initiatives is potentially misleading. This assumption is that legal compliance is the choice of the landholder alone. In fact, legal compliance is a reflection of a larger system that is established by public agencies. Legal compliance depends on a fair application of the regulation, with clear and decisive consequences for non-compliance. As seen in experiences around the world, the ultimate longevity and effectiveness of land-use regulations is that they work best when there is a blend of positive and negative incentives[393].

The BFC includes provisions for the eventual creation of positive incentives for legal compliance. Article 41 of the New Forest Code provides the legal framework for the establishment of systems for compensating the conservation and restoration of ecosystem services. However, it has yet to be adequately implemented. In the absence of positive incentives, we are left with command-and-control—options that limit what landholders can do with the forests on their land. Jair Schmitt has assessed compliance with the Brazilian Forest Code based on the economic theory of crime. A property owner's decision to deforest illegally is the result of two opposing considerations: economic advantage and punishment risk (deterrence value). For cattle ranching in the Brazilian Amazon, the economic advantage value was calculated to be R$3,000, while the deterrence value was R$38.54 per hectare.

The Amazonas state's suite of environmental tools aim to value the standing forest, generating jobs while promoting environmental conservation. The Environment and Sustainable Development State Secretary (SDS for its acronym in Portuguese), created in 2003 and re-structured in 2007[394], work in regions with a low human development index, and seeks to promote mechanisms that add tangible

[390] Stickler CM, Nepstad DC, Azevedo AA, McGrath DG. 2013. Defending public interests in private lands: Compliance, costs and potential environmental consequences of the Brazilian Forest Code in Mato Grosso.

[391] Soares-Filho, B.; Rajão, R.; Macedo, M.; Carneiro, A.; Costa, W.; Coe, M.; Rodrigues, H.; Alencar, A. 2014. Cracking Brazil´s forest code.

[392] Nepstad et al. 2014

[393] Cattaneo et al 2006

[394] Amazonas, Lei Delegada 66, 2007

value to standing forests, thus creating jobs and income while promoting environmental conservation in the traditional communities of the Amazonas state[395]. To this end, the Amazonas government and the SDS designed the Bolsa Floresta (Forest Grant) program to funnel financial resources to traditional communities preserving the forest[396]. This program was made effective by the enactment of two important laws in 2007; Law 3135, which institutes the state policy on climate change, environmental conservation, and sustainable development, and Complementary law 53/07, which establishes the criteria and standards for the creation, implementation, and management of State Conservation Units.

The Forest Grant mechanism works with state and private agencies to provide financial and social incentives to traditional communities living in conservation units. The framework laid out by law 3135 and complementary law 53, recognizes and rewards voluntary practice of sustainable use of natural resources, conservation, or environmental protection to traditional communities living in established conservation units[397]. The consolidation of conservation units and the management of policies affecting them are established by the Conservation Unit State Center (CEUC), an agency working under the SEUC[398]. The Amazonas Sustainable Foundation (FAS for its acronym in Portuguese) administers funds available for Payment for Ecosystem Services under four components: Income generation, Empowerment, Community Infrastructure and Entrepreneurship. Article 49 establishes that at least 50% of income obtained through concession of Conservation units is allocated to the Climate Change Fund, used to implement the Forest Grant program[399]. FAS can also receive and use donations from the state, national and private sector. Since 2018, PES program components became part of the Community Sustainable Development Program, also managed by FAS.

The ASF is a non-profit foundation developed solely to administer and support financial development of the programs and projects working under law 3134/07 and complementary law 53/07. A total of 9,427 families were benefited by the Forest Grant in September 2019[400].

Environmental protection plans at the federal and state level were created to strengthen this agenda:

- **Deforestation Prevention and Control Plan (PPCDAM).** Created in 2004 to reduce deforestation rates in the Legal Amazon and to support state-level strategies to control deforestation. A similar program for the Cerrado (PPCERRADO) was created in 2009. The 4th phase of PPCDAM was launched in 2015 during the COP21 in Paris and sets a target of reducing deforestation 80% by 2020 and achieving zero illegal deforestation by 2030.

- **National Plan for Climate Change (PNMC):** Created in 2008 to promote the rise in renewable energy, to increase use of biofuels, to reduce deforestation, to shift to low-carbon agriculture, and to expand planted forests.

[395] SDS and Amazonas, 2007

[396] Amazonas, Decreto Programa Bolsa Floresta, 2007

[397] Ibid, 2007

[398] Amazonas, Lei Complementar, Art. 6. (III), 2007

[399] Ibid, Art. 49, 2007

[400] Fundação Amazônia Sustentável. 2021. Programa Bolsa Floresta. FAS https://fas-amazonia.org/componente/programa-bolsa-floresta/

- **Program for Amazon Protected Areas (ARPA):** This program creates a target to set aside 60 million hectares of protected areas. ARPA is considered the largest program of its kind in the world and in 2015 had already reached 58.3 million hectares in 105 protected areas. See Figure A28.

Rapid expansion of agriculture and mining in the Brazilian Amazon frontier, over the past 80 years has installed a land-use change momentum difficult to halt. The Bioeconomy pathway may redirect the momentum, or at least significantly decrease dependence on extensive and impactful land use in the Brazilian Amazon.

In its 2020 report on Bioeconomy and Brazilian Industry, CNI lists the following laws as basis for the implementation of Bioeconomy[401]:

Biodiversity framework (law 13.123/2015 and Decree 8.772/2016); which creates the National Management System for Genetic patrimony and Associated Traditional Knowledge (SisGen). A digital platform that facilitates the online registry of research activities, decreasing bureaucracy.

Biosafety law (law 11.105/2005); establishes safety norms and fiscalization mechanisms on construction, cultivation, production, manipulation, transportation, transference, importing, exporting, storage, research, commercialization, consumption, dispersal and disposal of Genetically Modified Organisms (GMOs) and its derivatives.

Innovation, Science and Technology framework (law 13.243/2016); was the result of dialogue in the science and technology community to decrease the hurdles at the regulatory and operational level. Nevertheless, the business community agrees there are important regulatory framework challenges to be overcome and achieve an increase in the speed and quality of company innovation in Brazil.

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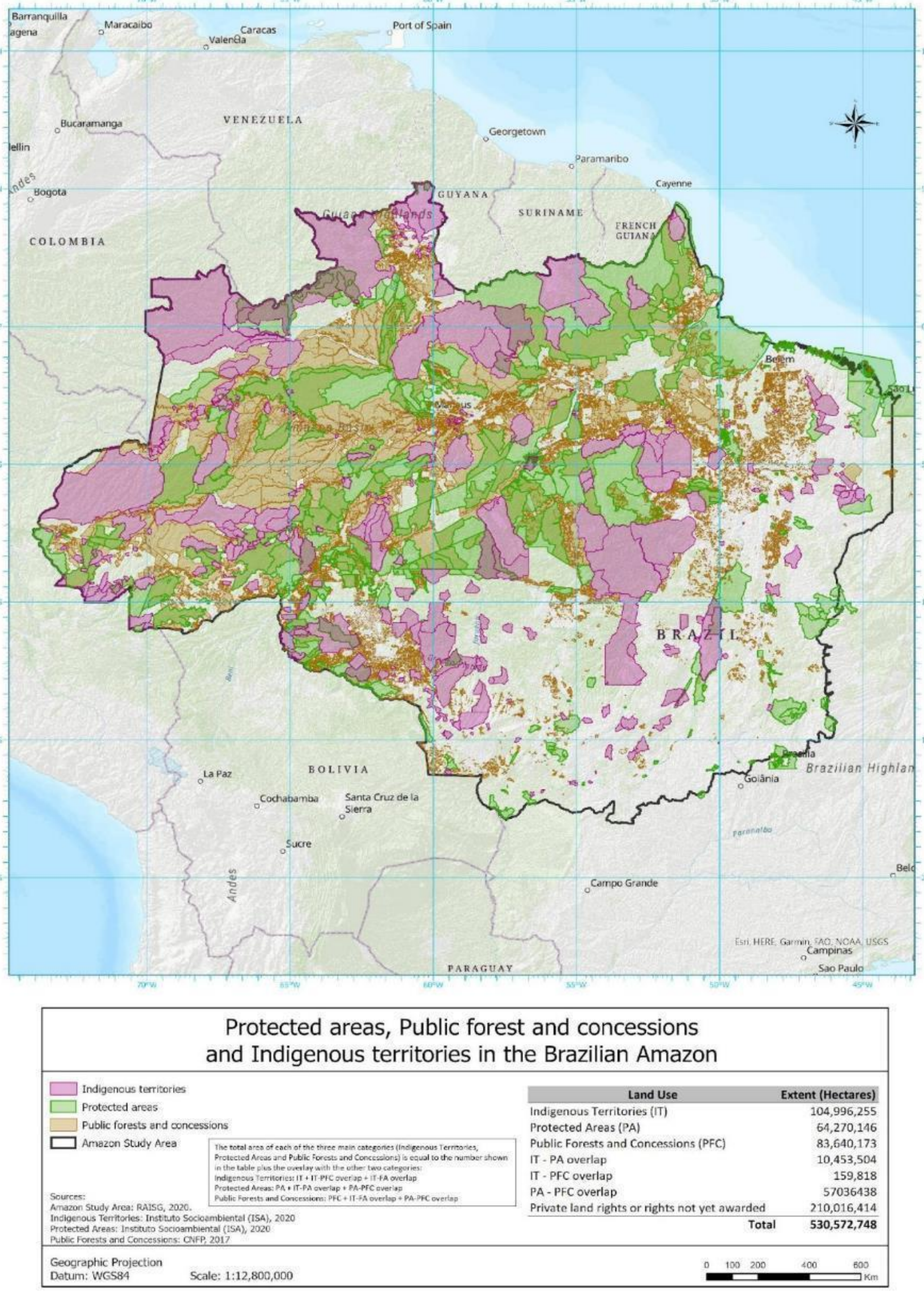
[401] Pereira, G.; Confederação Nacional da Indústria. 2020.Bioeconomia e a Indústria Brasileira. CNI - Brasília



Land Use	Extent (Hectares)
Indigenous Territories (IT)	104,996,255
Protected Areas (PA)	64,270,146
Public Forests and Concessions (PFC)	83,640,173
IT - PA overlap	10,453,504
IT - PFC overlap	159,818
PA - PFC overlap	57036438
Private land rights or rights not yet awarded	210,016,414
Total	530,572,748

Figure A28: Protected areas, public forests, and concessions and indigenous territories in the Brazilian Amazon

GDP, income and productivity

In 2020, Brazil's GDP fell -4,1% due to the COVID-19 pandemic. The worst GDP drop experienced in 24 years[402]. This fact was aggravated by the second wave, with critical death tolls and a collapse of the national health system. In relationship to 2019, subsectors reacted in different ways: Financial activity and services held a 4% accumulated growth, agriculture and cattle were at 2%, with leading produces being: soy (7,1%), coffee (24,3%) and corn (2,7%), with a decrease on orange (-10,6%), tobacco (-8,4%) and cattle production (unavailable data). Industries fell -3,5%, with negative contributions coming from construction (-7%), Energy, gas and water production and distribution (-0,4%) and transformation (-4,3%), including the automotive sectors, oil derivatives and biofuels, foods segments, chemicals and metallurgy. Transformation showed positive numbers in the food, pharmaceutical and paper industry, as well as in cleaning material. The extractive industry showed a 1,3% positive contribution, due to oil and gas extraction growth. The country registered drops in exports and imports of -1,8% and -10% respectively. Five states with greatest participation on GDP are Sao Paulo, Rio de Janeiro, Minas Gerais, Paraná and Rio Grande do Sul.

The central Bank analysts projected a return of 3,6% in 2021. Similar to 2020, agriculture and cattle maintains a 2.0% growth, whilst industry is expected to recuperate at 6,4%.[403]

Data from 2017 and 2018 from Amazonas state show significant contribution to the country's GDP. Manaus was ranked 6th in 2018, with a 20,18% contribution to Northern regional GDP and 1,12% of the national. Manaus' main activity is services (i.e. transportation, storage, commerce, information and communication). The Legal Amazon region contributed with 9% of national GDP (R$ 623 billion)[404]. The GDP distribution by sector for the legal Amazon is shown in Figure A29.

Currently, the state of Amazonas is preparing itself for a third wave of COVID-19 starting May, 2021. The state governor said their new strategy is to is to strengthen the Universal Health System (SUS for its acronym in Portuguese) by increasing the number of beds and augmenting hospital structures, mainly in the rural areas[405]. In Brazil, peak contagion occurred at the beginning of the year. Brazil holds the second largest mortality rate in the world, registering more than 355 thousand deaths due to COVID-19. Furthermore, the economy was impacted gravely as Federal Government financial emergency payment was ended, with no initiative taken up by states or municipalities.

An environmental impact of COVID-19 recovery measures done by the OECD shows that Brazil directed only 0,3% of its total US$105 billion recovery package towards environmental measures with

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402 IBGE. 2021. Contas Nacionais Trimestrais. https://agenciadenoticias.ibge.gov.br/media/com_mediaibge/arquivos/218e3ba211b420d0d5c1fd321b36bbc2.pdf

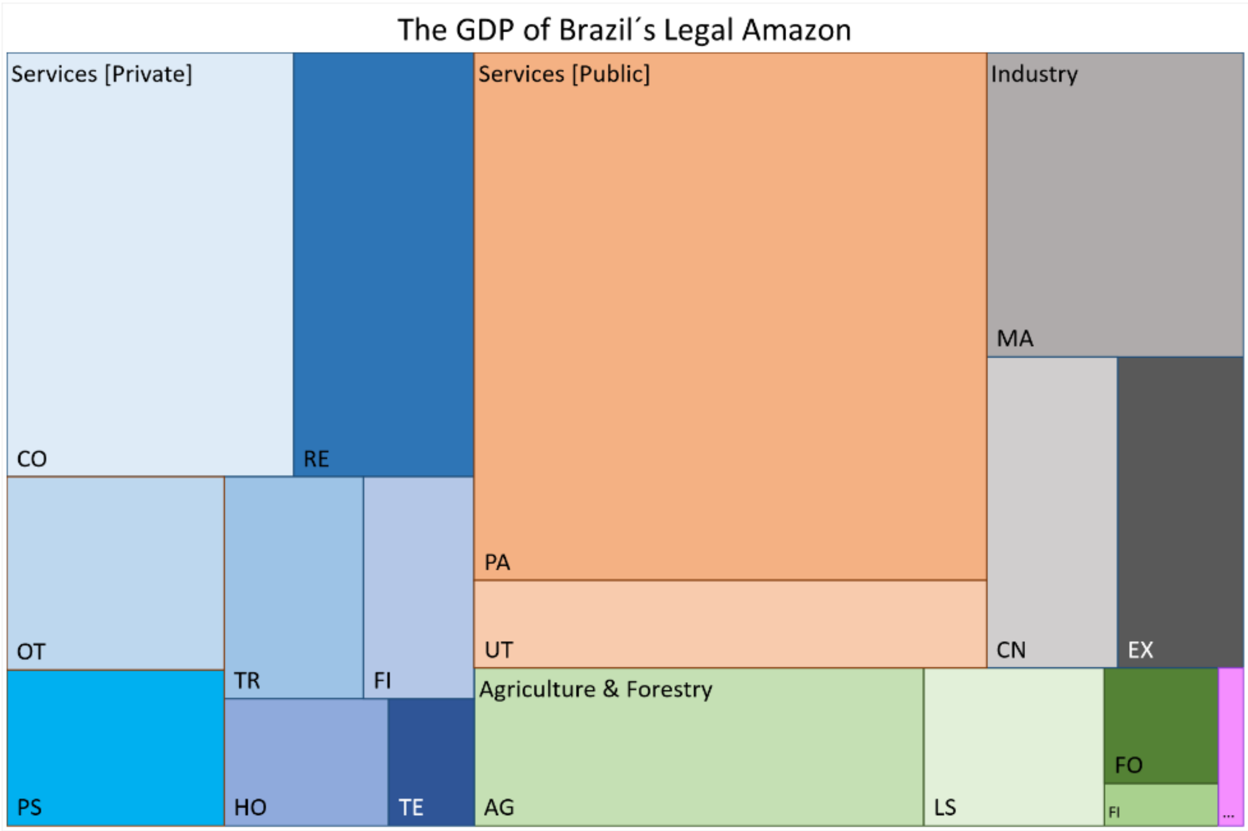
403 Mais Retorno. 2021. BC Revisa PIB do Brasil em 2021 para 3,6%. https://maisretorno.com/portal/bc-revisa-pib-do-brasil-em-2021-para-36

404 G1 AM. PIB de Manaus sobe para 6a posição entre maiores do país, aponta IBGE. https://g1.globo.com/am/amazonas/noticia/2020/12/16/pib-de-manaus-sobe-para-6a-posicao-entre-maiores-do-pais-aponta-ibge.ghtml

405 André, N.; CNN Brasil. 2021. Governo do Amazonas se prepara para terceira onda da Covid-19 em maio. https://www.cnnbrasil.com.br/nacional/2021/04/22/governo-do-amazonas-se-prepara-para-terceira-onda-da-covid-19-em-maio

clear positive effects on the environment. The OECD study concluded that almost 90% of Brazil's allocated resources will have implications on GHG emissions, mainly for energy and transportation sectors. Measures dealing with biodiversity will have less than 10% of funds[406].

Figure A29: The relative contribution of sectors and subsectors to the GDP of the Amazonian jurisdictions of Brazil



Note: Agriculture and Forestry: Agriculture (AG), Fisheries and Aquaculture (FI), Forestry (FO), Livestock (LI); Industry: Extractives (EX), Manufacturing (MA), Construction (CN); Services (Private Sector): Real Estate (RE), Commerce (CO), Transportation (TR), Hospitality (HO), Telecommunications (TE), Finance (FI), Professional Services (PS), Other services (OS); Services (Public sector): Public Administration (PA), Utilities (UT); Space Center (SP) Illicit Activities: Coca/Cocaine (CC), Artisanal Gold (Au).
Source: IBGE, Instituto Brasileiro de Geografia e Estatistica, Sistema de Contas Regionais – SCR.

Social and environmental context

Brazil has enormous natural capital and the means to transform the conservation and sustainable use of its environmental assets into opportunities, enabling the country to face a changing climate and to promote socio-economic prosperity[407]. The productive, biodiverse ecosystems across Brazil's Amazon region provides essential services for the nearly 30 million people inhabiting the region, including 350 indigenous communities.

[406] OECD. 2021. Going for growth 2021 – Brazil. https://www.oecd.org/economy/brazil-economic-snapshot/

[407] Metzger, J.P, Bustamante, J.; Ferreira, G.W.; Fernandes, F.; Librán-Embid, V.D.; Pillar, P.R.; Prist. 2019. Why Brazil needs its Legal Reserve? Perspectives in Ecology and Conservation https://doi.org/10.1016/j.pecon.2019.07.002

Early settlements of the Amazon basin began in 1930s with governmental colonization programs to ensure national sovereignty in this distant region and expand rubber production, much needed during the Second World War and beyond. The Brazilian government of 1960´s enacted policies to encourage settlement of the Amazonian states.[408] Motivated by its flourishing economy and agricultural prowess at the time, highways and roads were laid down, giving way to a migration that slowly begun covering states as far as Acre, in the far South-west of the Legal Amazon.

One such policy was the Operation Amazonia program, established in 1966. The program was managed by the Superintendent for the Development of Amazonia (SUDAM). It aimed at developing, occupying and integrating the Brazilian Amazon to national economy. This event marked the start of the agrarian reform, led by the National Institute for Colonization and Agrarian Reform (INCRA for its acronym in Portuguese) and the construction of trans-Amazonian roads, including the infamous BR-163, linking Cuiabá to the Amazon River harbor of Santarém in the state of Pará. This infrastructure-led model continued until mid-1980s, increasing the rates of deforestation, and awaking the concern of scientists who understood the perils of tipping the balance of this ecosystem. A clear example of the model´s implementation can be observed in the state of Mato Grosso.

Mato Grosso is located in the southern part of the Legal Amazon, characterized by the presence of a dynamic, global markets oriented agriculture sector and frontier pioneers. As part of their settlement trajectory of the land, farmers need to intensify their agricultural practices to ensure they can continue to develop, into what is called the intensification stage. At this stage, the agricultural area is established using intensive practices. In parallel urbanization occurs as new migrants are attracted by the agricultural development. This was the case in the early 1990s, when a new wave of farmers came from the southern regions of Brazil (Rio Grande do Sul, Santa Catarina, Paraná), where they had experience in soybean cultivation. Soybean production started in Mato Grosso at that time, and its expansion (from 1.5 million to 8.9 million hectares between 1990 and 2015) relied on favorable political and economic conditions.

At this stage, Mato Grosso became the main agricultural state in Brazil, with 28.5% of national soybean production in 2015. The increase was encouraged by federal policies, like 1994´s *Plano Real*, and the Brazilian Agricultural Research Corporation (EMBRAPA for its acronym in Portuguese), which developed new varieties adapted to tropical conditions and made the soybean expansion possible back in the 1980s. In the 2000s intensive practices such as double cropping systems (where soybean plantations are followed by corn or cotton) were implemented. In an attempt to decrease further deforestation the Sustainable Amazon Plan (PAS for its acronym in Portuguese) was adopted across the Legal Amazon between 2000 and 2003, but was only integrated by Mato Grosso in 2006.

In 2016 the soybean complex (raw soybean, soy oil and meals) represented 37.1% of all exports of the Brazilian agribusiness sector. It generated more than 28 billion US$(2015), from which 15 billion

[408] Campari, 2005

originated from exports to China. Soybean has become the top agricultural product exported by Brazil and China is its largest purchaser (MAPA 2016).

In recent decades, urbanization and the creation of new protected areas became significant, showing the dynamic nature of the agricultural frontier region. This can be observed in the following two figures.[409]

[409] Arvor, D.; Daugeard, M.; Tritsch, I.; Mello-Thery, N.A.; Thery, H,; Dubreuil. V. 2015. Combining socioeconomic development with environmental governance in the Brazilian Amazon: the Mato Grosso agricultural frontier at a tipping point.

Figure A30: Land cover in the Brazilian Amazon

Land cover in the Brazilian Amazon

Amazon Study Area

Land Cover Class	Extent (Hectares)
Forest	358,802,680
Floodplain forest and wetlands	968,299
Non forest vegetation and savanna	59,032,236
Mangrove	734,483
Agricultural mosaic	98,454,348
No vegetation	857,922
Lakes and rivers	11,722,780
Total	**530,572,748**

Sources:
Amazon Study Area: RAISG, 2020.
Land cover: RAISG, 2020

Geographic Projection
Datum: WGS84

Scale: 1 : 13 000 000

0 100 200 400 600 Km

In their 2020 report *Bioeconomy and the Brazilian Industry*, the National Industry Confederation (CNI for its acronym in Portuguese) calls for a new industrial model based on a sustainable use of the country´s biodiversity. Investing to bridge the gap between Innovation, Science and Technology (ICTs for its acronym in Portuguese) and the productive sector. The chosen definition for bioeconomy exemplifies the CNI strategy: … *economy which uses biological knowledge with commercial and industrial purposes towards the improvement of human well-being*. Also emphasized that: Bioeconomy employs new technology to originate ample diversity of products. It encompasses processing and service industries related to medicine, vaccines, industrial enzymes, new vegetal and animal varieties, bioplastics and composed materials, biofuels, bio-based chemical products, cosmetics, foods and fibers[410]. This view is also shared with the Ministry of Agriculture, Livestock and Supply (MAPA for its acronym in Portuguese) in their presentation of the Brazilian Bioeconomy – Sociobiodiversity program, instituted by Decree 121/2019.

The program has the general objective of promoting partnerships between the State, small and family farmers, traditional peoples and communities and their businesses and the business sector, aiming at the promotion and structuring of productive systems based on the sustainable use of the resources of sociobiodiversity and extraction, as well as the production and use of energy from renewable sources that allow to expand the participation of these segments in the productive and economic arrangements that involve the concept of the bioeconomy (Art; 2).

Article 3 of the decree lists the strategic action lines, with specific goals. They are summarized here: (1) promote the structuring of extractive value chains in all Brazilian biomes, with prevalence in the Amazon, thus contributing towards sustainable development, productive inclusion and income generation; (2) Promote productive links between the food and health sectors (Medicinal and aromatic herbs, spices, oils and specialty teas) as catalyzers of local development aligned with public policies to increase access to national and international markets; (3) Structure trails and productive arrangements around sociobiodiverse products and activities; (4) Promote agrobiodiversity conservation through recognition of traditional agricultural systems and fostering actions for their dynamic conservation towards their sustainable use, income generation, value addition, and genetic diversity maintenance of seeds and cultivated plants, and (5) promote the generation, and economic and productive use of renewable energy sources, specially solar. The program will be coordinated by MAPA´s Secretary of Family Agriculture and Cooperativism. The program states that its execution depends on technical and financial support from international entities, funds and development banks, research institutions, civil society entities, other ministries, federal entities and the business sector[411].

The agricultural frontier now appears to be at a tipping point and efforts are underway to establish effective environmental governance without hampering agricultural development. The spectacular 90% decline in annual deforestation since 2005 through (1) the decoupling of agricultural expansion

[410] Pereira, G; Confederação Nacional da Indústria. 2020. Bioeconomia e a Indústria Brasileira.CNI-Brasília.

[411] Ministry of Agriculture, Livestock and Supply. 2019. Decree 121, 18/06/2019. MAPA

and deforestation and (2) the adoption of new agricultural practices to reduce pressure on forests is the major achievement of this new agro-environmental governance model[412].

Deforestation under current administration increased in 34% from October 2019 to October 2020. More than 9,2 thousand km2 of forest. This is the second consecutive record deforestation rate monitored by satellite and published by the National Spatial Research Institute (INPE for its acronym in Portuguese). The first record was set between August 2018 and July 2019, with 6,8 thousand km2, or 50% more than the previous year. This came after a series of policies which dismantled the environmental legal framework. More than 99% of deforestation registered in Brazil in 2019 were illegal, either by lacking authorization or because they occurred in a prohibited area, such a protected area or indigenous peoples territories. In order of highest to lowest rates of deforestation by state are: Pará, Mato Grosso, Rondônia, Amazonas, Acre, Roraima and Tocantins[413]. Deforestation patterns over the past decades can be observed in Figure A31. Nevertheless, there is a silver lining on the horizon.

Deforestation rates in the state of Mato Grosso declined by 33,8% between August 2020 and February 2021. This occurred on year after the state launched a multi-agency, statewide strategy with partial funding from Germany and the UK through a *results-based* climate finance contract. The Earth Innovation Institute is providing technical support to Mato Grosso´s government on climate and conservation related issues, including REDD+ program full implementation at a state level, developing a *climate neutral soy* product, and increasing the efficiency of its environmental licensing process[414].

In a meeting between 40 global leaders, called *Leaders summit on climate,* held online on April 22 and 23, 2021, President Jair Bolsonaro committed to reach GHG emissions zero neutrality by 2050. Ten years earlier than agreed in the Paris accord. One of the measures is to eliminate illegal deforestation by 2030. Furthermore, when speaking of the country´s natural resource and the need to promote sustainable development in the Amazon region, he stated the need to improve land governance and make bioeconomy a reality *effectively valuing forest and biodiversity. This must be an effort that upholds the interests of all Brazilians, including indigenous and traditional peoples*[415].

[412] Arvor, D.; Daugeard, M.; Tritsch, I.; Mello-Thery, N.A.; Thery, H,; Dubreuil. V. 2015. Combining socioeconomic development with environmental governance in the Brazilian Amazon: the Mato Grosso agricultural frontier at a tipping point.

[413] Escobar, H. 2021. Desmatamento da Amazônia dispara de novo em 2020. Jornal da USP. https://jornal.usp.br/ciencias/desmatamento-da-amazonia-dispara-de-novo-em-2020/

[414] Earth Innovation Institute.2021. Amazon deforestation declines by one third in Mato Grosso State. EII Newsroom. https://earthinnovation.org/2021/03/amazon-deforestation-declines-by-one-third-in-mato-grosso-state/

[415] Verdélio, A. 2021. Bolsonaro promete fim das emissões de gases de efeito estufa até 2050. Agência Brasil. https://agenciabrasil.ebc.com.br/geral/noticia/2021-04/bolsonaro-promete-fim-das-emissoes-de-gases-de-efeito-estufa-ate-2050

Figure A31: Deforestation in the Brazilian Amazon

Deforestation period	Total year	Deforestation period	Total year
2001	3,140,748	2010	1,366,955
2002	3,689,173	2011	1,427,349
2003	4,551,610	2012	1,429,701
2004	4,104,083	2013	1,599,548
2005	3,455,560	2014	1,632,037
2006	2,766,832	2015	1,661,936
2007	2,177,577	2016	2,031,773
2008	2,057,845	2017	2,216,044
2009	1,523,137	2018	2,538,987
	Total	43,389,021	

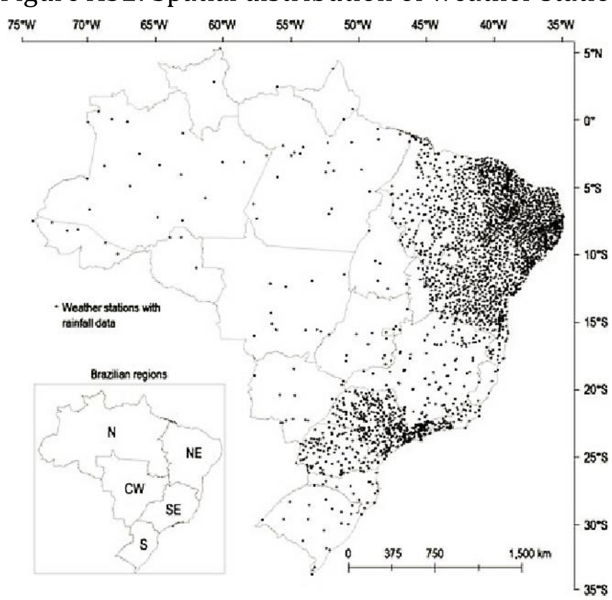
Climate profile

Data and knowledge gaps

This report provides information at the national level and, where possible, it tries to focus on the Amazon region –the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[416] Much of the accessible climatological data for Brazil is developed and compiled by the Ministry of Science and Technology, supplemented by data from weather and hydrometeorological stations, and agencies such as the Brazilian Institute of Geography and Statistics (IBGE) and the National Water Agency (ANA). Detailed information on climate variables, trends and projections is compiled based on the updated Fourth National Communications (FNC; latest version from 2020), the 2016 National Adaptation Plan (NAP) and the Nationally Determined Contributions (NDC) from 2020.

Nonetheless, it is important to note that information on climate risk and vulnerability varies per region in Brazil and additional research on these topics is needed. The quality of available historical and projected climate and hydrology data sets is compromised by the lack of data systemization and limited spatial data coverage and differentiation. In particular, climate risk and vulnerability studies are limited in Brazil's Amazon region, as these studies rightfully take a landscape approach rather than focusing on administrative boundaries and, otherwise, focus on more populated regions to the east and south. The distribution of weather stations across the country reflects this geographic unbalance; comparatively less data collection and processing sources are located within the Northern Amazon region, likely also due to issues of inaccessibility around the denser forest areas (see following Figure).

Figure A32: Spatial distribution of weather stations across Brazil



Source: Alvares et al. 2014, p. 714

[416] see list of references

The data is also limited given the vast territory, inadequate financial resources to undertake updated, site-specific visits and studies and engage domestic experts, limited capacity for training and disseminating information, and the lack of a participatory and integrated climate risk and vulnerability monitoring system.[417]

As such, it is important that the following report builds on existing information, and should be carefully interpreted considering the aforementioned data and knowledge gaps. It is recommended the program not only promotes activities with adaptation benefits, but also explores synergies to strengthen adaptation monitoring and reporting in the Amazon.

Overall climatology

Brazil's climate varies from equatorial in the north to temperate in the south. The country is divided into five macro-regions: North, Northeast, Central West, Southeast, and Southern regions. The Amazon territory covers fully or partially the first three regions.

The El Niño and La Niña phenomena are significant sources of inter-annual variability across the country, which determine both rainfall and temperature patterns. The El Niño phenomenon in the Pacific East results in precipitation deficits in large areas of the Amazon region during all seasons, especially between December and February.[418] The seasonal cycle of rain in Brazil is particularly affected by the interannual variations, which interact to cause unexpected impacts such as droughts during the rainy season, or at times, an overabundant rainy season. The presence of vast equatorial rainforest territory itself contributes to a variety of climates across the country and wider region; the Amazon is responsible for generating as much as 50% of its own rainfall. [419]

Temperature

Mean annual temperatures in the Amazon region range from 24°C to 26°C.[420] During dry season, average temperature is 27.9°C, and during the wet season, 25.8°C. Regarding average annual temperature distribution in Brazil, the highest temperatures are registered in the North and Northeast (Amazon) regions, reaching on average over 28°C (see Figure below). In these territories (including the state of Mato Grosso), temperatures can even range between 26°C to 30°C. In comparison, other parts of the country see averages between 22-26°C (Southeast region), and 14-20°C ranges in most of southern Brazil.[421] In comparison, outside of the Amazon, the northeast region of Brazil is semi-arid, and can get much hotter during the dry season, and the southeast is mostly humid and subtropical.

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[417] MCIT 2020

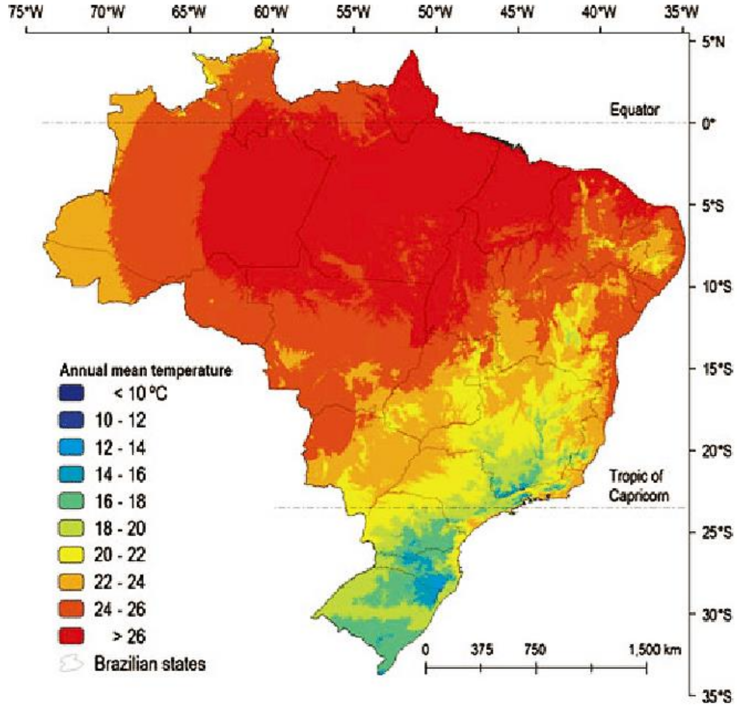
[418] Prüssman et al. 2016

[419] USAID 2018

[420] MCTI, 2020

[421] MCTI, 2020

Figure A33: Brazil annual mean temperature



Source: Alvares et al. 2014, p. 715

Precipitation

Rainfall levels in the Amazon region vary spatially and temporally. Precipitation over the southern Amazon and the southern and mid-western regions of Brazil have a well-defined annual cycle, i.e., two distinct phases of humid and dry. In the northern Amazon sector, rainy equatorial weather is noted with almost no dry season. Total annual rainfall exceeds 3,000mm in these regions, e.g., at the mouth of the Amazon River (Para), Amapá and Amazonas. Drier conditions are found along the northwestern Amazon region to the west/southeast corridors (from the state of Roraima to the eastern part of the state of Pará), with total annual rainfall varying between 1,500mm and 1,700mm.[422] On the other hand, some parts in southern and western Amazon state may face up to 5-month periods with less than 100 mm rainfall (see Figure below).[423]

The northeast part of the country -at the margin of the Amazon region, displays an erratic rainy season from March to May, with annual precipitation between 500mm to 1,300mm. The central-western region (including parts of the Amazon) records short amounts of rainfall during the dry season, with most of the average annual precipitation occurring in the rainy season.[424]

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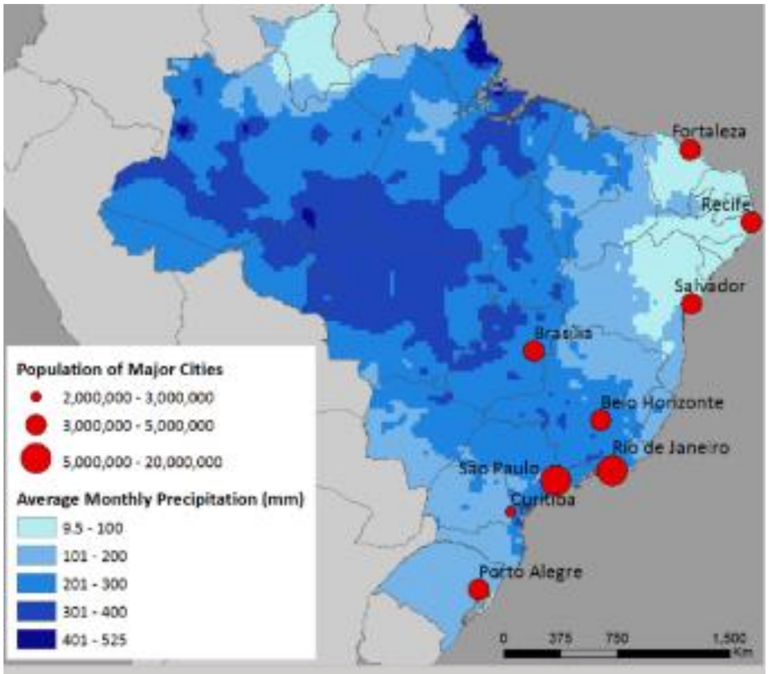
422 USAID 2018

423 MCTI 2020

424 USAID 2018

Figure A34: Monthly precipitation in Brazil



Source: USAID 2018

<u>Climate-related natural hazards</u>

The major climate-related natural hazards in Brazil are summarized in the table below. Climate-related factors paired with the country's topography and vast river delta territory, categorizes river flooding as 'high' risk across the entire country, especially in the Amazon region. The entire region also faces a high risk from wildfires. All states with a coastline, including three Amazon states, face a high risk of costal flooding. Extreme heat is a medium risk across all Amazon states.

Table A10: Climate-related natural hazards across Brazil, per Amazon region

	River flood	Coastal flood	Landslide	Extreme heat	Wildfire	Water scarcity	Cyclone
National							
Brazil	High	High	High	High	High	Medium	Very low
Amazon region							
Acre	High	N.A.	Low	Medium	High	Very low	N.A.
Amapá	High	High	Low	Medium	High	Very low	Very low
Amazonas	High	N.A.	Low	Medium	High	Very low	Very low
Pará	High	High	Low	Medium	High	Very low	Very low
Roraima	High	N.A.	Low	Medium	High	Very low	Very low
Rondônia	High	N.A.	Medium	Medium	High	Very low	N.A.
Mato Grosso	High	N.A.	Medium	Medium	High	Very low	N.A.
Maranhão	High	High	Low	Medium	High	Very low	Very low
Tocantins	High	N.A.	Medium	Medium	High	Low	Very low

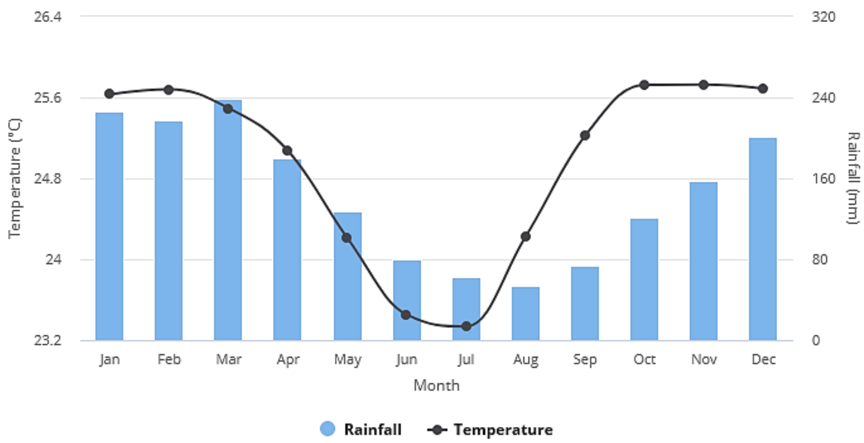
Source: GFDRRR No Date, https://thinkhazard.org

Observed trends of climatic variables

<u>Temperature</u>

Between 1901 and 2016, Brazil registered an average minimum temperature of 23.4° C and a maximum of 25.8°C (see Figure below). Simultaneously, the country recorded a minimum precipitation volume of 60mm and a maximum value of 240mm. the above-mentioned climatological recordings were significantly lower than the average temperatures and rainfall found in the Amazon regions[425].

Figure A35: Average monthly rainfall and temperature in Brazil (1901-2016)



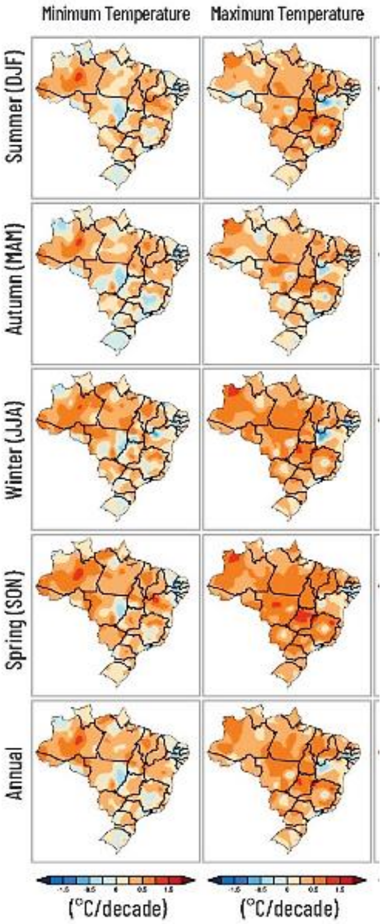
Source: World Bank Climate Change Portal

Temperature in Brazil's Amazon region increased by roughly 0.5°C since 1980 until 2018 (see Figure below), with the greatest increase registered during dry season. Over the same time period, the number of cold nights increased overall across the country, but decreased in the non-Amazon states of Santa Catarina and Paraná. Meanwhile, the number of warm days during the dry season moderately increased, and a significant increase in the number of warm days in the winter period was recorded[426].

[425] World Bank Climate Portal n.d.

[426] USAID 2018

Figure A36: Trends in minimum and maximum temperature, 1980-2018



Source: MCIT 2020

Precipitation

The tropical wet region of the Brazilian Amazon experienced roughly a 5% increase in rainfall over the past 30 years[427]. From 1981 to 2010, annual rainfall in Brazil varied from approximately 400mm to 3,450mm, with average occurrence above 3,000mm in the state of Amazonas, and below 850mm in the semiarid northern part of the state of Bahia. In comparison, in Central Brazil, outside the Amazon region, recorded a mean annual rainfall varied between 1,050mm and 1,800mm[428].

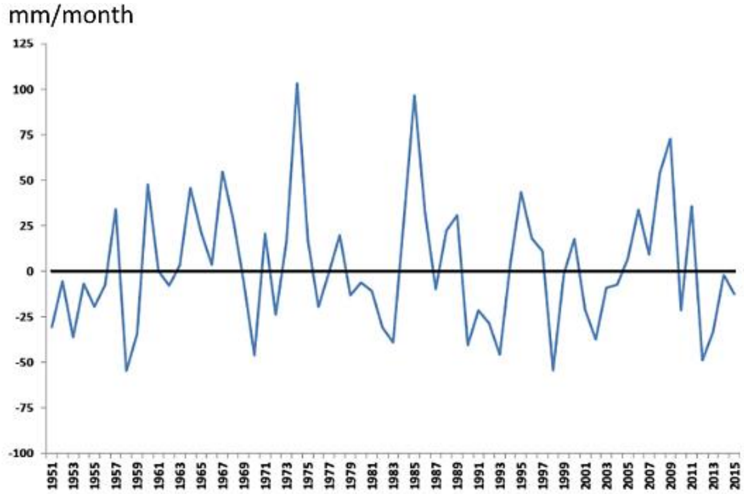
Rainfall anomalies and variability have been recorded continually over the past decades (see Figure below). In 1958, rainfall deficits and drought caused an estimated 10 million people to relocate from Northeast Brazil (Amazon region). In 1979–1981, rainfall anomalies resulted in over 70% reduction in production of rice, beans, and cotton, resulting in commodity price increases by 100%. Rainfall deficits between 1982–1983 resulted in an 80% decrease in livestock; whilst, during 1997–1998, 57% of the total agricultural production of the region was lost and resulted in economic damaged totaling 5% of the region's GDP[429].

[427] USAID 2018

[428] MCIT 2020

[429] Marengo et al. 2017

Figure A37: Rainfall anomaly (mm/month) during peak rainy season in Northeast Brazil



Source: Marengo et al. 2017

Climate-related natural hazards

The Brazilian Amazon region has seen three significant droughts in the past two decades, during the years 2005, 2010 and 2015/16. These episodes have been often associated with the El Nino-Southern Oscillation (ENSO). Floods have also been a reoccurring phenomenon in the region. The most recent flooding event with high adverse consequences occurred in 2015, which affected the municipalities of Brasileia and Epitãciolandia in Brazil, which resulted in significant shore erosion and damage.

In 2012, Brazil experienced its worst flood on record, and much of the Brazilian Amazon declared a state of emergency. Severe damage and disruptions to key infrastructure were reported, including flooded highways, roads and bridges, Numerous local small businesses and tourism attractions were also impacted.

Large forest fires are also a recurrent feature across the Brazilian Amazon. These events are conditioned by large-scale climate variability and sometimes influenced by El Niño events. Current fire patterns (changes in frequency, intensity and location) are rather different from historic patterns dating back to the 1970s, as anthropogenic interferences play major role. In the past, the opening up of road networks directly drove changes in forest fires, through an increase in agriculture and associated slash and burn practices. Additionally, fires with the greatest magnitude recorded during 2000-2014 (occurring during dry months in August and September) had the strongest and most wide-reaching effects across the Brazilian Amazon, south of the Pará region and north of Mato Grosso[430].

Climate change projections

The climate change projection data shown below uses the CMIP5 ensemble models from the World Bank Climate Change Knowledge Portal, and the Eta regional model and the HadGEM-3A model from Brazil's 4th National Communication to the UNFCCC. It is important to mention that CMIP5 model uses

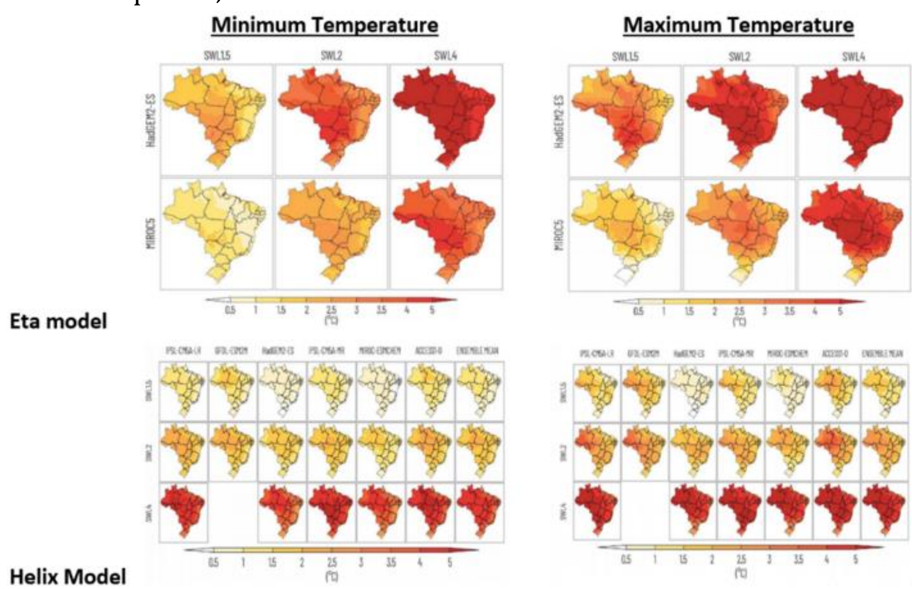
430 Prüssman et al. 2016

a reference period between 1986-2005[431], while Eta regional model uses the reference period 1981-2010, and Helix (HadGEM3-A) model uses the reference period 1961-1990[432].
Brazil's 4th National Communication (4NC) has adopted a Specific Warming Level approach (SWL) to be in compliance to the Paris Agreement and the IPCC report. As such, the country's 4NC considers three future scenarios where global average warming of 1.5°C, 2°C, and 4°C are reached; these three scenarios represent SWL1.5, SWL2, and SWL4. The projected periods differ for each scenario (SWL) based on the timeframe where the different modeled temperatures (1.5°C, 2°C, and 4°C) were reached. Additionally, the climatic projections modeled in the national communication are presented with 'model-specific projected periods', which are not aligned with more common projected periods (e.g., 2020-2040, 2040-2060, 2060-2080, and 2080-2100.)[433]

Temperature

According with climate projections of Eta regional model and Helix model presented in Brazil's 4NC, it is expected that the minimum and maximum annual temperature will reach and surpass the temperature thresholds of 1.5°C, 2°C, and 4°C (climate scenarios SWL1.5, SWL2, and SWL4) in all regions of Brazil, at some point before the end of the century[20] (see Figure below).

Figure A38: Change in annual minimum and maximum annual temperature (°C) in relation to the reference period, Eta model 1961-1990 and Helix model 1981-2020.



Source: MCTI 2020, p. 199, 202

According with CMIP5 ensemble models (World Bank, n.d.), temperature in Brazil is likely to increase compared to the baseline period 1986-2005; particularly under RCP4.5. The same scenario projections indicate that mean annual temperature will increase by 0.96°C in 2020-2039, 1.45°C in 2040-2059, 1.83°C in 2060-2079, and 2.01°C for the period 2080-2099 (see Figure below). Moreover, it is

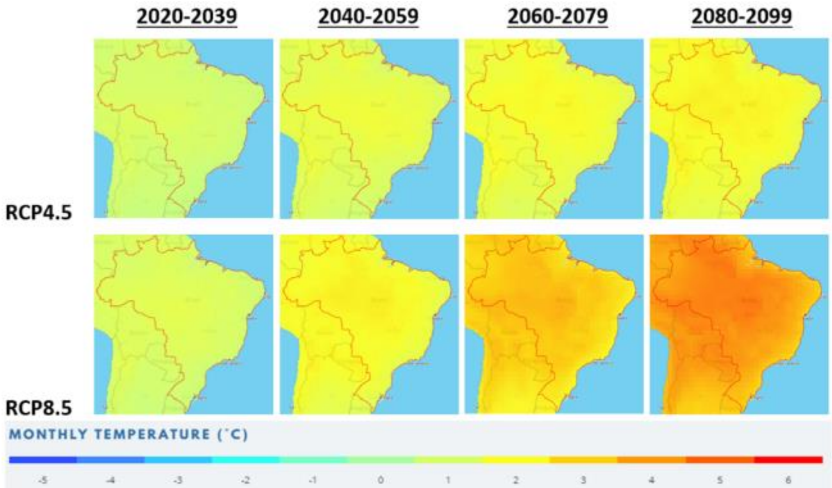
431 World Bank Climate Change Portal n.d.

432 MCTI 2020, p. 197-198, 201

433 For the projected time periods, please refer to Brazil's 4NC, p. 197-198

projected that the monthly maximum temperature variations will display a peak around August for the period 2020-2039, and a peak around November for the other three periods.

Figure A39: Change in monthly temperature of Brazil based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005



Source: World Bank Climate Portal n.d.

It is expected that the Brazilian Amazon region will experience an increase in temperature between 1.7°C and 5.3°C by 2085.[434]

The following table contains a summary of projected changes of temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005 (using data from World Bank, n.d.). Under RCP4.5, the number of days that could reach temperatures higher than 40°C - relative to the reference period (1986-2005), could be 4, 8, 13, and 15, for the modeled periods of 2020-2039, 2040-2059, 2060-2079, and 2080-2099 respectively. In contrast, under RCP8.5, the projected number of days with a temperature above 35°C, for the same projected periods as before, could be 6, 15, 31, and 55 days.

[434] USAID 2018

Table A11: Projected changes of temperature-related climate variables in Brazil (at the national level), compared to 1986-2005

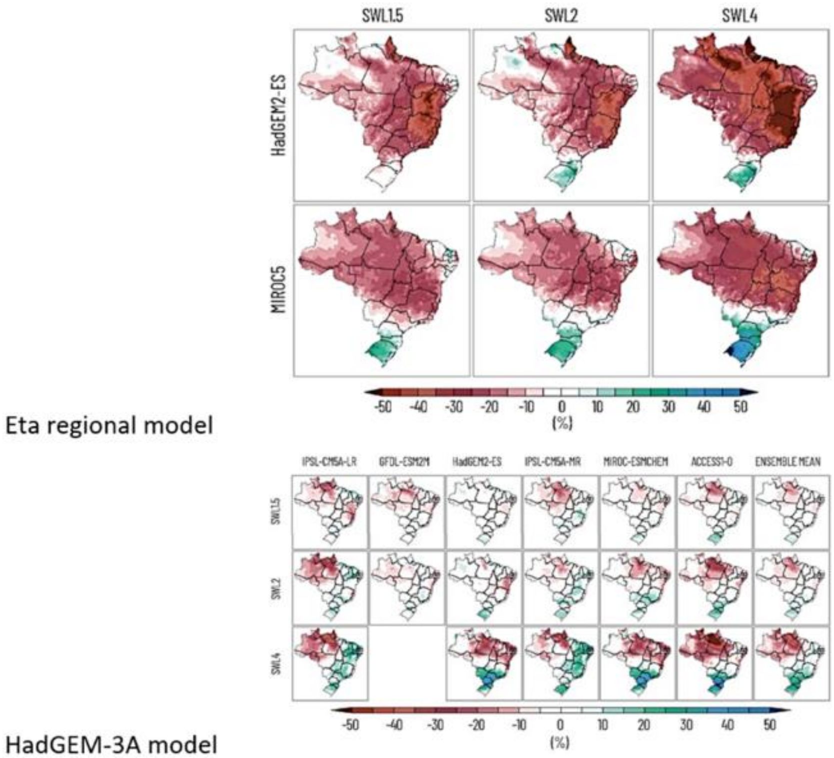
Variable	***RCP 2.6***				***RCP 4.5***				***RCP 8.5***			
	2020-39	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***
Maximum daily temperature (°C)	1.42	1.72	1.80	1.72	1.29	2.05	2.60	2.86	1.53	2.77	4.31	5.97
Minimum daily temperature (°C)	1.01	1.26	1.23	1.30	1.13	1.66	2.13	2.23	1.20	2.10	3.33	4.50
Hot days (above 35ºC)	24.54	32.32	33.23	32.99	24.57	38.33	52.72	58.67	28.43	55.78	97.17	145.79
Hot days (above 40ºC)	5.02	7.05	7.80	7.38	4.63	8.95	13.55	15.39	6.03	15.89	31.82	55.72

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

According with Eta regional model and Helix model projections presented in Brazil's 4NC (MCTI 2020), it is expected that annual precipitation will decrease in most areas of Brazil (central and north regions), with a special attention to the states of Minas Gerais and Bahia. In contrast, the south region of the country will experience an increase of 20% to 40% in precipitation in comparison with the period 1961-1990 (see Figure below).

Figure A40: Change in annual precipitation (%) in relation to the reference period, Eta model 1961-1990 and HadGEM3-A model 1981-2020.

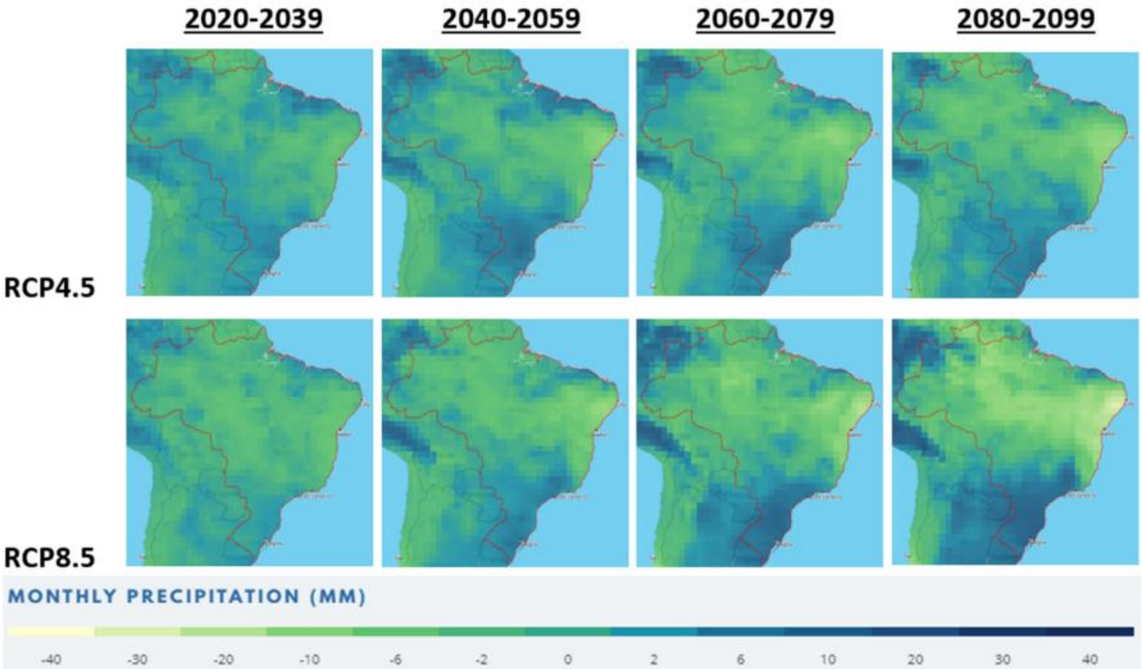


Source: MCTI 2020, p. 198, 201

Based on a climate change model ensemble (see Figure below),[435] projections of change of annual rainfall based on RCP4.5 display a slight decrease of (-)0.11mm for the period 2020-2039, while for the periods 2040-2059, 2060-2079, and 2080-2099 changes in annual precipitation are 0.07mm, -0.90mm, and -1.00mm, respectively. According with RCP4.5 and RCP8.5, the north and central regions of Brazil will expect a slight negative change in precipitation compared with the reference period 1986-2005; in contrast, the southern region of Brazil -including the states of Mato Grosso do Sul, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul, will experience a positive change on the monthly precipitation compared to the period 1986-2005.

[435] WB n.d.

Figure A41: Change in monthly temperature of Brazil based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005

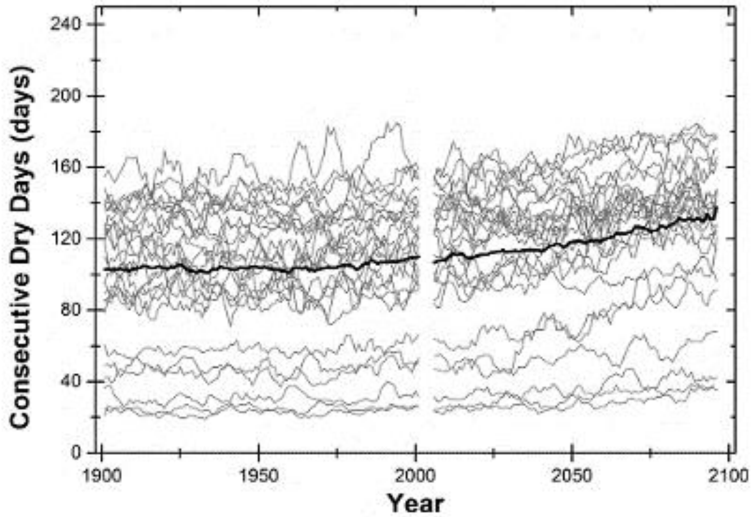


Source: World Bank Climate Portal n.d.

While precipitation anomalies show the erratic nature of rainfall patterns over time, the following Figure displays a definitive upward projected trend in the number of consecutive dry days reported in the northeast region, according with RCP8.5, with the highest projected increase to be expected between 2071-2100[436].

[436] Marengo et al. 2017

Figure A42: Consecutive dry days, 1901-2100



Source: Marengo et al. 2017

Rainfall volume is predicted to decrease in the Brazilian Amazon Region. Simultaneously, a tendency for intense rainfall episodes between dry and warm periods (which will be more prolonged in nature) are expected. The dry season across the Amazon region will likely become longer, due to expected decreased precipitation. The tropical wet region is projected to have a significant increase in dry spells, from a decrease of 5 dry days to an increase of 19 days, depending on the model[437]. The following Figure shows regionalized precipitation projections with minimum and maximum thresholds (RCPs 4.5 and 8.5).[438] During summer, the centres of maximum rainfall reduction are positioned over Brazil's central-west and southeast regions, in areas under the influence of the South Atlantic Convergence Zone (SACZ) phenomenon, which causes accumulation of rainfall.[439] The centres of maximum rainfall reduction extend into parts of the Amazon region. In the north-eastern area, projections suggest a possible reduction or increase in rainfall during the summer.[440] These simulations also foresee increased rainfall in the Southern region under the various scenarios. Increases in rainfall are foreseen for 2011-2040, becoming more intense toward the end of the century.

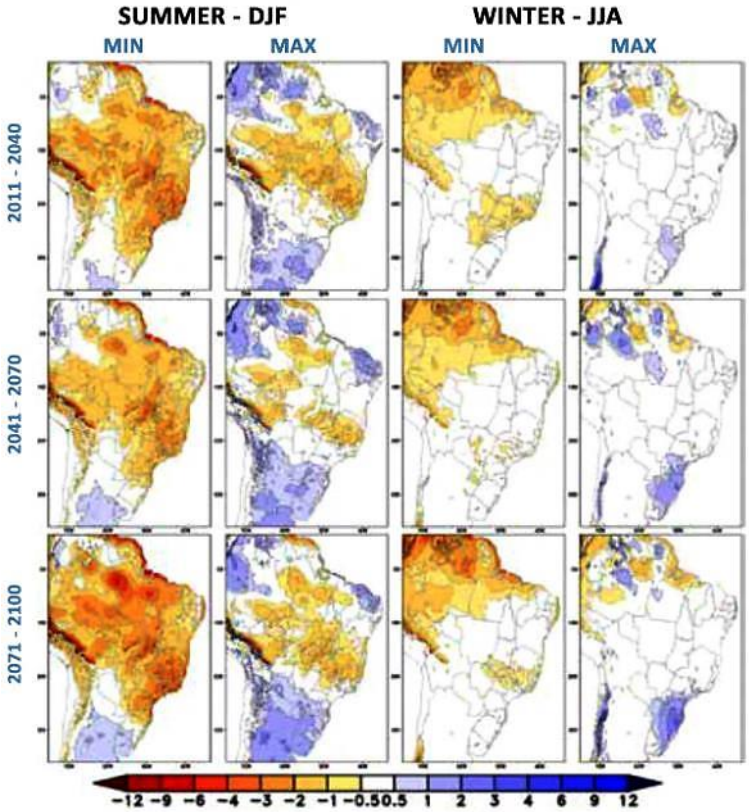
[437] USAID 2018

[438] Ministry of Environment 2016

[439] Ministry of Environment 2016

[440] Ministry of Environment 2016

Figure A43: Precipitation projections (mm/day) for the Brazilian Amazon Region compared with the period 1961-2005



Source: Ministry of Environment 2016, p. 15

The following table contains a summary of projected changes of precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.[441] Under RCP8.5, climate change models forecast a change towards strongly marked year to year variability between wettest and driest years because the projected values for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099 are positive and increase on 24.16mm, 21.39mm, 65.99mm, and 84.94mm, respectively.

Table A12: Projected changes of precipitation-related climate variables in Brazil (at the national level), compared to 1986-2005

Variable	RCP 2.6				RCP 4.5				RCP 8.5			
	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99
Days with rainfall >20mm	-0.31	-0.33	-0.38	-0.50	-0.24	-0.05	0.25	0.23	0.47	1.24	1.69	2.06
Rainfall of very wet days (%)	-10.81	-12.25	-13.60	-13.59	-2.69	-0.48	-0.46	-0.62	1.37	5.94	8.93	12.68

441 World Bank, n.d.

Maximum daily rainfall (10 year RL) (mm)	1.94	3.36	3.06	2.84	2.10	3.67	6.04	6.04	4.15	7.82	11.21	16.43
Maximum daily rainfall (25 year RL) (mm)	3.05	5.14	4.93	4.42	3.18	5.38	8.46	8.42	5.50	10.29	14.83	21.66
Projected change in annual rainfall (mm)	-14.55	-7.92	0.11	-10.81	-21.94	-16.88	-9.37	-12.48	24.16	21.39	65.99	84.94
Severe drought likelihood	0.08	0.09	0.11	0.11	0.08	0.11	0.15	0.17	0.10	0.15	0.23	0.36
Probability of heat wave	0.06	0.08	0.08	0.08	0.07	0.12	0.17	0.19	0.08	0.18	0.33	0.49

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Climate-related natural hazards

Even though drought and floods are part of the wider Amazon region's natural variability (i.e., they have occurred in the past and will continue to occur in the future), they have displayed an unprecedented intensity during the last decade. This indicates that, in spite of the high levels of overall uncertainty about climate information, it can be said with a good degree of confidence that floods and droughts will continue to increase in the future, with higher frequency and magnitude[442].

This is partly due to ENSO events which are predicted to become stronger and more frequent in the future. As a result, an increase in the length of dry periods is expected, resulting in increased drought incidences across Brazil's Amazon region. This will occur hand in hand with an increase in the duration of heat waves across much of the Amazon territory from 18 to 214 days by the year 2085[443].

Increasing sea levels will additionally cause inundation and a 0.2 to 2m sea level rise by 2100 along Brazil's coast. While this does not always directly impact the Amazon region, it can result in increasing migration inland and, ultimately, put pressure on land resources, as well as cause potential land use competition and conflicts in this region. In addition, sea level rise will impact the Amazon river delta, likely leading to more frequent and damaging flood incidences.

Another effect of increasing intensity of ENSO events is the associated rise in wildfires. It is projected that forest fire events and the Oceanic El Nino Index interactions could reach its highest across the Southern frontier of Brazil's Amazon region (see Figure below). This information can be extrapolated to predict with some confidence a future increase in density of wildfires across this region[444].

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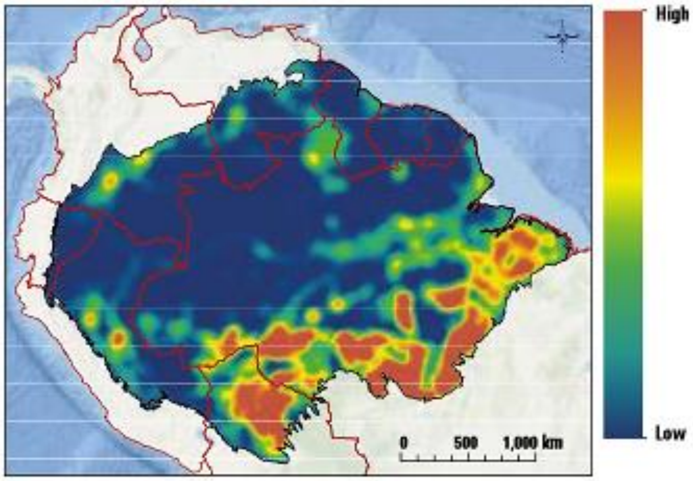
[442] Prüssman et al. 2016

[443] USAID 2018

[444] Prüssman et al. 2016

Figure A44: Correlation between forest fires and ONI between 2001-2015



Source: Prüssman et al. 2016

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:
In terms of sensitivity, there are various biophysical considerations:

- **Flooding:** The susceptibility of slopes and soils against flooding is predominantly very high throughout Brazil's Amazon region (see Figures below)[445]. In terms of hydrological endowment, the region has high diversity ranging from very low to high susceptibility to floods (see Figure below)[29]
- **Droughts:** Brazil's Amazon region is susceptible to droughts when considering its hydrological endowment, with mostly moderate to very high susceptibility, especially in the Eastern and Southern region (see Figure below)[29]

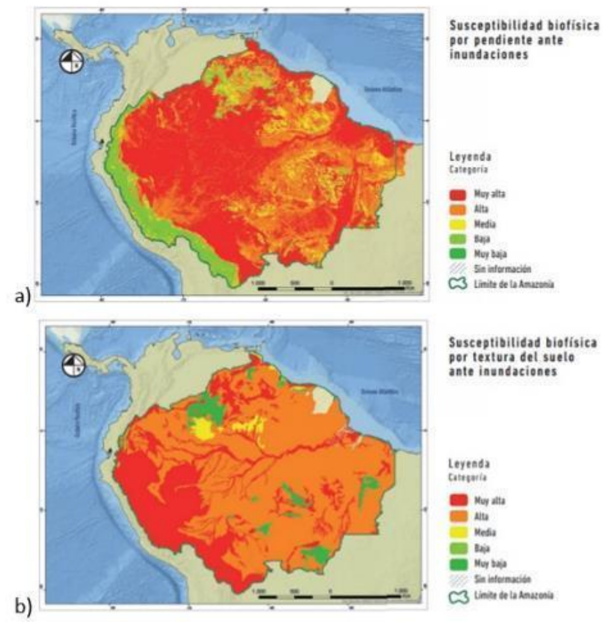
Brazil´s Fourth National Communication to the UNFCCC further highlights that the Amazon forest is sensitive to climate change due to sensitivity to temperature and precipitation changes[446], which is exacerbated by forced land use conversion[447]. The common use of fire further increases the susceptibility of the Amazon rainforest to climate change impacts, such as wildfires.

[445] Pabón-Caicedo et al. 2018

[446] Cox et al. 2004 and Nobre et al. 2016 in MCTI 2020

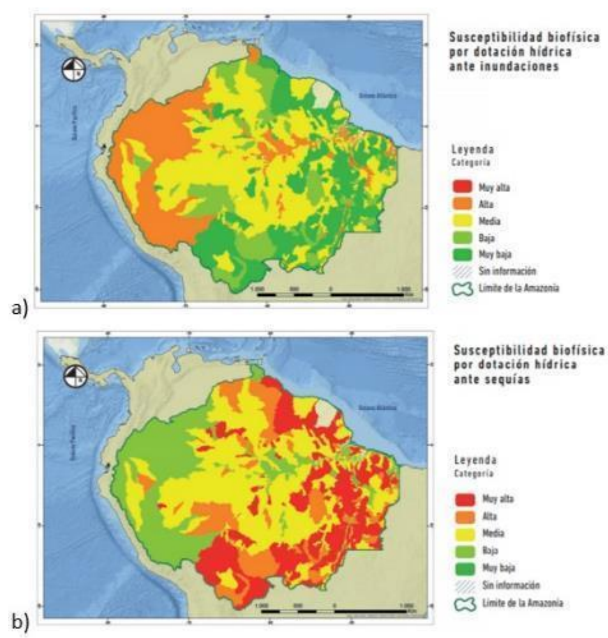
[447] Davidson et al. 2012, Hoegh-Guldberg et al. 2018, and Marengo et .al 2018 in MCTI 2020

Figure A45: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin



Source: Pabón-Caicedo et al. 2018, p. 42

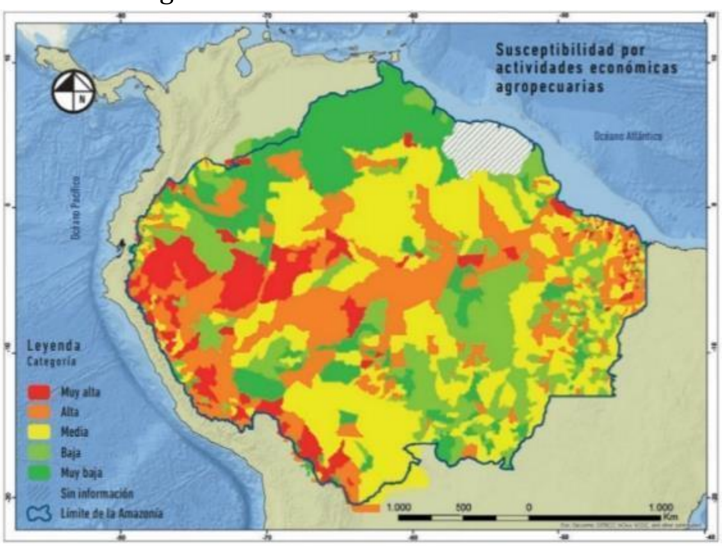
Figure A46: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin



Source: Pabón-Caicedo et al. 2018, p. 42

In terms of regional vulnerability, the Fourth National Communication to the UNFCCC states that "*large urban centers in the Amazon are highly vulnerable to the impacts of drought and flood events due* *to the high population density and poverty rate*"[448]. This is due to various factors, including: their comparatively remote location with limited access to other large urban centers, poverty, deficiencies in infrastructure, insufficient access to drinking water and waste collection, among others[449]. Brazil's National Adaptation Plan (2016) highlights the particular sensitivity and vulnerability of the agricultural sector. It further states that it is "*essential that adaptive capacity of the sector be reinforced, thereby enabling the productive sector to make better decisions for structuring production systems, making them sufficiently resilient to the effects of climate uncertainties*."[450]. Strengthening adaptive capacity through promoting suitable instruments, technologies and processes is highlighted within the country's adaptation program for the sector (Ministry of Environment 2016). In terms of dependence on agricultural activities, Brazils Amazon region ranks from low to very high susceptibility (see Figure A47)[451].

Figure A47: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector



Source: Pabón-Caicedo et al. 2018, p. 41

Climate risks and impacts on the bioeconomy and local livelihoods

Climate Risk Brazil

Brazil experiences a high level of climate risk. According with GermanWatch's Climate Risk Index, Brazil was ranked 27th overall in the world in 2019. However, in terms of climate-linked fatalities and losses, it was ranked 5th and 17th respectively. The scoring takes into account the extent to which Brazil is affected by climate related extreme weather events and its impacts. This ranking has

[448] Pinho et al., 2014 in MCTI 2020, p. 261

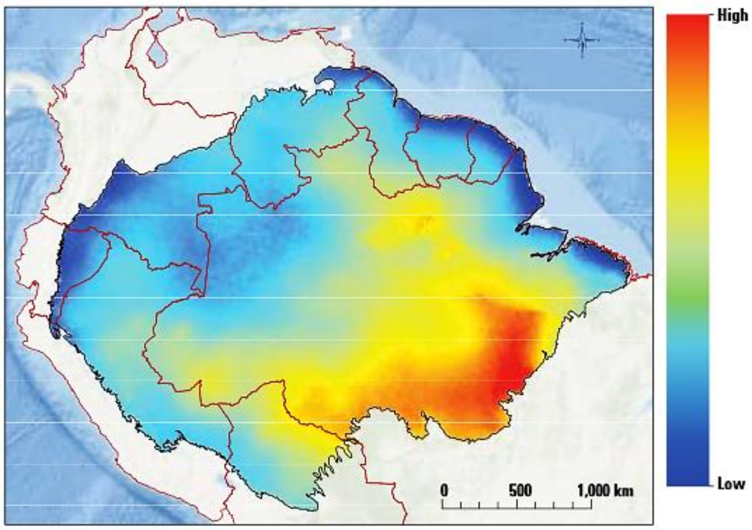
[449] Mansur et al. 2016 in MCTI 2020

[450] Ministry of Environment 2016, p.18

[451] Pabón-Caicedo et al. 2018

worsened over time relative to the world; over the period of 2000-2019, Brazil on average ranked 81st in the world, and in terms of climate-linked fatalities, 17th and in terms of losses, 16th.
It is important to note that climate change vulnerability is not uniform across the Amazon, nor across the country. A study integrating the regional climate change index and the socio-cultural vulnerability index, with differences in precipitation, temperature, seasonality and future climate scenarios, established that the area within the Amazon biome at greatest risk is the east, i.e., within the Brazilian state of Pará, as well as the southern zone of the states of Rondônia and Mato Grosso (see A49 below).[452] Climate change vulnerability is also predicted to be high in north-eastern Brazil, due to a combination of high population density, projected reductions in water resource availability, and limited adaptive capacity among those living there.[453]

Figure A48: Regional Climate Change Index for the Amazon biome



Source: Prüssman et al. 2016

Climate Risk for Brazil's Amazon Region
The productive, biodiverse ecosystems across Brazil's Amazon region provides essential services for the nearly 30 million people, including 350 indigenous communities. An estimated 60% of Brazil´s Specific Traditional Population Groups live in the Amazon region, who have a strong dependence on forests and natural resources for their livelihoods.[454] Several adverse effects on the health and livelihoods of the population as well as vital ecosystems in the Amazon region can be inferred from the possible effects of climate change. It is important to note that the adverse impacts caused by climate-related hazards are exacerbated by ongoing anthropogenic activities that result in deforestation and environmental degradation.

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and

452 Prussman et al. 2016

453 USAID 2018

454 MTCI 2020

related livelihoods. Potential impacts in Brazil's Amazon region could include: changes in productivity, crop failure, increased or changing need for production inputs, losses and damages, shifting production zones, pest and disease outbreaks, among others. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.).

- In addition to changing slow-onset climate trends, the sector is at risk from increasingly unpredictable and severe climate change-linked hazards, such as extreme drought, wildfire and flood events. Extreme rainfall events in the Amazon region in 2020 and past years were reported to have affected the **food security** of indigenous peoples, e.g., due to crop rot and production failures. This may also limit access to food and foraging across the Amazon region.
- Overall, given the vulnerability of the agriculture sector specially to increasing climate variability, a **decrease in agricultural production can have cascading, cross-sectoral consequences** across Brazil and the wider region. This may include an increase in land pressure from farmers around the Amazon territory, and an increase in urban migration, all of which can in turn exacerbate other climate-related risks. For example, increases in temperature and a change in rainfall patterns could impact the spread of disease. Urban flooding in particular can lead to greater prevalence of infectious and vector-borne diseases, as with the 2015-2016 Zika outbreak.

Risk of negative impacts on freshwater ecosystems affecting local livelihoods, energy security and mobility

- Annual recurring drought events threaten water quality and quantity for local populations, the fisheries sector, mobility/ transportation, and energy generation through hydropower.
- Freshwater quantity and quality deterioration severely threatens large areas of Amazon fresh water and fisheries. Includes changes in pH and oxygen due to drier conditions from prolonged drought, combined with increased evapotranspiration due to increased temperatures. Frederico et al. 2016, found in their study that freshwater quality poses a particularly high risk for fisheries in the Amazon region.[455]
- Hydropower is also vulnerable to climate change, especially power plants with small reservoirs, due to declining stream flow, water levels, and increasing sedimentation (e.g. from flooding and erosion).[456]
- Rivers are used for transporting goods and people within the Amazon region, and declines in water levels could restrict transportation.[457] Riverways are important for transferring also supplies for local communities, including medicine, food, and other goods, all of which will be greatly impacted by lowered water levels. Brazil's Fourth National Communication to the UNFCCC cites an article by Betts et al. 2018 that projects water flows reducing by up to 25% in the scenario of a 2°C increase in temperature.[458]

Risk of damages and losses to infrastructure and economic sectors

- In addition, climate-related hazards could result in **increasing losses and damages to communities** in the Amazon, as well as infrastructure (e.g., housing, small-scale farms and tourism

[455] Frederico et al. 2016

[456] Ministry of Environment 2016

[457] MCTI 2020

[458] MCTI 2020

infrastructure). Sea level rise, storm surges and river flooding will have substantial impacts on lowland livelihoods across the Amazon delta.

- Threats to tourism include sea level rise and coastal floods, which threaten important natural resources, built infrastructure, and coastal populations. Between 2070 and 2100, over 600,000 people per year are projected to be impacted by flooding due to sea level rise in Brazil;[459] exact figures for the Amazonian states are not known. In the Amazon region, Zika and vector-borne diseases also pose a threat to the tourism industry. Overall, Zika is reported to have contributed to an estimated $644–$888 million direct losses to Brazil's tourism sector between 2015 and 2017.[460]

Risk of injury, illness, death, disease and adverse health impacts

- Climate change is expected to generate negative health impacts, including: death and injury from climate-related hazards, air pollution (incl. from forest fires, flooding etc.), increased cardiovascular and respiratory disease due to increased temperatures, among others. During droughts in 2005 and 2010 there was an observed increase in hospitalizations of children due to respiratory diseases.[461]
- It is expected that predicted combination of higher temperatures, changing rainfall patterns, and **more frequent and intense extreme weather events, could significantly impact the local populations and economies** by potentially **increasing vector and waterborne disease** outbreaks country-wide. For example, Zika was introduced to Brazil in 2013, and the 2015 and 2016 outbreak in the Americas likely resulted from favorable climate conditions, partially caused by El Niño.

Risk of ecosystem transformation, and loss of ecosystem services and biodiversity

- Higher temperatures and heat stress can **alter the spread and survival of biodiversity,** which is worsened by anthropogenic activities. In some cases, changes in the range and distribution of temperature sensitive species across the Amazon region and beyond are reported. A composite ecological risk index taking into account trends in deforestation, forest fires, urban spread, agriculture/livestock expansion, gas and mining concessions and infrastructure development establish the southern Amazon basin area (spanning several Brazilian states) as the area with the highest risk.[462]
- Beyond this, **deforestation and forest degradation in the Amazon exacerbate the impact of climate change** on ecosystems and local communities. Deforestation leads to increasing erosion and sedimentation, which can in turn increase flood risks, and result in riverbed rise and riverbank cutting. The conversion of forests into savannah or grasslands potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness, which reduce evapotranspiration and ultimately rainfall recycling. Forest degradation may also contribute to pest and disease outbreaks, and reduced provision of other key ecosystem services. Studies across the Amazon have shown a negative correlation between growth rates of trees and increases in annual average temperature, annual maximum temperature and intensity of the dry season (including a study by Beaumont et al. 2011 in Ministry of Environment 2016). This will result in stress and reduced net primary production and, causing impacts on

[459] USAID 2018

[460] UNDP 2017

[461] Smith et al. 201 4 in MCTI 2020

[462] Prüssman et al. 2016

ecosystem structure, and fragmenting forest margins. These areas are then more vulnerable to stresses such as increased wind speed, turbulence, elevated temperatures, reduced humidity, increased sunlight, increased drought and fire risk, etc.[463]

- The effects of **increasing climatic exposure** may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, open roads, and deforestation usually cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change (e.g., erosion and sedimentation could contribute to an increased risk of flooding, exacerbated by projected increases in precipitation).

The following Table provides a summary of potential climate risks on the main sectors covered by the proposed GCF program:

Table A13: Overview of potential climate change impacts on key sectors in Brazil's Amazon region

Sector	Potential impacts
Agriculture	▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures and reaching of upper heat thresholds ▪ Changes in crop yields and productivity of key crops (particularly soybeans & cotton – moderate decline – and maize, wheat – large decline) in inland areas ▪ Increase in consecutive dry days will have severe impact on rain-fed agriculture ▪ Decrease in proportion of arable land and fertile soils
NTFPs	▪ Decrease in NTFP quality and availability (particularly traditional medicines, essential oils, açaí berries, Brazil nuts etc.) due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks
Aquaculture & Fisheries	▪ Annual recurring drought events threaten water quality and quantity for fisheries sector ▪ Water quality deterioration severely threatens large areas of Amazon fresh water and fisheries. Includes changes in pH and oxygen due to drier conditions from prolonged drought, combined with increased evapotranspiration due to increased temperatures ▪ Sea level rise threatens marine fisheries (reduction in fish stocks and loss of incomes and nutrition for local communities) ▪ Sea level rise and increasing temperatures have adverse impacts on mangrove forest aquaculture
Tourism	▪ Damage to key tourism hotspots (coast and forest resources) and tourism infrastructure – including river transportation – creating higher operational costs e.g. insurance, evacuation, back-up systems) and trip cancellations ▪ Damage to forest resources (tourism hotspots) due to wildfires

[463] Bovolo et al. 2011

	▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (Zika, malaria, dengue) and prolonged droughts ▪ Damage to coastal forests (mangroves) and infrastructure from sea level rise and riverbank inundation ▪ Risk of decreased attractiveness of key tourism features (waterfalls) due to precipitation variability ▪ Reduced attractiveness of eco-tourism opportunities contingent on unique species (arapaima fish, acai berry, etc.) that are highly vulnerable to climate change
Ecosystem regulation services	▪ Decrease in biodiversity (threatened species) due to changes in habitat and changing climatic conditions, and endangerment of key flora and fauna ▪ Risk of loss of key ecosystem functions including regulatory, production and cultural services ▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience) e.g., mangrove forests that serve as breeding grounds for marine species and double as natural barriers to prevent flooding and erosion ▪ Local species adapted to seasonal flooding may not cope with changing flood patterns
Forests	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume ▪ Tree mortality due to invasive species, forest fires, excessive heat and dryness, especially along forest edges ▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities ▪ Risk of forest dieback and transition to savannah ecosystems

Source: World Bank CC Portal; USAID 2018;

Bioeconomy sectors and actors

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g., country, region, site-conditions, etc.), many of the program's investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g., agroforestry, ecotourism)

The following sub-section will provide an overview of the Brazilian bioeconomy and key sectors and actos.

Overview

In Brazil, bioeconomy policy strategies begun in 2007, focusing on the production of bioenergy, such as biofuels, foods and fibers, and lastly on Amazon rainforest resources. The CNI 2020 Bioeconomy report highlights the need for the country to think and act strategically, fostering collaborative work between the primary productive sector at all its levels; private sector at all levels and its confederations; government institutions and academia; and even the consumers.

The study points out that biodiversity is the subsidy towards the fourth industrial revolution, as it provides the materials and designs to be transformed into sources of wealth. This could be done when connecting Knowledge and Entrepreneurship. To become a Bioeconomy power, *the country´s existing innovation network must be expanded, integrating different actors for the generation of new technologies and aggregated value products.* Furthermore, they stress the importance of removing barriers to the country´s competitive edge in the public and the productive sector [464]. Below we will explore two sectors with big potential for decreasing deforestation and achieving positive economy returns.

Agriculture

Agriculture supports the livelihoods of millions of families across the Pan Amazon. For many migrant families, it provides a pathway out of poverty. For the middle class, it is a way to accumulate family wealth and ensure the prosperity for future generations. For entrepreneurs, it represents a business opportunity with a proven technology and manageable levels of risk. When viewed as long-term investment, agricultural production systems can assume a role as key elements of a sustainable economy. When practices as a speculative enterprise, however, extractive practices that yield cash flow tend to degrade the productive potential over the medium-term. Under-investment in smallholder communities forces them to adopt non-sustainable options that function as a poverty trap and robs the regional economy of an important driver of growth.

Agricultural production systems can be classified as a proximate cause of deforestation, but the demand for commodities is the ultimate driver that motivates producers to expand production.[465] The markets that influence agricultural production are as varied as the commodities that are produced by the farmers of the greater Amazon. Global markets dominate the supply chains of soy, coffee and cacao, while maize, rice, manioc and perishable fruits are largely commercialized in national markets. Beef and palm oil are global commodities and are influenced by international markets, but most of the production in the Pan Amazon is commercialized domestically to meet the needs of national

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[464] Cruz, C.M. 2020. Bioeconomia permite ao brasil se tornar referência econômica mundial. Energia que fala com você. https://www.energiaquefalacomvoce.com.br/2020/09/01/bioeconomia-permite-ao-brasil-se-tornar-referencia-economica-mundial/

[465] Assunção, J., Gandour, C., and Rocha, R. 2015. Deforestation slowdown in the Brazilian Amazon: prices or policies?. Environment and Development Economics, 20(6), 697-722.

consumers. Understanding the market dynamics of each commodity is essential for devising strategies that promote sustainability and to eliminate deforestation.

Biofuels

Brazil has a long history of promoting bioenergy, particularly ethanol from sugar cane, and the Brazilian sugar industry is renowned for its efficiency and low GHG footprint. The Brazilian government also supports biodiesel production with blend mandate of 10%. Most of the feedstock is soy oil; in 2019, 4.8 million m^3 of soy oil, which is equivalent to the oil content of ~18% of the total national production and 50% of the soy oil processed domestically within Brazil. Mato Grosso produced 26% of that total. In contrast, < 2% of the biodiesel mandate was supplied by palm oil in 2019, which represented less than 6% of the total national harvest.[466] Most of that by *Brasil Biofuels,* which blends it with conventional diesel to fuel 18 power plants located in remote regions of Acre, Roraima, Rondônia, and Amazonas that are disconnected from the grid.[467]

The decision to promote soy rather than palm oil as a biodiesel feedstock is noteworthy, because the GHG footprint of Brazilian palm oil is significantly smaller than soy. The carbon emissions of palm oil are approximately 50% less than soy when land-use change is excluded from the calculation; however, if palm oil is assumed to be deforestation free and soy expansion occurs via the conversion of Cerrado landscapes, then the GHG footprint is about 140% less for palm oil when compared to soy. Palm oil produced on degraded pastures is carbon negative, because both above and below ground biomass increase over time until they reach an equilibrium after a couple of decades.

Presumably, the decision to give priority to soy over palm oil was driven by the pre-existing logistical infrastructure near the urban centers in Southeast Brazil and the limited capacity of palm oil companies to produce the volume of feedstock required by law.[468] Political influence may also have contributed to favor the soy sector, which had gross revenues of about $us 40 billion in 2015 compared to about $350 million for palm oil.

Açai and the Amazonian native foods[469]

Açai fruit, from the *Euterpe oleracea* palm*,* is a super-food due to its nutritional and functional qualities. Despite its operational difficulties: being a fresh, minimally processed fruit, transported frozen from the forest to consumer, it has gained markets both nationally and abroad. Enriched natural agroforestry systems with acai have shown to give annual returns of US$200 to 1000 per hectare. This amounts to more than US$1 billion annually to the regional economy. This is a great example and basis to consider other Amazonian biodiversity foods that are traditionally consumed by

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[466] EPE – Empresa dde Pesquisa Energetica 2019. Análise de Conjuntura dos Biocombustíveis, Ano 2019, Ministerio de Minas e Energia, https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-489/Analise_de_Conjuntura_Ano_2019.pdf

[467] Brazil Biofuels. 2021. Power Generation, https://www.brasilbiofuels.com.br/en/power-generation/

[468] Total Brazilian production of crude palm oil was 305,000 tons, while the total biodiesel demand was 3.4 million tons. (source *Secretaria de Agricultura do Estado do Pará* (2013) and USDA-FAS / GAIN Report, Brazil Biofuel report 2016)

[469] Nobre, I.; Nobre, C.A. 2018. The Amazonia Third Way Initiative: The role of technology to unveil the potential of a novel tropical biodiversity-based economy. Provisional Chapter. IntechOpen

the local population, where cultural knowledge of both management and its uses may lead the way to successful products. Just to list a few:

Camu-camu (*Myrciaria dubia* (HBK) McVaugh), for example, has 4 times more vitamin C than acerola; murici (*Byrsonima crassifolia* (L.) Rich.), has excellent antioxidant properties, as well as açaí. In addition to antioxidant activity and being a source of five types of carotenes, taperebá (*Spondias mombin* L.) is a rich source of vitamin A, at the rate of 100 g of fruit corresponding to more than 37% of the daily needs of the vitamin. Brazil nut (*Bertholletia excelsa*), cumaru-ferro (*Dipteryx odorata*); cupuaçu (*Theobroma grandiflorum*); uxi (*Endopleura uchi* (Huber) Cuatrecasas); graviola (*Annona muricata* L.); patauá (*Oenocarpus bataua* Mart.); guaraná (*Paullinia cupana*); priprioca (*Cyperus articulatus* L.); and bacuri (*Platonia insignis*), among many others.

Further research of the biological, chemical and physical properties of these species may lead us to innumerable applications and the development of products in high added value markets, such as cosmetic and perfumery products or pharmaceutic sector. Furthermore, the raw material may come either from natural forests or managed agroforestry systems.

The rural area is home to communities where the first basic stages of preparation of the material collected or harvested for subsequent supply occur, such as cleaning, threshing, drying and other low-tech processes. Logistic processes such as the transport of the material from the collection and production sites to the pre-processing sites, storage and shipment to the processing centers also occur in the rural domain. In every aspect of this beginning of the value chain, there are opportunities for individual, family, cooperative or business based on local entrepreneurship.

After pre-processing, the materials are taken by boat or truck to companies or cooperative facilities in the Amazon or in another region in Brazil or in other Amazonian countries (e.g., Bolivia) where most or the entire product's actual processing takes place, in facilities with varying degrees of automation. From there it is ready for consumption, locally or in markets elsewhere in Brazil or abroad. Based on a comprehensive study we conducted with value chains of five plant species, we developed a conceptual diagram that represents the main places, environments and activities carried out throughout the whole transformation cycles, from inputs origin to final consumption.

Cacao

Brazil produced more than 275,000 tons of cacao in 2014 mainly from Bahia (58%) and Pará (42%), particularly in the municipalities located on the north bank of the Amazon River Corridor (HML # 1) and the Transamazônica highway (HML # 10) where yields are almost double those of traditional cacao growers in Bahía. The popularity of cacao in smallholder landscapes is expected to grow over the short-term and the *Associação Nacional das Indústrias Processadoras de Cacau* (AIPC) has pledged to double production over the next ten years.[470]

Certification as environmental guidance

[470] https://brazilian.report/business/2021/04/04/brazil-top-cocoa-producer/

The mechanism used to reform supply chains is typically a voluntary certification system that verifies that the production, trade and transformation of a commodity has complied with a set of best practices that have been agreed to by all the parties.

The efficacy of these initiatives has been questioned by some environmental activists who view them as a form of greenwash. Participating companies certify the production within their own supply chain, but the roundtable initiatives have not succeeded in transforming their respective sectors.[471] The increased profile of certified products has failed to attract a critical mass of producers that would actually transform the market and change the economic drivers of deforestation and other forms of environmental degradation. The highest levels of adoption are for coffee (40%) and cocoa (22%), while those commodities linked to industrial plantations are much lower: palm oil (25%), sugar (3%) soy (2%) and beef (<1%). Part of the explanation for the slow uptake of the voluntary standards is the lack of demand; for example, typically only about 50% of certified production is actually sold as a certified commodity.[472]

The lack of uptake is yet another manifestation of the dilemma of allocating the cost of environmental protection and social justice. Sustainability protocols cost money, which either adds to the price of a consumer good or reduces the profit margin of commodity producers. Although North American and European consumers are concerned about deforestation, most still choose a lower cost product, while those in Asia, Latin America and the Middle East are overwhelmingly focused on price.[473] Moreover, global commodity markets are dominated by producers on landscapes that were transformed by agriculture decades or centuries in the past and these farmers operate without fear of being accused of environmental crimes. Consequently, traders are not motivated to pay farmers on the agricultural frontier.[474]

A few producers seek to differentiate their production as organic, deforestation-free, fair, or antibiotic-free, because they are selling their products into a differentiated market and receive a premium for their production in compensation for the extra cost and reduced yields that these systems entail. Others participate because it guarantees them market access. Most producers opt to circumvent the voluntary guidelines, or sell to traders unconcerned about sustainability.

Social advocates have questioned the economic benefits of certification, because they tend to discriminate against small-scale producers who cannot meet the record keeping and logistical demands of a certification process. These protocols are negotiated by large-scale producers that dominate the roundtable initiatives and tailor the certification criteria to their supply chains. [475] As formalization spreads throughout national and international markets, these groups could be

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[471] Lambin, E. F.; Gibbs, H.K.; Heilmayr, R.; Carlson, K.M.; Fleck, L.C.; Garrett, R.D.; Nolte, C. 2018. The role of supply-chain initiatives in reducing deforestation. Nature Climate Change, 1.

[472] Potts, J. et al. 2014. State of Sustainability Initiatives Review – 2014, International Institute for Sustainable Development. https://www.iisd.org/sites/default/files/pdf/2014/ssi_2014. pdf

[473] The emphasis on price is only superseded by health issues. In advanced economies consumers seek "healthy" products, while in developing countries there is a greater focus on quality and, in the case of China, an ingrained fear of contaminated products.

[474] Rainforest Alliance, UTZ-Certified, Fair Trade are the best known organizations offering certification protocols that cover multiple commodities.

[475] Roundtable for Sustainable Palm Oil (RSPO), Round Table Responsible Soy (RTRS), Global Roundtable for Sustainable Beef (GRSB), BONSUCRO the global sugarcane platform for sustainability, 4C-Association for a better coffee world.

increasingly marginalized within regional and even local markets in contradiction with the stated social objectives of these certification schemes.[476]

Aquaculture

Fishing exploration in the Amazon acts mainly within law 7679/88 and federal decree 221/67, also denominated *Fishing code*. According to the law, given the nature of all bodies of water being of public domain, fishing is guaranteed to all people properly registered in the different fishing categories. Although the law is clear, many times it is unknown or misunderstood. This has led to fishing territorial conflicts over many decades. Furthermore, beyond the conflicts, fishing natural resource management in the Amazon is challenging. The size and watershed network adds to this complexity, as well as the high ictiofauna diversity and their habits, the many different kinds of equipment and fishing methods, or the great amount of fishermen and the inefficiency in the professional organization and public sector assistance systems[477]. These issues must be understood locally before any initiative is launched.

It is estimated that around 3,000 species can be found in the Amazon basin of Brazil, but only a small portion (100 species) are commercially exploited. Of these, 90% is concentrated in the landing of few species, such as: the cachama or tambaquí (*Colossoma macropomum*), the bocachico or curimatã (Prochilodus nigricans), the jaraqui (*Semaprochilodus spp.*), Matrinxã (*Brycon spp.*), Pacú (*Mylossoma spp.*) And the sergeant or tucunaré (*Cichla ocellaris*). There is evidence that some fish populations are being exploited beyond their capacity, like the tambaquí.[478]

Largest volume of catches occurs during the emptying of the rivers, from August to November, mainly on the Solimões and Amazon rivers, their tributaries and their inland lakes. This is also the time of highest ambient temperature. The largest volume of fish landings occurs in Manaus port between June and November, *harvest period*. With peaks between August and October. Furthermore, there is a commercialization ban during the reproduction period called *piracema*, from November 15 to March 15[479]. Fishermen receive a *Ban Insurance* benefit to encourage compliance. This equals to a minimum monthly wage during all 4 months of *piracema.*

Regional fish demand is high, twice the national average, at 11 kg/habitant/year. There is big potential for aquaculture expansion. This demand is supplied by fishing production, favored by the diversity of native fish with commercial potential and access to water resources that increase business development opportunities.

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[476] McGrath, D.G.; Castello, L.; Almeida, O.T.; Estupiñán, G.M. 2015. Market formalization, governance, and the integration of community fisheries in the Brazilian Amazon. Society and Natural Resources, 28(5), 513-529.

[477] http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142005000200010

[478] Ibid. Avdalov et al. 2020

[479] Avdalov, N., Pereira, G., Josupeit, H., de Jesús, R., Mendoza Ramírez, D., Menezes, A.C., Perucho Gómez, E. y Ward, A. 2020. Estimaciones de pérdida de pescado – Brasil, Colombia y Perú. FAO, Circular de Pesca y Acuicultura.

The aquaculture productive chain is composed by: Supplies and services (feed, young forms, medicines, equipment), *producers* (rearing and fattening), processing industries, commercialization/distribution and final costumer. Producers are well established, while feed and processing industries need to be strengthened. In Acre and Roraima there are still no fish warehouses with a Federal Inspection System (SIF). Regarding input (larvae, post-larvae and fry), there are producers in all states found in the Amazon region, with difficulties to attend specific species like the pirarucu[480]. It is important to note that Brazil´s fishing fleet is old and obsolete. The boats do not have appropriate conditions for handling and conditioning the fish on board. The majority were built of wood and are about 20 years old on average.[481]

Tambaqui production is widely practiced in Brazil and South America, especially in high temperature regions. The fish adapts well to harsh conditions. This fish belongs to a group of fish popularly known as *round fish*, together with pirapitanga, caranha and pacu. Hybrid species are bred, namely the tambatinga and the tambacu, which present higher *carcass* yield and tolerance to lower temperatures, respectively. Pirarucu is one of the best known species in the Amazon. It breeds easily, has great growth rates and spineless file makes of this species a popular choice. Fished Pirarucu had an annual average of 1,2 thousand tons, while pirarucu production reached 2,3 thousand tons in 2013. Aquaculture production for these fish across all 9 Legal Amazon states in 2019, and their respective production values, is shown in Table A14.

Table A14: Production and values for Pirarucu, Tambacu-Tambatinga and Tambaqui fish in the Legal Amazon

Fish species	**Aquaculture Production in 2019 (tons)**	**Production Value (Thousand BRL)**
Pirarucu	1,939	255,429 BRL
Tambacu, Tambatinga	39,875	587,407 BRL
Tambaqui	97,550	10,220 BRL

Inland fisheries worldwide have shown steady growth between the decade of 2007-2016, as pointed out by a 2020 study by FAO.[482]Nevertheless, this trend may be misleading, as it shows continuous growth over time. This may be due to an overall improved reporting and evaluation system at the country level. For example, catch and aquaculture data from Brazil has not been officially reported to FAO since 2014. Brazil statistics are estimated through Regional Fishing Monitoring Organizations. The bioeconomy program must implement a strong reporting and monitoring strategy at the state, municipality and fishing colony level, so as to evaluate the sector´s impact on fish biodiversity and

[480] EMBRAPA.2015. Aquicultura na Amazônia. Interview: Antônio Abelém, Guamá Science and technology Park. https://ainfo.cnptia.embrapa.br/digital/bitstream/item/140643/1/CNPASA-2015-af.pdf

[481] Avdalov, N., Pereira, G., Josupeit, H., de Jesús, R., Mendoza Ramírez, D., Menezes, A.C., Perucho Gómez, E. y Ward, A. 2020. Estimaciones de pérdida de pescado – Brasil, Colombia y Perú. FAO, Circular de Pesca y Acuicultura.

[482] FAO. 2020. El estado mundial de la pesca y la acuicultura 2020. La sostenibilidad en acción. Roma. https://doi.org/10.4060/ca9229es

promote greater environmental awareness, leading to more sustainable practices, along the value chain.

COVID-19 impacted fisheries gravely. Data obtained from Fishermen Colony Z-20, in Santarém, Para state, between the months of March and June 2020 at the *Fish Fair,* the main fish trading center in Santarém, show significant decrease in the volume of fish landed. The average volume of fish in the months of March, April, and May was 50.6% lower when compared to the historical average of the same period in the last eight years, going from an average of 46.72 tons to 23.10 tons during the pandemic, which represents a loss of revenue of approximately R$ 235,000.[483]

Law 4330 was signed, On December 2020. The normative law provides small-scale fisherman, who are given up to 3 hectares of flooded area to fish, with access to a faster environmental licensing procedure and lines of credit. The law was created by the Rural Production Secretary of the State (SEPROR) in partnership with the Fish and Aquiculture State Council (CONEPA) [484].

Silvopastoral systems

Pasture is a major driver of land-use change throughout Latin America. This is especially true in the Brazilian Amazon, where an estimated 70% of deforested land is under pasture. In response to the growing international demand for animal products, the Brazilian cattle herd grew by approximately 50% from1990 to 2016, or from 147 to 219 million heads[485]. Eighty percent of this increase occurred in Brazil's Amazon and Cerrado tropical zones.

Higher yields of dominant production systems can also facilitate reductions in deforestation rates, and this appears to be one of the reasons that deforestation of the Brazilian Amazon has slowed down. The Brazilian cattle industry is inefficient and extensive. Its herd of 216 million heads is 2.4 times larger than the US herd of 89 million head, but produces 28% less beef at 8.4 million tons vs. 11.7 million tons[486]. This comparison demonstrates the potential for producing more beef in Brazil with a stable or diminishing area of pasture. This potential is particularly high where cattle production is occurring side-by-side, or on the same farms, as agro-industrial production systems, which provide local supplies of silage and animal ration to accelerate weight gain and reduce the time required to slaughter[487].

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483 Pena da Gama, A.S.; McGrath, D.; Bentes, A.J.; Batista, P.; Lopes de Sousa, W.; Bonfim, S. 2020. Impactos da COVID-19 nas comunidades de pescadores de Santarém-PA. SAPOPEMA, UFOPA, EII, Colônia de Pescadores Z-20 https://drive.google.com/file/d/1VWlVUBD670xMXuxtfYtirn_kSfeYh17o/view

484 Secretaria de Produção Rural. 2020. Wilson Lima assina lei que impulsiona a atividade da aquicultura http://www.sepror.am.gov.br/wilson-lima-assina-lei-que-impulsiona-a-atividade-da-aquicultura/

485 ABIEC. 2017. Perfil da Pecuária no Brasil – Relatório Anual - Associação Brasileira das Indústrias Exportadoras de Carne. http://abiec.siteoficial.ws/images/upload/sumario-pt-010217.pdf.

486 Merry, F and Soares-Filho, B. 2017. "Will Intensification of Beef Production Deliver Conservation Outcomes in the Brazilian Amazon?" Elementary Science Anthology 5: 24.

487 Strassburg, BBN, Latawiec, AE, Barioni, LG, Nobre, CA, Vanderley P, et al. 2014. "When Enough Should be Enough: Improving the Use of Current Agricultural Lands Could Meet Production Demands and Spare Natural Habitats in Brazil." Global Environmental Change 28: 84–97.

The intensification of cattle production is allowing the Amazon industry to produce more beef per area of pasture through several different modalities. In some operations, cattle are fattened and finished during the dry season, which is usually a time of weight loss in grass-fed systems, through confinement and diet supplements of minerals, ration, and silage. Others plant forage grasses following a crop of soy and corn or soy and cotton, which takes advantage of the residual fertilizer levels, and graze cattle in what is called an integrated agriculture-livestock system.

Silvopastoral systems is the integration of trees, forage and cattle in one area. A known example is the association of macauba palm with pasture as an important alternative for increasing the income of small and medium-sized ranchers, while also increasing carbon storage in above and in soil, foster biodiversity, reduce heat stress to livestock and decrease water flow erosion from the fertile layer. In addition to all these advantages, the macauba palm would also improve per hectare economics through its various co-products.

Case Study: Macaúba Project

Palm oils can be used by a variety of economic segments, namely: food, chemical, cosmetics, lubricant, fuels and others. They require high amounts of water, and are thus planted in tropical forest regions around the world. This has increasing deforestation in enormous areas causing large GHG emissions.

An alternative to palm oil is the Macaúba palm Project, by INOCAS. The project is located in the Cerrado biome. A study financed by the EU, done by the German Leuphana University, between 2011 and 2014, tested the projects technical, economic and social viability of the project, pointing out macaúba as an alternative capable of becoming the main sustainable vegetable oil source in the world.

The project was classified as the best in the world by the Forest Investment Program of the World Bank, a CIF subprogram. Guaranteeing initial investment of US$4 million through IDB. The projects goals are to (1) plant 2.000 hectares of macaúba in silvopastoral systems, in degraded pasture lands in association with family farmers, with a potential of 600,000 tons of CO_2 (2) promote extractivist harvest of 1.500 tons of native palm fruits annually, (3) develop a model power plant for the processing of macaúba fruits.

The implementation is done over a 20-year period, according to the INOCAS Project implementation strategy. Years 1-3 establish a 60% silvopastoral and 40% agrisilvicultural system, without livestock on the ground. Years 4-5 introduce the cattle in the silvopastoral area (80%), leaving 20% to agrisilvicultural crops. The last phase, the *capitalization phase,* occurs in years 6-20. During this phase, 90% of the area is silvopastoral and 10% is left for agrisilvicultural system plantations.

EMBRAPA calculated more than 32 million hectares of degraded pastures in the Brazilian cerrado biome. Due to their high potential for scalability, companies in the renewable energy segment and

European impact funds have sought partnerships with Brazilian institutions to make the planting of macaúba viable in consortium systems in degraded pasture areas of more than 20,000 hectares.

Approximately 200,000 hectares of macaúba plantation in the silvopastoral system are needed to eliminate palm oil imports from Brazil. The implementation of an area of this size within 20 years appears to be realistic. In the Patos de Minas project region alone, 594,000 hectares of pasture are available.

In relation to the communities, INOCAS plans to develop a cooperative of Macaubeiros that allows greater autonomy in the commercialization of fruits, a better insertion of its by-products in the market, a reduction in manufacturing costs and access to public policies by of extractivists. The large volume of raw material (25 tons / hectare) that will be produced on the project's partner farms will generate work and income for the communities, move the local economy and press for the improvement of local infrastructure and services.

The workers interviewed in the Leuphana University feasibility study earned, on average, R$73 per day, that is, R$ 1,600 per month with the harvest of the native macaúba. This was equivalent to more than twice the monthly minimum wage in 2012. When all the macauba palm trees planted reach maturity, the project will create between 250 and 350 jobs during the months of October to January, reducing seasonal unemployment outside the coffee harvest spikes.

Tropical silviculture

Brazil is among the main producers of cellulose, paper and timber panels in the world. With an area of 7.84 million hectares of reforestation, the Brazilian forestry sector is responsible for 91% of all timber produced for industrial purposes. In 2018 the forest sector contributed to 6.9% of the industrial GDP, and 1.3% of national GDP. Exports totaled US$12,5 billion, an increase of 24.1% from 2017.

Native tree species plantations for commercial purposes is as yet a limited activity in Brazil. A detailed study on native species in the Atlantic rainforest considers tropical silviculture to be an important strategy for timber production as well as ecosystem service provision, such as carbon sequestration, soil and water conservation, biodiversity maintenance and the recuperation of degraded areas.

Dialogue and experiments on native species behavior for their use in silviculture begun early in the XX century, with records of study since the 1930s. Early studies occurred in São Paulo and Parana states. Until early 1980s there is record of series of experiments with positive results on both growth and adaptation to degraded areas, nevertheless, uptake of native species has been slow and their use continues to be marginal in the Atlantic rainforest. This is mainly due to lack of public and private investment to the development of silvicultural technology, as well as lack of lines of credit to incentivize rural farmers[488].

Financial system and bioeconomy businesses

An analysis done by the IDB lab and the Climate Change and Sustainable Development Department´s Natural Capital Lab (CCS/CSD NC Lab) observed exponential growth in the environmental investment sector since 2015. Networking efforts in Brazil, between universities, scientific organizations, and cross-national networks such as *Parceiros pela Amazonia*, Amazon 4.0, and FAS are working to support the ideation and pilot stages of entrepreneurship in bioeconomy.

In parallel, international forums such as the G-8, the Convention on Biological Diversity COP, the Climate COP, the Leticia Pact for the Amazon, the Coalition for Tropical Forests, Conservation International, the Green Climate Fund (GCF), and the World Economic Forum are developing specific and actionable financing plans, structures, or targets for bioeconomy, as are regional countries and sub-national states.

The IDB is in dialogue with these partners, and working with Amazon regional bank departments to create investment templates to channel additional national and international resources to bioeconomy companies in Brazil, Colombia and Peru. Successful progress is seen with the Leticia Pact countries to develop a fund for the sustainable development of the Amazon, to be housed at the IDB. Moreover, IDB is working with the French Development Agency, which has recently deployed US$4M to create a pipeline to support early-stage businesses with grants and pre-investment[489]. The IDB has also recently has recently collaborated with the UK Treasury-led Dasgupta Review of the Economics of Biodiversity to draft a paper (forthcoming) on past impact investing experiences and lessons learned in the biodiversity sector of LAC. The time is right to develop a high-risk tolerant vehicle to bridge the finance gap and close the circle.

In Brazil, the National Fund for Benefit Sharing (FNRB for its acronym in Portuguese), instituted by Art. 30 of the Biodiversity Law and regulated by the Decree 8.772/2016, aims to *value the Brazilian genetic heritage and its traditional knowledge, promoting its sustainable use*. The fund is managed by the BNDES, the Ministry of the Environment and state institutions in its Management Committee[490]. The committee includes administrative entities with competence in: Conservation issues, defense of the rights of Indigenous peoples, Traditional Peoples and Communities and Family farmers; financial administration; science, technology and innovation activity control; as well as it includes the participation from civil society representatives from Indigenous peoples, traditional peoples and

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488 Rolim, S. G., Piotto, D. 2018. Silvicultura e Tecnologia de Espécies da Mata Atlântica.. – Belo Horizonte

489 IDB Lab. 2020. IDB Lab and IDB Natural Capital Lab trust fund to create new fund for bioeconomy startups. https://bidlab.org/en/news/1782/idb-lab-and-idb-natural-capital-lab-trust-fund-create-new-fund-bioeconomy-startups

490 Ministerio do Meio Ambiente. 2020. Fundo Nacional de repartição de benefícios irá fomentar a agenda da bioeconomia. https://www.gov.br/mma/pt-br/noticias/fundo-nacional-reparticao-beneficios-ira-fomentar-agenda-bioeconomia

communities, family farmers and the academic sector[491]. The collection will be made as follows: companies that benefit from the Brazilian genetic heritage should contribute to the fund with 1% of the annual net revenue obtained from economic exploration, while the activity lasts. The expectation is that it will be possible to bring a financial return that generates income and sustainable development for communities that have traditional knowledge of use, in addition to encouraging sustainability projects, combating biopiracy and providing investors with legal certainty, since exploration is regulated.[492]

The banking system offers lines of credit suited for the development of the agricultural sector at the small, medium and large scales. Table A15 shows specific lines of credits, grouped by the authors, with rates that may be incentive rates, linked to public funds, such as the Constitutional Northern Financial Fund (FNO for its acronym in Portuguese), exclusively destined to the development of Brazil´s northern region. In general, credit concession in the northern region is 3,23%, inferior to the national rate of 5,40%. Similarly, interest rates are higher, and change depending on the size of the company: Micro (53,3%); Small (47,2%); Medium (34,7%); Large (42,2%). Financial entities working in Brazil, amount of lines of credit available per entity (1,4…), and their range of active interest rates can be grouped as such.

Table A15: Lines of credit

	BNDES	**Afeam**	**Banco da Amazônia**	**Fomento - TO**	**BanPará**	**AFAP**
Sustainable agriculture projects	(1)4,5–6,0%		(1) 2,75%			
Innovation	(1) 6,0%					
Productivity	(2) 2,7 - 6,0 %					
Infrastructure	(4)1,1–7,5%	(1)2,7-7,2%				
Equipment	(3) 0,95-7,5%	(1) 0.0%		(1)1,39-2,8%	(2) 6,0%	
Cooperatives	(2) 7,0%					
Family farming			(3) 0,5-4.0%			(1)1,5%
Export and commercialization	(1)1,45- 1,5%				(1) 6,0%	
Technical assistance		(1) 0.0%				
Working capital	(3)1,1 – 1,93%		(2)1,5-4,0%	(2)1,39-2,8%	(1)5,0-6,0%	
Sugar cane	(1) 1,3					

Source: Central Bank [493]

According to a study done by the Brazilian Tree Industry (IBÁ for its acronym in Portuguese), the forest sector should receive US$5,9 billion in investments between 2020 and 2023. According to IBA´s president, these resources will be invested in the operation chain, from planting to end product

[491] Ministerio do Meio Ambiente. 2020. Comitê gestor do Fundo Nacional para a repartição de benefícios. https://antigo.mma.gov.br/patrimonio-genetico/fundo-nacional-para-a-reparticao-de-beneficios/comite-gestor-do-fundo-nacional-para-a-reparticao-de-beneficios.html

[492] Ministerio do Meio Ambiente. 2020. Fundo Nacional de repartição de benefícios irá fomentar a agenda da bioeconomia. https://www.gov.br/mma/pt-br/noticias/fundo-nacional-reparticao-beneficios-ira-fomentar-agenda-bioeconomia

[493] Slivnik, A. Personal communication: Linhas para bioeconomia, Região Norte. March, 26, 2021

production, as well as in technology and innovation. Between 2014 and 2018 the sector received support of more than US$4 billion[494].

Barriers and enablers

The 2020 CNI´s report on bioeconomy states that, even though Brazilian government has action plans towards Bioeconomy, these are carried out in an unarticulated way, by different ministries, with no consensus on what bioeconomy development is. A National Bioeconomy strategy is needed to create implementation guidelines that articulate the different initiatives, with objective and result-oriented management.[495]

Overcoming current challenges require coordinated action amongst stakeholders. One such front is the drafting and implementation of effective regulatory policy. A recent positive change was the enactment of law 13.123/2015, called Biodiversity law, which cleared uncertainties relative to investments (see Finance note on the FNRB in this annex), fine-tuned legislation to access local genetic heritage, and stimulated the development of productive chains aiming to add economic and social value in a sustainable way[496].

A 2019 evaluation on the potential of implementing the bioeconomy model in the MFTZ, by Instituto Escolhas, observes that the current regional incentive model is ineffective, and points out four major barriers that must be overcome:

- Companies and investments move to regions offering incentives, without considering comparative advantages and competitive factors.
- Distortion to markets and production chains is created by unfavorable conditions in logistics costs, supply chain development, access to intermediate and final goods
- There are no conditionalities for the private sector, promoting a lack of commitment on productivity, employment, market access, and technology. Furthermore, the public sector has no social or fiscal goals.
- There is little encouragement for beneficiary sectors and companies to seek independence from incentives and subsidies.

The above mentioned may also be seen as potential risks to Bioeconomy implementation in the region.

The Instituto Escolhas study, couple with the 2020 CNI report and a working paper from WRI on research gaps and priorities in native species silviculture in Brazil point to the following enablers:

- Focus on research and development (R&D). Promoting a conducive environment to knowledge cross-pollination between universities, research institutes, and industry will further scientific and technological development needed for the implementation of Bioeconomy.

[494] Referência Florestal. 2019. Cadeia produtiva em números. http://referenciaflorestal.com.br/cadeia-produtiva-em-numeros/

[495] Pereira, G., CNI. 2020. Bioeconomia e a indústria Brasileira. CNI – Confederação Nacional da Industria – Brasília

[496] BNDES Sectorial. 2018

- Business models must be designed to adhere to the needs of such a model. Innovation at the processes, products, market approaches level should be adapted to each region´s particularity.
- Strengthen productive chain integration towards qualified and competitive companies, able to integrate themselves to global value chains, generate exports, and internationalize their businesses.
- A competitive market arena stimulates companies to use and improve their technology, processes and/or products.
- Federal and state policies must be well coordinated and integrate all areas mentioned: Technology, production, industry, and social development, inducing the creation of an innovation ecosystem that bring together the three federal levels, companies and academia.

WRI´s working paper on native species silviculture in Brazil points out that addressing the knowledge gaps and implementation challenges will be done through the establishment of a cooperative network and develop a pre-competitive R&D Platform. They further explore four investment scenarios to build such platform. Best scenario has a 20-year timeframe and works with 30 species. This scenario requires an investment of around US$7,3 Million, with its largest costs being the reforestation of 500 hectares with experimental trials and annual monitoring costs over the total 20-year timeframe[497].

Risks of bioeconomy financing in Amazonia

In a study[498] conducted by the European Investment Bank bio-based/regenerative industries, it became clear that the greatest challenges that these firms face are: lack of investment; lack of public awareness/marketing about the advantages of regenerative economy and its products, and lack of commercial networks/markets support to entry.

The current COVID-19 pandemic brought urgency to this matter. The need to integrate inclusive early-stage businesses that regenerate biodiversity, involve local communities, and have a positive impact on forest cover, becomes essential in the Post-COVID recovery period[499]. Not only would these businesses be a driver for green jobs and income creation, but conserve and maintain biodiversity resources for the pharmaceutical industry to deal with new diseases and tackle emerging challenges.

Furthermore, as stated before, current lack of a national Bioeconomy strategy, which lays down the guidelines to promote integration between stakeholders and actions in the financial, political and ICTs arena leave potential companies without incentive.

By creating investment readiness and scaling capabilities via technical cooperation (grants) and investment programs, the selected early-stage businesses will exponentially increase their impact. Productive activities that reduce pressure on tropical forests or restore forest cover will be supported, and the whole regenerative economy innovation ecosystem of investment; lack of public

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[497] Rolim, S.G. et al., 2019. Research Gaps and Priorities in Silviculture of Native Species In Brazil. Working Paper. São Paulo, Brasil: WRI Brasil. https://wribrasil.org.br/pt/publicacoes

[498] Leoussis, J.; Brzezicka, P. 2017. Access-to-finance conditions for Investments in Bio-Based Industries and the Blue Economy. EIB, 2017.

[499] Watson, G.; Zuñiga, M., Edwards, G. 2020. Can nature support a green and inclusive economic recovery? IDB Blogs. https://blogs.iadb.org/sostenibilidad/en/can-nature-support-a-green-and-inclusive-economic-recovery/

awareness/marketing about the advantages of regenerative economy and its products, and lack of commercial networks/markets support to entry[500].

[500] Villacís, S.J.B.; Trabacchi, C.; Schneider, M.E.N.A.C.; Watson, G. 2020. A call for an integrated framework for the bioeconomy in Latin America and the Caribbean region. IDB Blogs. https://blogs.iadb.org/sostenibilidad/en/a-call-for-an-integrated-framework-for-the-bioeconomy-in-latin-america-and-the-caribbean-region/

Appendix 5 – Colombia Bioeconomy Context

Overview of policy, regulations and norms

In 1973, Colombia enacted Law 23, driven largely by the initiative of the Human Environment Conference at the United Nations and the Stockholm Declaration of 1972. Although this law dates back more than 40 years, it is one of the fundamental pillars of environmental regulation in Colombia. This law includes civil and administrative liability for environmental damages and rules on pollution, as well as enabling the government to regulate the National Code of Renewable Resources, which is in full force.

After the issuance of Law 23 of 1973 and the Renewable Resources Code, Colombia entered into a constitutional process that led to the creation of the current Colombian Constitution of 1991. The latter has been listed as one of the most progressive constitutions of the world, particularly for the special protection it gives to the environment, to the extent that it has been called a 'green' Constitution. It contemplates the right to a healthy environment and introduces the definition of sustainable development. It included not only the aforementioned innovative rights but also the most efficient mechanisms to ensure their effective compliance.

Law 99 of 1993 established the environmental institutional framework in Colombia, which was also called the National Environmental System. Among the most important and innovative regulatory aspects brought by Law 99 of 1993, we find the obligatory nature of environmental licenses, an administrative act before any environmental activity that may affect the environment. Likewise, the principles of the Rio Declaration of 1992 were incorporated, and other principles such as the subsidiary rigor and pre-emption rules among authorities at national, regional and local levels were established.

Colombia has national, regional, and local regulators, each one with different powers and scopes of action listed in this section. Similarly, to a federal government, national regulations pre-empt regional and local regulations. Thus, regional and local regulations cannot conflict with national regulations enacted by Congress or the executive branch. On a National level: The Ministry of Environment and Sustainable Development (MADS) is the highest environmental authority in Colombia, and it establishes public policies regarding recovery, conservation, protection, management, use and exploitation of renewable natural resources. On a Regional level: The Regional Autonomous Corporations (CARs) and Corporations for the Sustainable Development (CDS) are considered the highest environmental authorities within the limits of their jurisdiction. Their powers are limited to areas of the same ecosystem or the same geopolitical, biogeographic or hydro geographic units. The duty of overseeing and controlling environmental activities lies in these agencies as well. The CARs/CDS also have the power to issue environmental licenses for several projects as long as they do not interfere with "Autoridad Nacional de Licencias Ambientales" (ANLA) jurisdiction[501].

Multi-sectorial policies: Environmental sector

[501] The Environment and Climate Change Law Review: Colombia. Guillermo Tejeiro Gutiérrez, Juana Valentina Micán, Camila Harmelly Bermúdez, Andrés Lafaurie Bornacelli and Liliana Marcela Rubiano Brigard and Urrutia Abogados. 27 February 2020

The *National Policy for Sustainable Production and Consumption*, approved in 2010, aiming at guiding the change in production and consumption patterns towards environmental sustainability, represented an important advance in the articulation of the different sectors that provide goods and services and the environmental sector, through strategies such as the creation of sectoral agendas, responsible purchasing, and green business entrepreneurship. Through this Policy, goals were established related to the efficiency of energy and water consumption, as well as the environmental management of companies with social and environmental indicators.

Subsequently, in 2010 the *National Policy for the Integral Management of Water Resources* was adopted with a horizon of 12 years (2010-2022). The general objective of this policy is to guarantee: (1) efficient and effective water use management; (2) the articulation between the planning tool for ordering and use of the territory; (3) the conservation of the ecosystems that regulate the water supply; (4) water management as a factor for economic development and social welfare; and (5) the implementation of participative processes. Since its approval, important advances have been made in regulation and in the formulation of planning and economic instruments. Challenges remain in the articulation of the sectoral agendas and the instruments that minimize the conflicts generated around the use of water.

In 2012 the MADS published the *National Biodiversity Policy* updated version, which incorporated new concepts and a new approach aimed to generate greater inter-sectoral articulation and more social and community participation. However, the implementation of this policy, requires a strengthening of the entities involved and which is fundamental to achieve momentum in the bioeconomy at the national and regional level.

The most relevant policy regarding bioeconomy is the 2014 *National Green Business Plan.* It was formulated with a horizon to 2025; its main objective is to provide guidelines that allow the development, promotion and demand for green and sustainable businesses (NVS). The implementation of this Plan calls for the creation of specialized offices within regional environmental authorities, in order to verify, advise and facilitate green business initiatives. The Regional Green Business Programs have been created for the Caribbean, Central, Pacific, Orinoquía and Amazon; however, the Plan has yet to execute many projects due to a lack of incentives, which are required to scale-up projects and access national and international markets.

In 2016 the *Policy for Sustainable Land Management* seeks to promote sustainable land management for the conservation of biodiversity, water and air, land use planning and risk management converge. The action plan is established with a horizon of 20 years and it includes six strategic lines related to: 1. Institutional strengthening and harmonization of norms and policies; 2. Education, training and awareness; 3. Strengthening of environmental and sector planning instruments; 4. Monitoring of soil quality; 5. Research, innovation and technology transfer; 6. Preservation, restoration and sustainable use of the soil.

The *National Climate Change Policy* was approved aiming to incorporate climate change management into public and private decisions to advance a path of climate-resilient and low-carbon development reducing associated risks. It is an innovative policy to the extent that it identifies opportunities and benefits of a coordinated management between the economy and climate change based on five strategic axes: (1) rural development; (2) urban development; (3) the mining-energy sector; (4) strategic infrastructure; and (5) management and conservation of ecosystems and their services. In this sense, efforts to develop low-carbon and climate-resilient production processes and technologies contribute to the vision of green growth.

The *Comprehensive Strategy to Control Deforestation and Forest Management - Forests Territory of Life¨* was adopted, aimed at reducing deforestation, forest degradation and promoting their conservation and sustainable management, through a policy and an institutional coordination that links the productive sector, local communities and civil society. Based on the implementation of this policy, the Inter-sectoral Commission for the Control of Deforestation was created in 2017[502].

Finally, but especially for the department of the Amazon region, where deforestation is the highest in the country, the issuance of Resolution 261 of 2018, by which the *National Agricultural Border* is delineated, was defined at a scale of 1: 100,000 and a methodology for its general identification has been adopted. This is an important milestone within the framework of the implementation of Peace Agreement, which intends to conserve natural capital, increase agricultural productivity, and contribute to reducing the loss of ecosystems of environmental importance.

Energy sector

The Law 1715 of 2014 aims to promote the development and use of *non-conventional sources of renewable energy*[503] (sustainable energy besides hydroelectric energy), through their integration into the electricity national market, their participation in non-interconnected areas and in other energy uses. This establishes the legal framework and the instruments for the use of non-conventional sources of renewable energy (FNCER,), the promotion of investments in innovative technologies for energy generation, the promotion of small and large-scale self-generation and distributed energy generation. Additionally, this law creates mechanisms that allow the response to demand and energy efficiency guidelines, and tax exemptions. Although some aspects of this standard have already been regulated, additional technical instruments are required to allow its implementation.

Agricultural and forestry sector

In 2018 the Rural Agricultural Planning Unit (UPRA) published *the Action Plan for the Development and Consolidation of Forest Plantations*, in which the forestry sector develops a timeline for the consolidation of the plantations sector to 2038. It includes twelve strategic objectives grouped into four structural axes: Productivity and the market, institutions, social inclusion, decent work, and environmental commitment. The plan focuses on promoting commercial forestry plantations.

The Law 1876 of 2017 establishes a framework for supporting research, technological development, technology transfer, knowledge management and training, in order to improve the productivity, competitiveness and sustainability of the agricultural sector. The *National System of Agricultural innovation (SNIA*) incorporates elements such as the Strategic Plan for Agricultural Science, Technology and Innovation, the National Dynamic Agenda for Agricultural Research, Technological

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[502] Decreto 1257 de 2017 "Por el cual se crea la Comisión Intersectorial para el Control de la Deforestación y la Gestión Integral para la Protección de Bosques Naturales y se toman otras determinaciones".

[503] De acuerdo con la Ley 1715 de 2014, la biomasa, los pequeños aprovechamientos hidroeléctricos, la eólica, la geotérmica, la solar y la mareomotriz, se consideran fuentes no convencionales de energía renovable (FNCER).

Development and Innovation and the Departmental Agricultural Extension Plans and defines Territorial Innovation Systems. The SNIA is coordinated by the Ministry of Agriculture and Rural Development and the National System of Competitiveness, Science, Technology and Innovation (SNCCTeI). The SNIA constitutes a platform to strengthen rural extension with the potential to improve the country's agricultural productivity and includes a vision and criteria that ensure environmental performance as a priority for the agricultural sector.

Colciencias adopted in 2018 the *Green Book 2030* as the National Policy on Science and Innovation for sustainable development, with the aim of guiding science and innovation so that they contribute to solving the country's social, environmental and economic problems. To achieve this objective, the policy establishes actions in three specific directions: (1) promote the adoption of the transformative approach in the science and technology (2) guide science and innovation to achieve the SDGs; and (3) support the deployment of the transformative approach to achieving the SDGs at the territorial level.

Inter-sectorial Environmental Normativity: Colombian Green Growth approach through the National Council for Economic and Social Policy – CONPES

CONPES is the highest national planning authority and serves as an advisory body to the Government in all aspects related to the economic and social development of the country. The most important CONPES related to creating base ground for Bio economy in Colombia are:

CONPES Document 3697 (in 2011)**.** The policy for the commercial development of biotechnology based on the sustainable use of biodiversity was formulated, aiming to create economic, technical, institutional and legal conditions for the development of companies and commercial products based on the sustainable use of biodiversity. With a horizon to 2014, this policy proposed to obtain the financing of the seed capital for small and medium companies by means of the allocation of development funds and own resources, as well as to study the creation of the National Bioprospecting Company, which could not be carried out and finished. As a result of its implementation, the creation of the Genetic Resources Group in the Ministry of Environment and Sustainable Development was created.

Subsequently, in 2016, *CONPES Document 3866,* The National Productive Development Policy, was approved, which seeks to solve market, government and articulation failures, with actions aimed at improving production and innovation capacities, closing human capital gaps and compliance with quality standards to promote the internationalization of Colombian products. Also, in 2016, *CONPES 3874* was approved. The National Policy for the Integral Management of Solid Waste proposes to move towards a circular economy, where the value of products and materials is maintained for as long as possible in the productive cycle.

In 2018, *CONPES Document 3918,* the Strategy for the implementation of the Sustainable Development Goals (SDG) in Colombia was approved, which outlines indicators and goals aimed to consolidate a sustainable development model for the country with a horizon to 2030.

CONPES Document 3919 National Sustainable Building Policy, also approved in 2018, aims to promote the inclusion of sustainability criteria for all uses and within all stages of the building life cycle through regulatory adjustments, the development of monitoring mechanisms and the promotion of economic incentives that help mitigate the negative effects of building activity on the environment. For 2018, *Document CONPES 3926*, the Land Adequacy Policy 2018-2038 was approved, which promotes a public and private management model to reactivate or start new water irrigation and drainage projects with financial support, and also calls for technical generation assistance processes implementation, road infrastructure, innovation, commercialization systems and formalization of land ownership. This aims to expand the coverage of this service by 500,000 hectares, which will require an estimated indicative investment of 15.4 billion pesos between 2018-2038.

Finally, *The Green Growth Plan*, *CONPES 3934,* which underline multi sectorial guidance, objectives and goals for a greener Colombian path. The purpose of the Green Growth Policy is to boost the sustainable productivity and economic competitiveness of the country by 2030, while ensuring the sustainable use of natural capital and social inclusion compatible with the climate, on a period of implementation of 13 years between 2018 and 2030. Within the framework of this policy, trajectories of sustainable growth that guarantee long-term economic development, conservation of natural capital, social welfare and climate security will be established. This policy main objectives are:

1. To generate conditions that promote new economic opportunities based in the wealth of natural capital.
2. Strengthen mechanisms and instruments to optimize the use natural resources and clean energy in production and consumption.
3. Develop guidelines to build human capital for green growth.
4. Strengthen multi sectorial capacities.
5. Improve inter-institutional coordination, information management and financing for the implementation of the Green Growth Policy in the long term.

The National Development Plan - Pact for sustainability, Law 1955 of 2019

This comprehensive and transversal policy mandates the National Planning Department to coordinate with multiple agencies (Ministry of Environment and Sustainable Development, the Ministry of Commerce, Industry and Tourism, the Ministry of Agriculture and Rural Development, the Ministry of National Education, the Ministry of Housing, City and Territory, the Ministry of Mines and Energy, the Ministry of Labor, the Ministry of Transport, the Ministry of Finance and Public Credit, the Administrative Department of Science, Technology and Innovation, the National Administrative Department of Statistics) to provide recommendations to the National Policy Economic and Social Council.

The pact focuses on counteracting the current dynamics of deforestation and degradation of ecosystems and promote productive activities committed to sustainability and mitigation of climate change, such as sustainable forms of agricultural, transport, renewable energies and energy efficiency, low-carbon industry and infrastructure (NDP, 2018).

The National Development Plan has three goals on forest plantations:

1. Increase the share of the forest economy in national GDP by 1% (today 0.6%)

2. Increase the commercial reforestation area by 122,000 hectares by 2022 and reach 1.5 million hectares by 2030.
3. Generate areas with planned productive transformation through forestry cluster initiatives. According with IGAC most of legal available Amazon soil should be dedicated to sustainable forest practices on their different modalities. [504]

GDP, income and productivity

Colombia has a diversified economy with an important services component. The country's economic production is dominated by its domestic demand and household consumption spending is the largest component of GDP. Colombia's gross domestic product grew by 3.3% in 2019 compared to 2018 with 2.5%. In 2019, the GDP figure was US$326 billion, making the country the 42nd largest economy in the global ranking.[505] Colombia is considered as an "emerging economy;" it is a member of the OECD, the UN, the OAS, the Pacific Alliance and other international organizations; it is the only country in Latin America that is a global partner of NATO.

Colombia halved poverty over the past ten years. The Colombian human development index is 0.747 and its average life expectancy is 75.1 years. It is the second country with the highest inequality index in Latin America, after Brazil, and tied with Panama, according to the World Bank database

Colombia has a track record of prudent macroeconomic and fiscal management, anchored on an inflation targeting regime, a flexible exchange rate, and a rule-based fiscal framework, which allowed the economy to grow uninterrupted since 2000. However, productivity growth is low and it has been a drag on economic growth. A large infrastructure gap, low labor productivity, low trade integration, high immigration rates from Venezuela and barriers to domestic competition are among the factors that weigh on total factor productivity. Exports are highly concentrated in non-renewable commodities (oil in particular), which increases the exposure of the economy to price shocks.

After slowing to 1.4% in 2017, economic growth accelerated to 3.3% in 2019, driven by private consumption and stronger investment. Growth was on track to accelerate further in 2020, but the COVID-19 pandemic caused a deep recession. The Government responded promptly and took decisive actions to protect lives and livelihoods, and to support the economy. The Government announced a sizable fiscal package for 2020 totaling over COP 31 trillion (or almost 3% of 2019 GDP), to provide additional resources for the health system, increase transfers to vulnerable groups through existing programs and the establishment of new ones (Solidarity income *Ingreso Solidario*), VAT reimbursements for low-income segments of the population, delay tax collection in selected sectors, lower tariffs for strategic health imports, and help hard-hit firms pay employees. The government also set up special lines of credit and loan guarantees for firms in selected sectors or that have been deeply affected by the crisis, potentially totaling 72 trillion (or 6.8% of 2019 GDP). On the monetary front, the central bank cut its intervention rate by 250 basis points between March and September and reduced it to its lowest historical level.

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[504] https://igac.gov.co/es/noticias/no-hay-una-sola-hectarea-apta-para-la-ganaderia-en-la-amazonia-colombiana-director-del-igac

[505] https://www.oecd.org/economy/surveys/Colombia-2019-OECD-economic-survey-overview.pdf

These measures are expected to mitigate the impact on the economy of COVID-19, but the economy contracted by 6.8% in 2020.[506] A rebound is expected for 2021-2022 provided that the pandemic is short-lived. The low interest rate environment is expected to boost private consumption as COVID-19 containment measures are eased and investment from major infrastructure projects such as the 4G road and the Bogota metro projects resume. Inflation is expected to fall towards the lower part of the Central Bank's targeted range, as exchange rate pass through pressures are tempered by weak demand. The lower oil prices and reductions in global demand are expected to compensate the demand-driven drop in imports, while strong inflows of remittances and lower dividends to foreign direct investors are expected to cause the current account deficit to improve slightly, from 4.2% of GDP in 2019 to 4.1% of GDP in 2020. A normalization of trade flows and an unfolding of backlogs of dividend payments to foreign direct investors is expected to cause the current account deficit to rebound in 2021, until it stabilizes at 4.2% of GDP in 2022.

Amazon economy

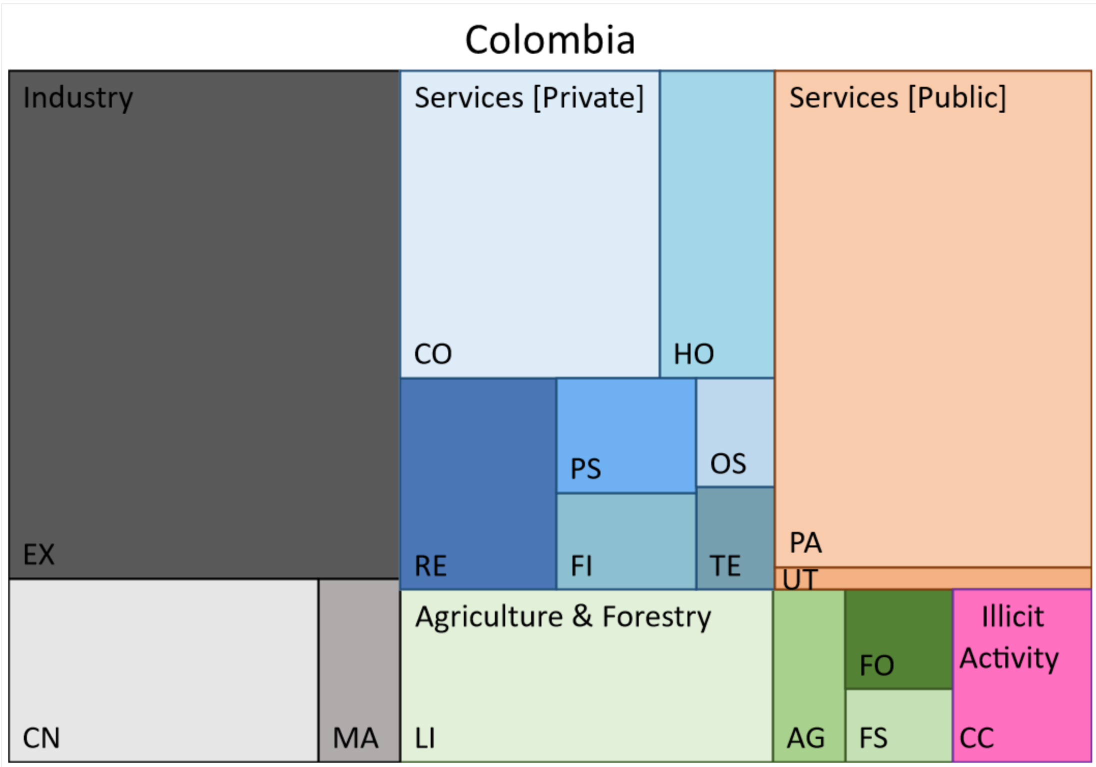
As shown in Figure A49, government economic programs play an important role on Colombian amazon. Programs linked to the peace agreement have increase public expenditures in the region. The main economic sectors in Caquetá and Putumayo are fossil fuel exploration and extraction activities, followed by livestock and agriculture; the contribution of forestry, legal timber extraction, and fishery products are minor (Corpoamazonía 2018), at least in official metrics [507] The contribution of the Amazonian economy to national GDP is the lowest in the nation, averaging only 1.07% in the 2010-2016, slightly higher than the experienced in the period 2000-2010. Nonetheless, growth of GDP for region between 2010 and 2016 was second highest averaging 4.29% (Fedesarrollo 2018).

Excluding the extractive sector, agriculture (including forestry and livestock) represented about 30% of the total value of the production of goods and services in the region. The importance of sectors such as industry, construction and commerce is low due to a scarcity of roads and telecommunications infrastructure. The inability to access markets impacts the cost of production and transportation (MINCIT 2019).

[506] https://www.portafolio.co/economia/pib-de-colombia-en-2020-registro-historica-caida-549142

[507] Corpoamazonía 2018. Informe de resultados.

Figure A49: GDP of the Amazonian jurisdictions of Colombia



Note: Agriculture and Forestry: Agriculture (AG), Fisheries and Aquaculture (FI), Forestry (FO), Livestock (LI); Industry: Extractives (EX), Manufacturing (MA), Construction (CN); Services (Private Sector): Real Estate (RE), Commerce (CO), Transportation (TR), Hospitality (HO), Telecommunications (TE), Finance (FI), Professional Services (PS), Other services (OS); Services (Public sector): Public Administration (PA), Utilities (UT); Illicit Activities: Coca/Cocaine (CC), Artisanal Gold (Au).
Source: DVAE - Dirección Nacional de Estadística.

Social and environmental context

Colombia hosts close to the 10% of the planet's biodiversity and ranks second among the countries containing the greatest biodiversity in the world. Additionally, Colombia ranks seventh in the world in terms of area covered by tropical forests (44.6 million hectares), which cover more than half of the country's mainland area (see Figure A50).

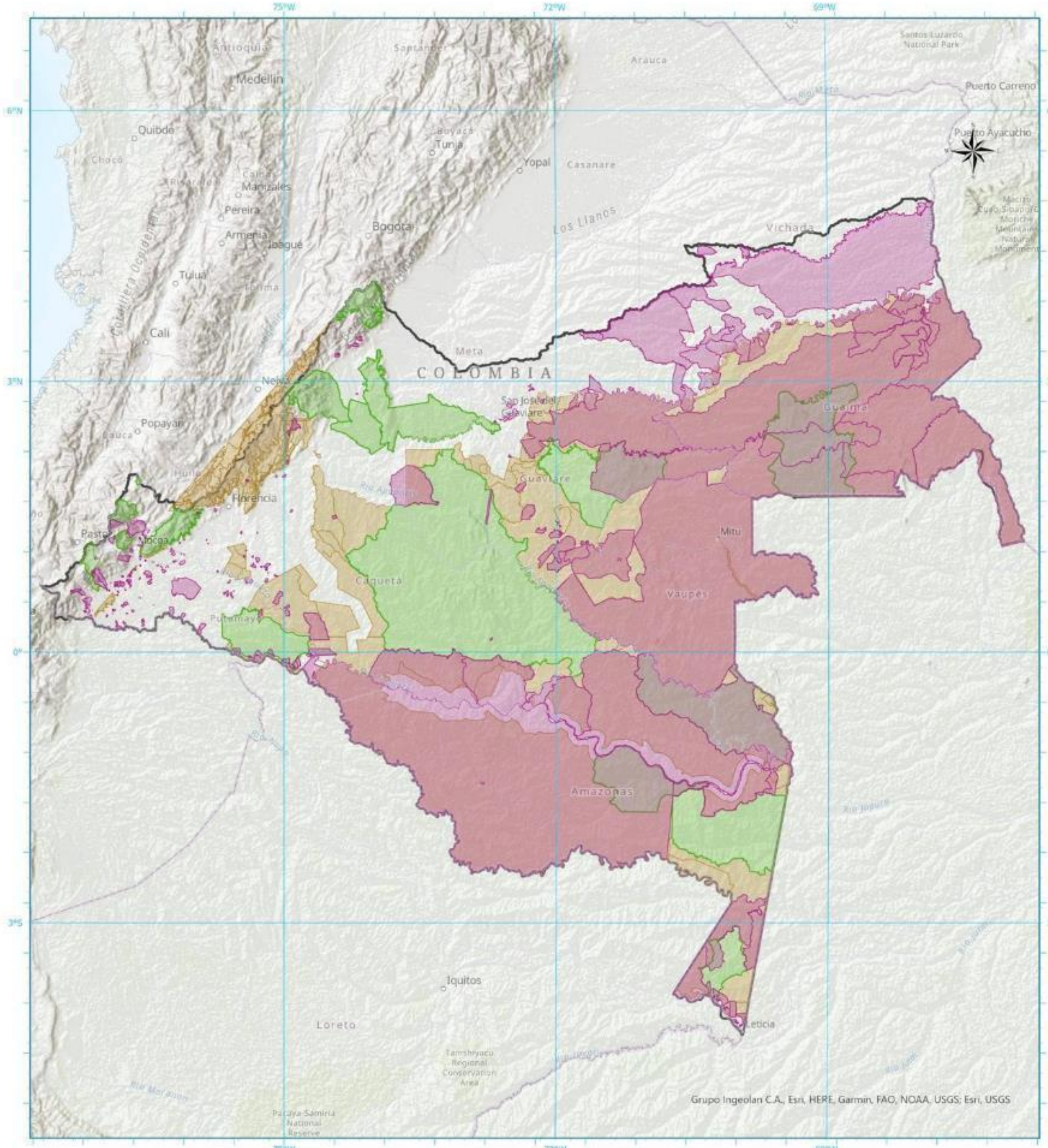
Deforestation is concentrated in those municipalities most affected by the internal conflict of the past 50 years; it is especially pronounced where illicit crop production and land grabbing were exacerbated by the absence of the state. Various estimates show that environmental degradation in Colombia (deforestation and forest degradation) represent losses equivalent to 3.7% of GDP (World Bank 2018). Agriculture, particularly the cultivation of illicit crops and cattle ranching are the leading causes of deforestation (compare Figures A51 and A52). The conflict also impacted the ratio of rural-urban population and internal migration accelerated in the second half of the twentieth century. Between 1990 and 2010 four million rural inhabitants were expelled from their homes and sought protection in urban areas (Andrade et al., 2018). That process has contributed to the land tenure chaos that negatively impacts investment in agriculture and other productive systems.

The country loses ~220,000 hectares of forest per year, 70% of that deforestation occurs in the Amazon departments (MADS 2018). Threats to biodiversity have been classified into two large groups. The first is the loss or replacement of natural cover by deforestation and transformation caused by infrastructure and agricultural frontier expansion (Figure A14). The second, ecosystem degradation, is caused by a loss of the ecological functions caused by the non-sustainable extraction of species, or the direct use of a resource beyond the carrying capacity of the managed ecosystems, as well as the introduction of exotic and invasive species or water and air contamination that negatively impact a natural or quasi-natural ecosystem. During the 2020-2018 period more than 2 million hectare of forest were lost.

Although these unsustainable models existed prior to the signing of the peace agreement, the post-conflict era is exacerbating environmental degradation, specifically an increase in annual deforestation rates in areas where the FARC had a presence like Caquetá and Putumayo.

Almost 80% of Colombian amazon (over 40 million hectares) are under active management of indigenous peoples, protected areas and forest reserves. Data shows that these instances had played a key role on non-allowing deforestation drivers to expand further into the amazon. Since those forests are valuable and productive for their stewards/managers (through food supply, tourism, timber and other non-timber forest products), a basis for a bioeconomy is already functioning on the ground. Even in the more than 3.2 million hectares already used for agricultural purposes, climate-smart practices and restoration techniques could be used in order to increase its productivity without needing more land extension.

Figure A50: Land tenure in the Colombian Amazon



Protected areas, Forest reserves and Indigenous territories in the Colombian Amazon

- Indigenous territories
- Protected areas
- Forest reserves
- Amazon Study Area

The total area of each of the three main categories (Indigenous Territories, Protected Areas and Forest Reserves) is equal to the number shown in the table plus the overlay with the other categories:
Indigenous Territories: IT + IT-PA overlap
Protected Areas: PA + IT-PA overlap
Forest Reserves: FR + IT-FR overlap

Land Rights	Extent (Hectares)
Indigenous Territories (IT)	4,792,944
Protected Areas (PA)	7,963,862
Forest Reserves (FR)	6,481,010
IT-PA overlap	3,204,510
IT-FR overlap	18,860,708
Private land rights or rights not yet awarded	9,471,369
Total	**50,774,403**

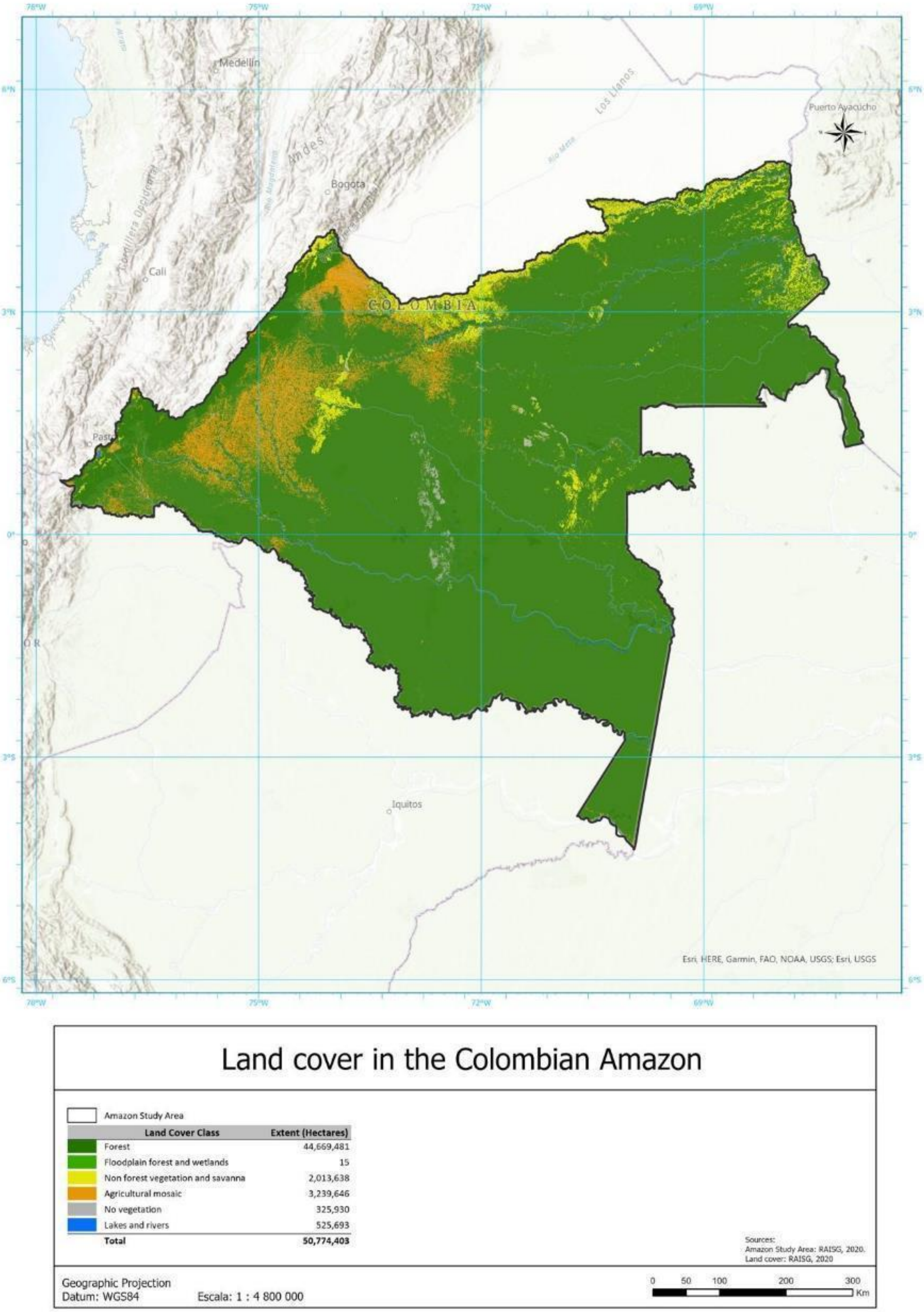
Sources:
Amazon Study Area: RAISG, 2020.
Indigenous Territories: Agencia Nacional de Tierras, 2019
Protected Areas: Parques Nacionales Naturales de Colombia, 2019
Forest Reserves: Parques Nacionales Naturales de Colombia, 2019

Geographic Projection
Datum: WGS84
Scale: 1:4,500,000

0 50 100 200 300 Km

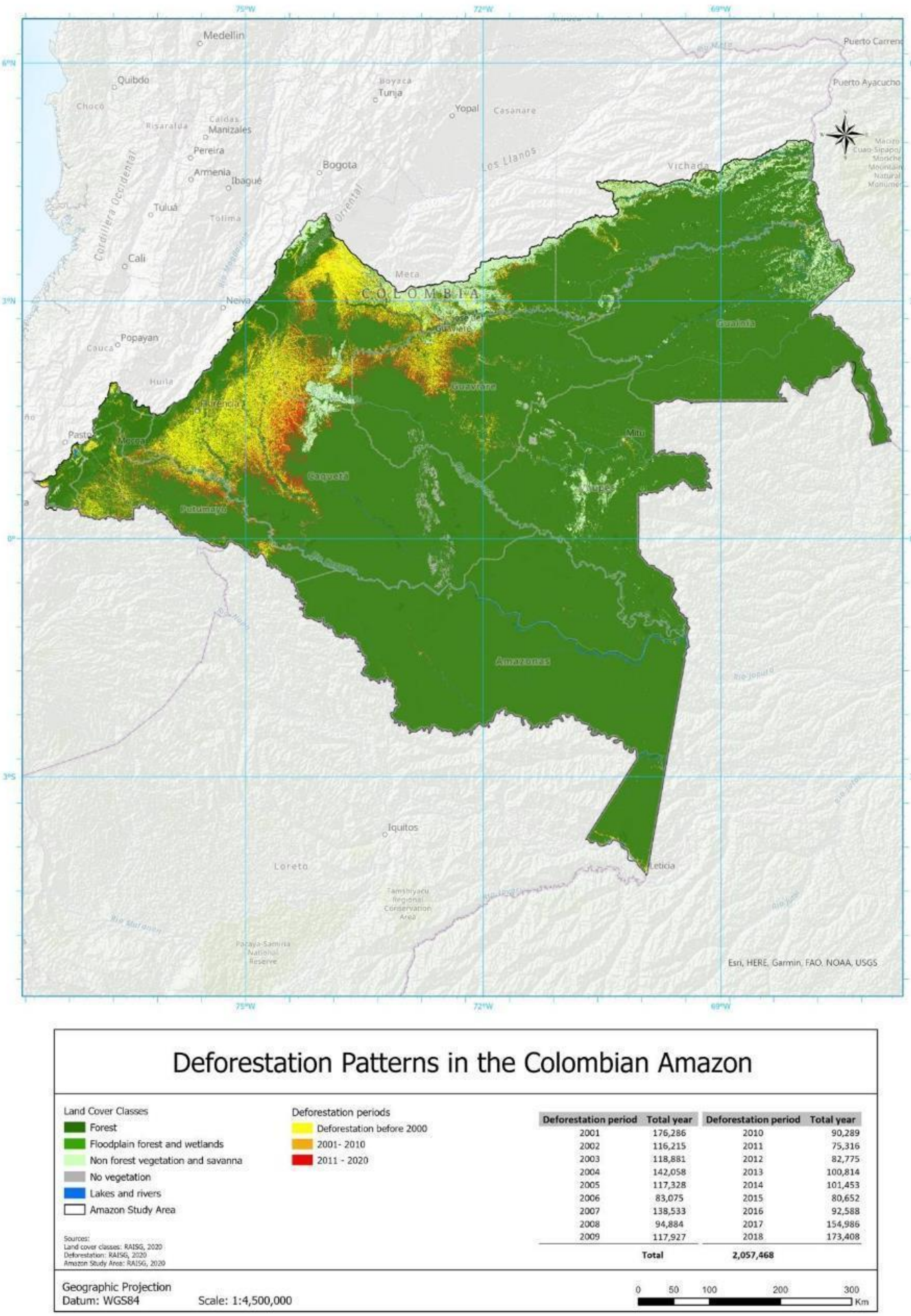
Source: Feasibility study team, based on RAISG 2020

Figure A51: Land cover in the Colombian Amazon



Source: Feasibility study team, based on RAISG 2020

Figure A52: Deforestation in the Colombian Amazon



Deforestation period	Total year	Deforestation period	Total year
2001	176,286	2010	90,289
2002	116,215	2011	75,316
2003	118,881	2012	82,775
2004	142,058	2013	100,814
2005	117,328	2014	101,453
2006	83,075	2015	80,652
2007	138,533	2016	92,588
2008	94,884	2017	154,986
2009	117,927	2018	173,408
	Total	2,057,468	

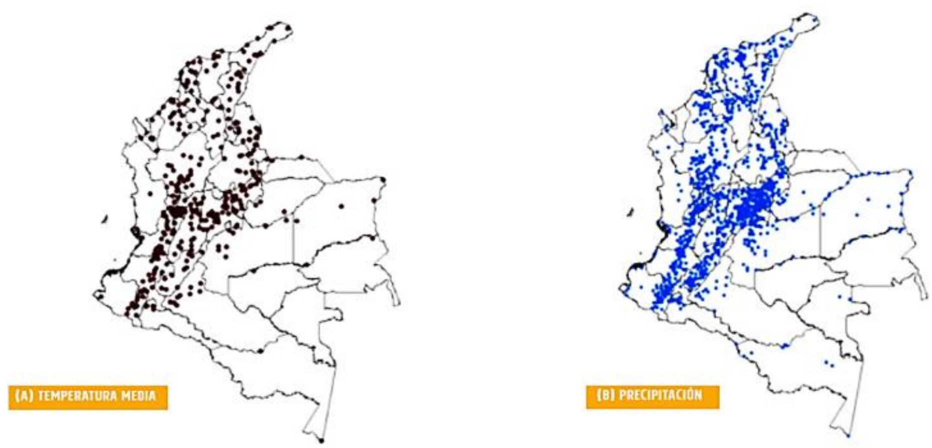
Source: Feasibility study team, based on RAISG 2020

Climate profile

Data and knowledge gaps

This report provides information at the national level, and where possible tries to focus on the Amazon region – the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[508] Much of the accessible climatological data for Suriname is compiled by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM, Instituto de Hidrología, Meteorología y Estudios Ambientales). Detailed information on climate variables, trends and projections is available through the country's Third National Communications to the UNFCCC from 2017.[509]
A notable data gap was finding specific information on the Colombian Amazon. In terms of meteorological monitoring, the distribution of meteorological stations in Colombia are spread predominantly throughout the Andean and Caribbean regions with a lack of weather stations in the Amazon region (see figure below). There is a tendency for climate change related documents and strategies to focus on more populated areas in the Andean and Coastal regions. This is an issue of uneven population distribution, but also the remoteness of much of the Amazon region.

Figure A53: Distribution of meteorological stations across the national territory of Colombia to monitor: a) mean temperature; and, b) precipitation.



Source: IDEAM et al. 2017

Overall climatology

Temperature

Colombia's mean annual temperature is influenced by the country's orographic characteristics. According with the third national communication,[510] the historic temperature across the country

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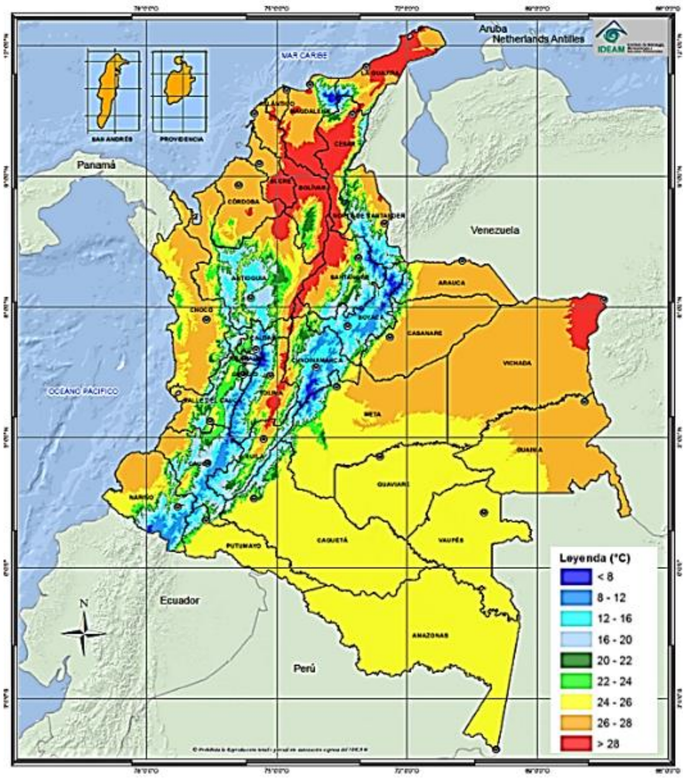
508 see list of references

509 IDEAM et al. 2017

510 IDEAM et al. 2017

ranges from warm (>24°C), temperate (24°C to 18°C), cold (18°C to 12°C), very cold (12°C to 6°C), sub-páramo (6°C to 3°C), páramo (3°C to 1.5°C) and snowy (<1.5°C) (see figure below).

Figure A54: Spatial distribution of average mean temperature for the period 1981-2010.



Source: IDEAM 2015.

<u>Precipitation</u>

The country's average mean annual precipitation is 3000mm (see figure below).[511] The Andean region is characterized by displaying a bimodal[512] rainfall pattern for the months April-May and October-November, which can be associated with the Intertropical Convergence Zone (ITCZ).[513] The Orinoquía and Amazon regions have a unimodal rainfall pattern, meanwhile the Caribbean region is characterized by having rainfall during the months of May to November.[514]

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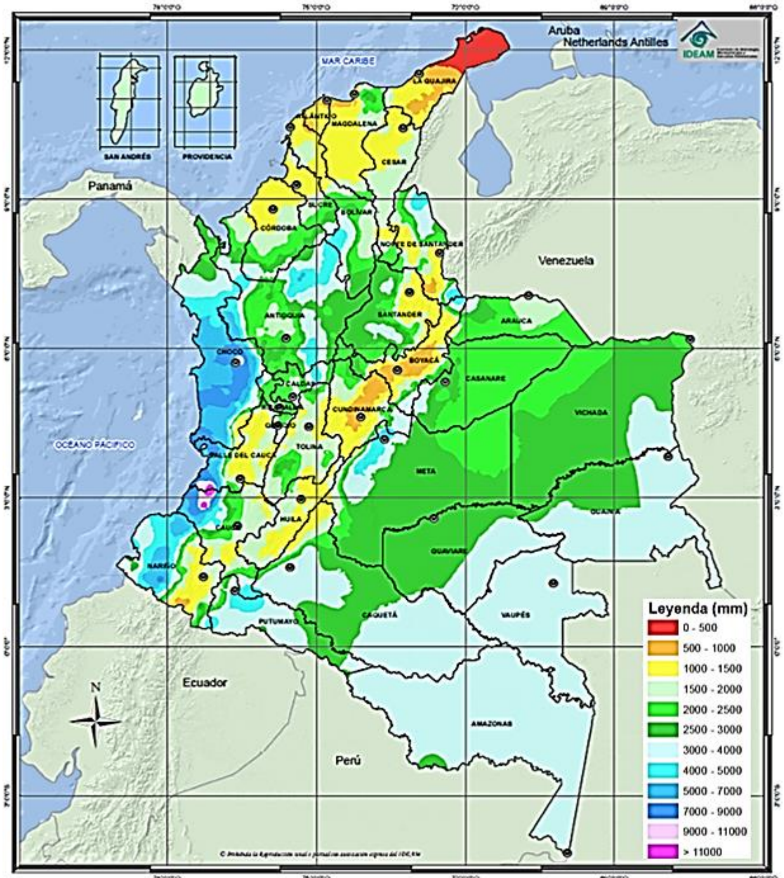
511 UNGRD 2018

512 Unimodal rainfall pattern refers to the occurrence of one dry season and one rainy season, and, in contrast, bimodal rainfall pattern refers to the occurrence of two or more wet seasons separated by at least one dry season (Urrea et al., 2019).

513 IDEAM et al. 2017

514 IDEAM et al. 2017

Figure A55: Spatial distribution of average mean annual precipitation for the period 1981-2010.



Source: IDEAM, 2015

Climate-related natural hazards

According with the Disaster and Risk Atlas of Colombia,[515] the main hazards facing the country are:[516]

- **Floods**: Flood events are strongly linked with 'La Niña' phenomenon. The areas that are particularly prone to flooding events are the valleys of the rivers Magdalena, Cauca, Atrato, Putumayo, among others (UNGRD, 2018). In the context of the Amazon, the region has areas that are the most vulnerable to floods are between departments of Vichada-Guianía and Putumayo-Caquetá (see Figure A56). GFDRR (n.d.) ranks all departments in the Colombian Amazon region as 'high risk' of river floods (see Table below).
- **Droughts**: Drought periods are strongly related by 'El Niño' phenomenon and affect drastically to food production across the country. The regions more vulnerable to droughts are those located in the Caribbean and some departments in the Amazon region, including: Vichada, Arauca, Guainía, and Meta departments.
- **Landslides**: The areas that are more vulnerable to landslides are located along the Andean foothills (see Figure A57), particularly along 'Cordillera Oriental' -which includes some areas of the departments

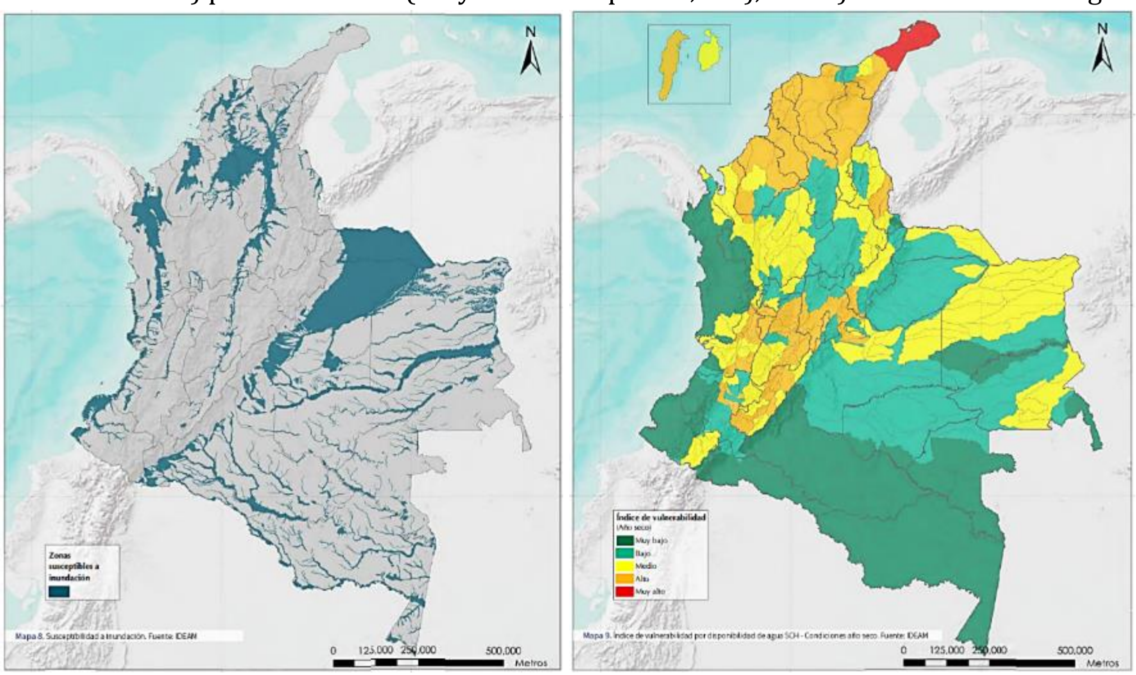
[515] UNGRD 2018

[516] Information from UNGRD 2018, unless otherwise mentioned.

of Note de Santander, Arauca, Boyacá, Cundinamarca, and Meta; and along the ‘Cordillera Occidental’ -including certain areas of the departments of Antioquia, Chocó, Risaralda, Valle del Cauca, and Cauca. GFDRR (n.d.) ranks Caquetá, Putumayo and Meta as “high risk” in terms of landslides, and all others in the Amazon region as “low risk”.

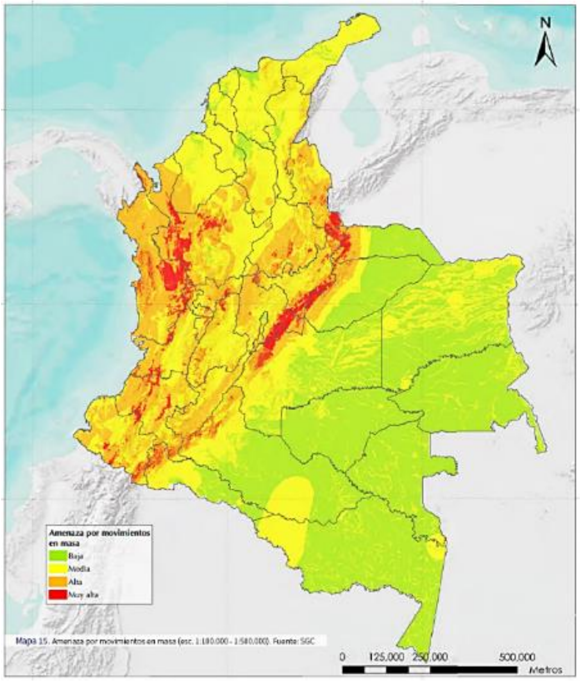
- **Wildfires**: The main period of occurrence of wildfires at the national level is during the months December-March and July-August. These events can be intensified by ‘El Niño’ phenomenon, particularly for the departments of Tolima, Huila, Nariño, Cundinamarca, Boyacá, Norte de Santander, César, Magdalena, Bolívar and Atlántico (see Figure A58). On the other hand, the Amazon region displays a decrease on the risk level, changing from ‘low’ to ‘very-low’ for the vast majority of the Colombian amazon. GFDRR (n.d.) has a slightly different ranking, which finds parts of Caquetá, Meta and Vichada are considered “high risk” (although this is likely parts of Meta and Vichada that are outside of the Amazon region), parts of Guaviare, Guainía and Putumayo are “medium risk”, and the rest are “low risk”.

Figure A56: Areas i) prone to floods (50-year return period, left), and ii) vulnerable to droughts (right)



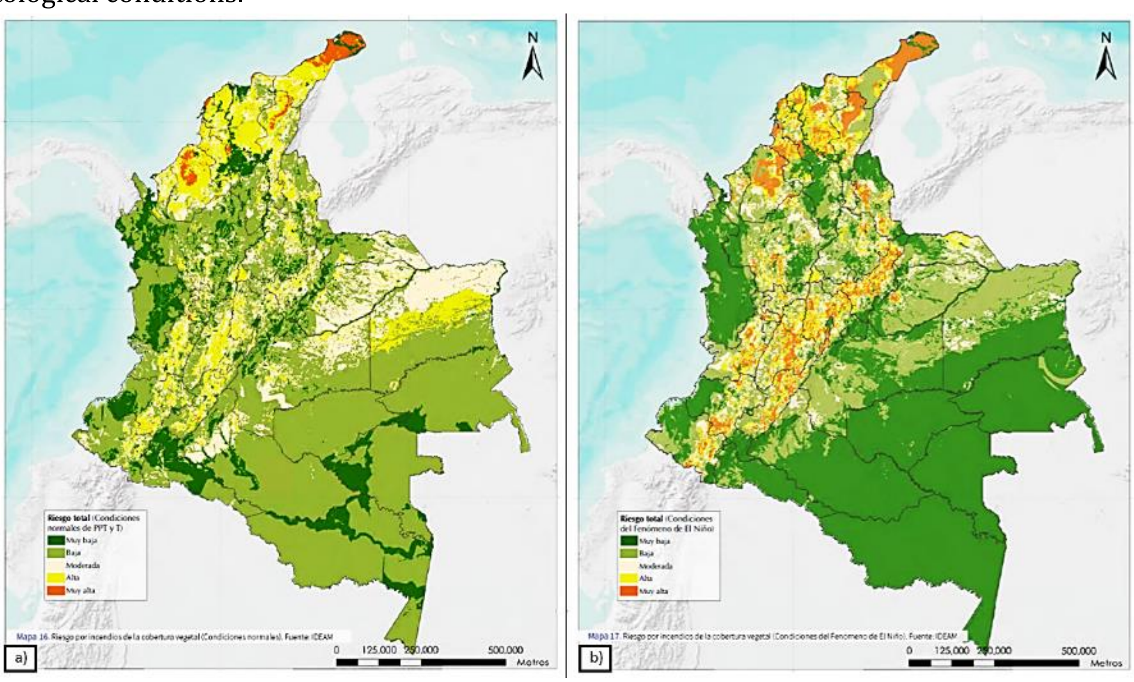
Source: UNGRD 2018, p. 48 and 54

Figure A57: Areas more vulnerable to landslides in Colombia.



Source: UNGRD, 2018, p. 70.

Figure A58: Wildfire risk areas under: a) normal precipitation and temperature conditions; b) 'El Niño' climatological conditions.



Source: Colombia's risk atlas (UNGRD, 2018), p. 78, 79.

The following Table provides a summary of the main climate-related hazards in the Colombian Amazon according to GFDRR (n.d.).

Table A16: Overview of climate-related natural hazard risk in Colombia and the Colombian Amazon

	River flood	Landslide	Extreme heat	Wildfire	Water scarcity	Cyclones
National						
Colombia	High	High	High	High	Low	High
Department level (for departments located in the Amazon region)						
Amazonas	High	Low	Medium	Low	Very low	Very low
Caqueta	High	High	Medium	High	Very low	Very low
Guaviare	High	Low	Medium	Medium	Very low	Very low
Guainía	High	Low	Medium	Medium	Very low	Very low
Putumayo	High	High	Medium	Medium	Very low	Very low
Vaupés	High	Low	Medium	Low	Very low	Very low
Meta*	High	High	Medium	High	Low	Very low
Vichada*	High	Low	Medium	High	Very low	Very low

*partly containing the Amazon region.

Source: GFDRR No date, https://thinkhazard.org/

Observed trends of climatic variables

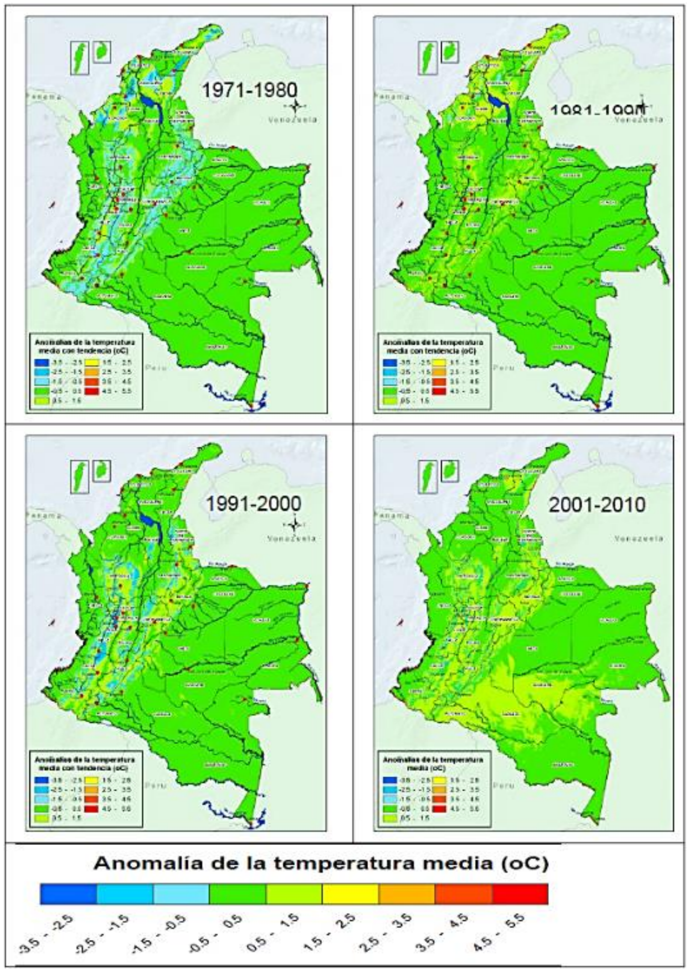
Temperature

The mean annual temperature has increased in 0.8°C from 1971 until 2015, with an average value of 22.4°C.[517] At a local scale, the regions of Amazonía, Orinoquía, Pacífico and some areas of the Caribbean displayed a variability of -0.5°C and 0.5°C for the period 1971-2010; contrastingly, some regions of the high Andes and Sierra Nevada de Santa Marta displayed atypical increases between 0.5°C and 1.5°C (see Figure below).[518]

[517] IDEAM et al. 2017

[518] Arango et al. 2012

Figure A59: Spatial distribution of the average temperature for the decades 1971-1980, 1981-1990, 1991-2000, and 2001-2010



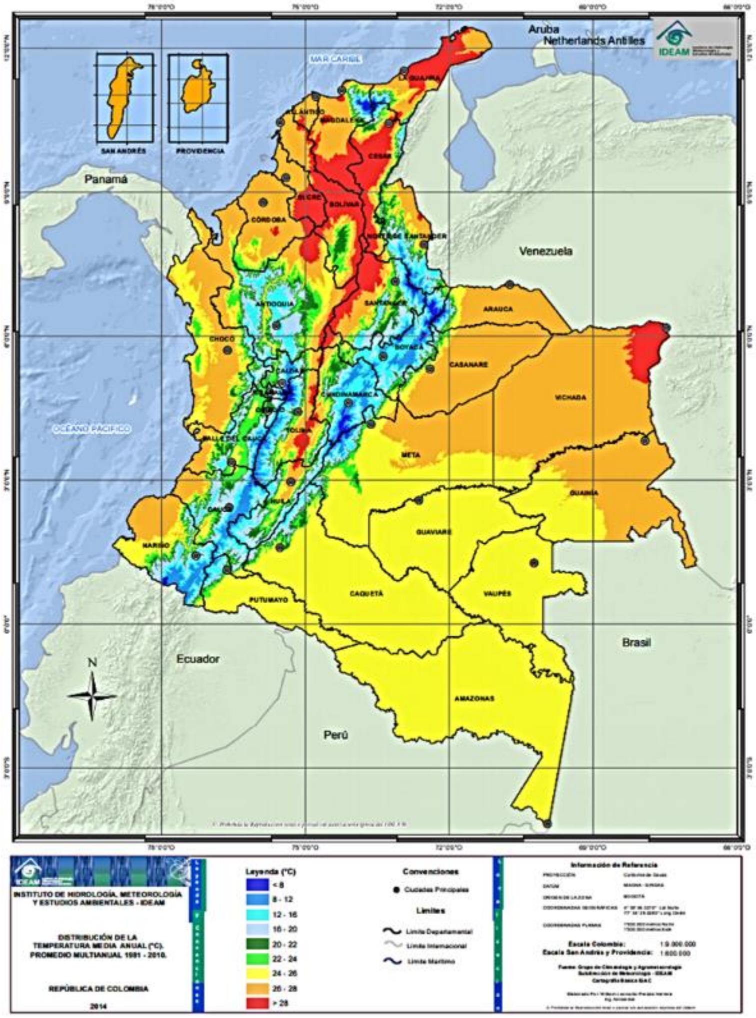
Source: Arango et al., 2012, p. 23.

Historical data shows that the regions that have recorded temperature above 28°C are located mostly in the Andean and Caribbean regions -along the 'Valle del río Magdalena', which include the departments of Huila, Tolima, Caldas, Boyacá, Santander, Antioquia, Bolivar, César, Sucre, Magdalena, and Atlántico, and the Caribbean area of the Department La Guajira; and a little nugget in the north-east region of Department of Vichada, in the Orinoquía region.

The Colombian Amazon region[519] has experienced an increase in temperature between 0.5°C and 1.5°C during the period 2001-2010 (see Figure 8), displaying a mean annual temperature distribution between 24°C to 26°C during the period 1981-2010 (see Figure below).

[519] The Colombian Departments that are part of the Amazon region are (CEPAL 2013): Amazonía, Caquetá, Guainía, Guaviare, Putumuayo, Vaupés, and south parts of Meta and Vichada.

Figure A60: Distribution of mean annual temperature (°C) for the period 1981-2010 in Colombia



Source: IDEAM 2015

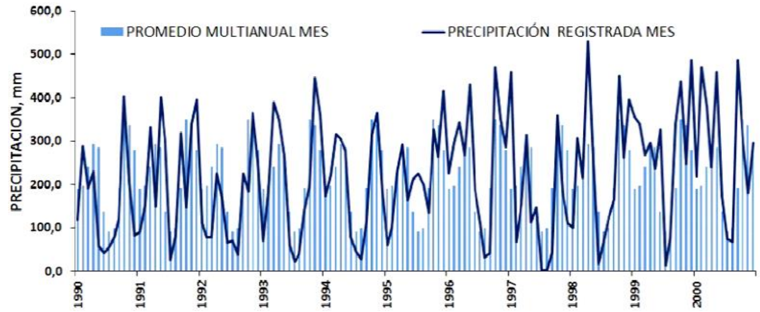
Precipitation

For the period 1981-2010, the country recorded mean annual precipitation values ranging from 500mm to 11000 mm.[520] In recent years, precipitation has been occurring earlier for central parts of the country in comparison with 25 years ago. For the period of 1961-1990, annual precipitation has varied between -4% and 6% (see Figure below).[521]

520 IDEAM 2015

521 World Bank 2021

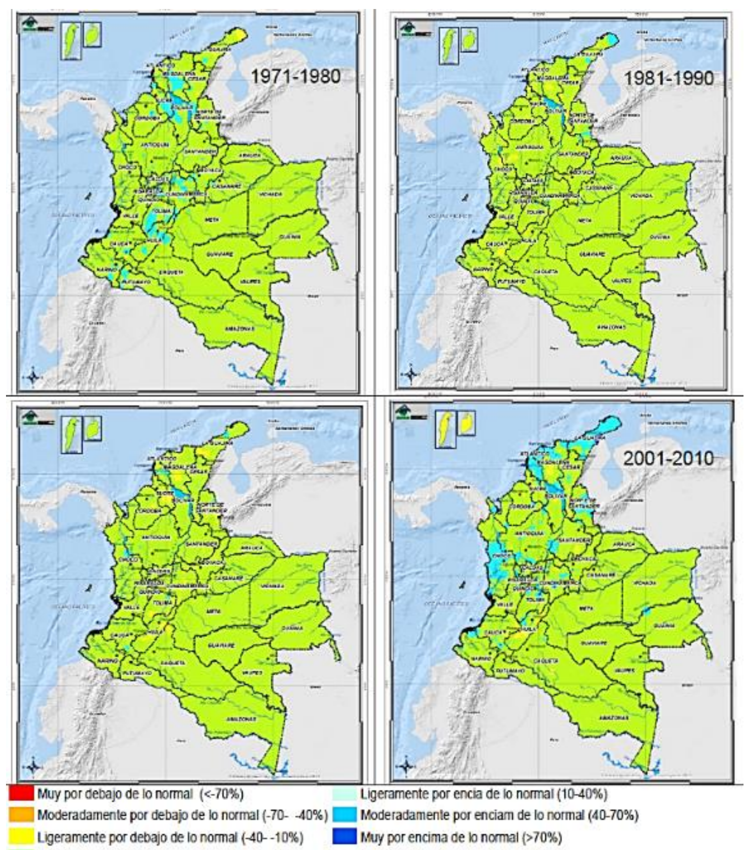
Figure A61: Trend in precipitation (line) and mean precipitation per month (bars) for the period 1990-2000



Source: IDEAM-UNAL 2018, p. 14.

According with Arango et al. (2012), the decade 2001-2010 recorded precipitation values between 10% and 40% above the average recorded for the period 1971-2000, particularly in the departments of La Guajira, Atlántico, Chocó and northern Magdalena and Santander; in contrast, there was a decrease between 10% and 40% of precipitation in some regions of Huila, Cauca, Cundinamarca, Santander and Magdalena (see Figure A62).

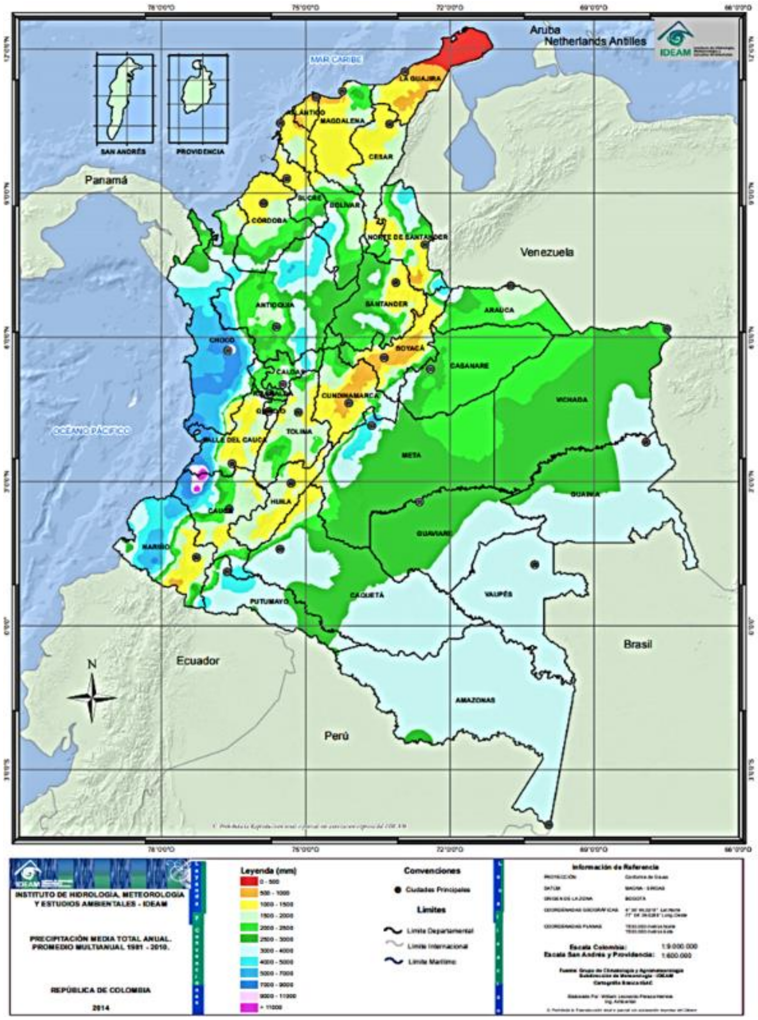
Figure A62: Spatial distribution of extreme events on precipitation for the decades 1971-1980, 1981-1990, 1991-2000, and 2001-2010.



Source: Arango et al., 2012, p. 22.

The Amazon region of Colombia displays a normal distribution of extreme precipitation events for the period 1971-2010, with values ranging from -10% and 10% (see Figure 11).[522] Additionally, the Pacific region of Colombia recorded the highest mean annual precipitation during the period 1981-2010, with most of the values in the range of 4,000mm to 9,000mm, and a small patch between the Departments of Cauca and Valle del Cauca, where precipitation values ranged between 9,000mm and above 11,000mm (see Figure below).

Figure A63: Mean annual precipitation of Colombia for the period 1981-2010



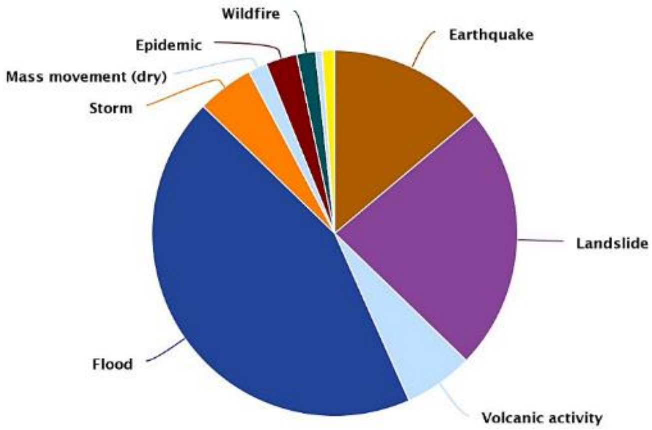
Source: IDEAM 2015

Climate-related natural hazards

For the period 1900-2018, the country's more recurrent climate-related natural hazards were (see below; World Bank 2021): flood with an average occurrence of 43.89% followed by landslide (23.33%), tropical storm/cyclone (5.00%), wildfire (1.67%), and drought (1.11%).

[522] Arango et al. (2012)

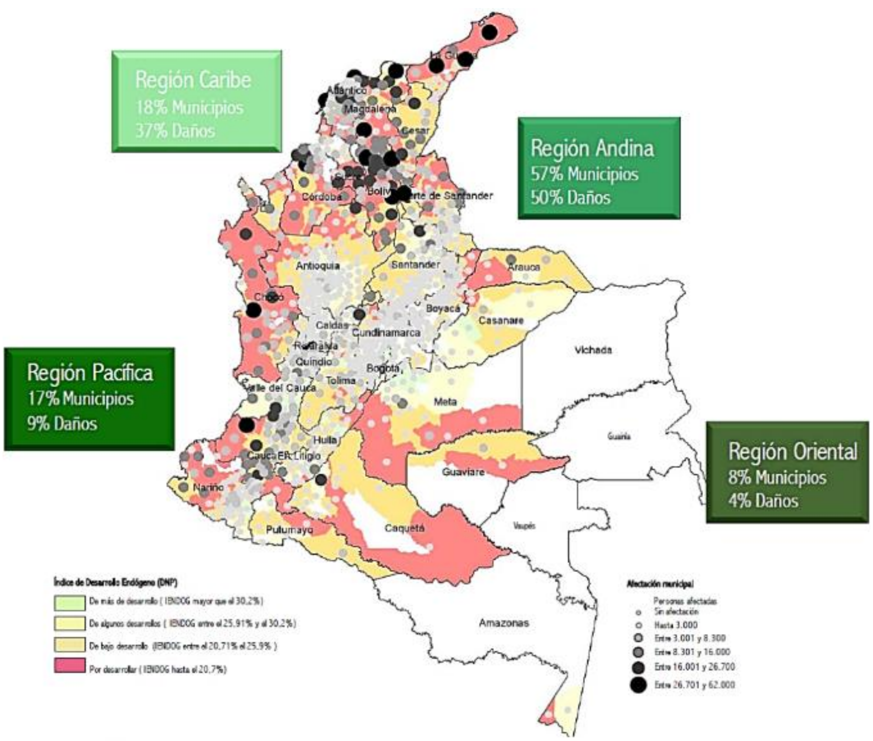
Figure A64: Average annual natural hazard occurrence for the period 1900-2018.



Source: World Bank 2021.

There is evidence that extreme climate-related natural hazard events are displaying an increase of occurrence and intensity. During the 'La Niña' climatic phenomenon that occurred during 2010-2011, the country exceeded the historic flooding events for the past 39 years; which generated damages on 50% on the Andean region, 37% on the Caribbean region, 9% on the Pacific region, and 4% on the Amazon region (see figure below).[523]

Figure A65: Estimated impacts of "La Niña" ocean-atmospheric phenomenon during the years 2010-2011.



Source: DNP 2018, p. 39.

523 DNP 2018

Climate change projections

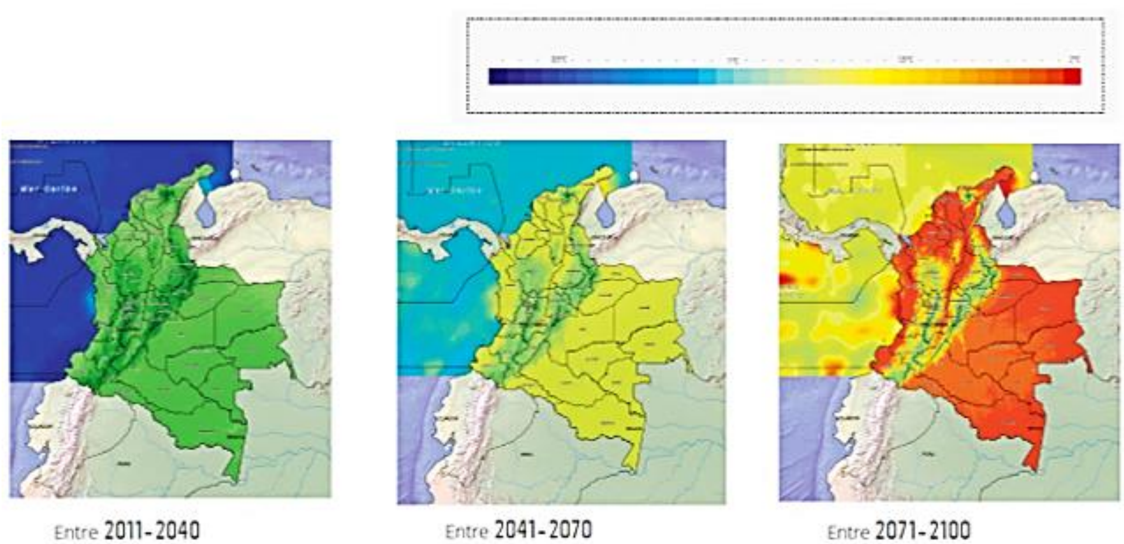
The CMIP5 model (used in the latest IPCCC report), and RCP 2.6 and 8.5 are primarily used for these projections, due to their use in Colombia´s Third National Communication to the UNFCCC. Information from the Third National Communication has been complemented by information using the CMIP5 model from the World Bank Climate Change Knowledge Portal.

Temperature

According with the representative concentration pathways (RCP), the temperature can change between 1°C to 1.5°C and 1.5°C to 2°C for the RCP2.6 and RCP8.5, respectively, for the period 2041-2070; moreover, for the period 2071-2100, it is expected to have an increase of 1°C for the RCP2.6 and an increase between 2°C to 3.5°C according with the RCP8.5.[524]

It is expected that by the year 2040 the temperature could rise by 0.9°C, by the end of 2070 by 1.6°C, and 2.4°C by the end of 2100 (see Figure below).[525] This projection would imply an average mean annual temperature of 24.8°C by the end of the century.[526] The Coastal and Amazon regions are expected to see the largest increases in temperature. In terms of seasonal changes, average changes in temperature would be similar for all quarters of the year (December-February, March-May, June-August, and September-November).[527]

Figure A66: Projected temperature scenarios for the period 2011-2100 (with respect to the period 1976-2005)[528]



Source: IDEAM et al., 2017, p. 25.

[524] IDEAM et al. 2017

[525] IDEAM et al. 2017

[526] IDEAM et al. 2017

[527] IDEAM et al. 2017

[528] This is the average of all 4 RCPs.

The following table contains a summary of projected changes of other temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A17: Projected changes of temperature-related climate variables in Colombia (at the national level), compared to 1986-2005

Variable	***RCP 2.6***				***RCP 4.5***				***RCP 8.5***			
	2020-39	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***
Maximum daily temperature (°C)	1.09	1.37	1.47	1.52	1.07	1.66	2.23	2.38	1.24	2.43	3.81	5.28
Minimum daily temperature (°C)	1.06	1.37	1.35	1.30	1.16	1.62	2.08	2.23	1.23	2.22	3.38	4.58
Hot days (above 35°C)	13.43	17.65	19.86	20.41	13.35	24.76	37.49	41.50	16.38	40.17	81.61	131.64
Hot days (above 40°C)	0.21	0.35	0.46	0.41	0.24	0.60	1.47	1.66	0.40	1.95	7.67	23.91

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

According to the Third National Communication to the UNFCCC,[529] there is no clear tendency of increase or decrease on future precipitation and, additionally, there is no significant differences on the precipitation volumes modelled by all the RCPs. Nonetheless, a reduction between 10% to 30% of the mean annual precipitation could be expected for the for the period 2011-2040 in contrast with the period 1971-2000.[530]

It is expected that for the period 2011-2100 the Caribbean and Amazon regions will experience a reduction on precipitation between the ranges of 10% to 40%, however there is substantial uncertainty associated with these projections (see below).[531] In terms of seasonality, the Caribbean region would see stronger precipitation in the period from March-May and September-November. Increases in precipitation intensity would occur in the Andean region from June-November, and possibly Orinoquia and the Southern Caribbean in the period from March-May. [532] Precipitation reductions are projected in the period from December- February in the Andean, Caribbean, Central and Southern Pacific Region, as well as Orinoquia and the Amazon region.[533]

529 IDEAM et al. 2017

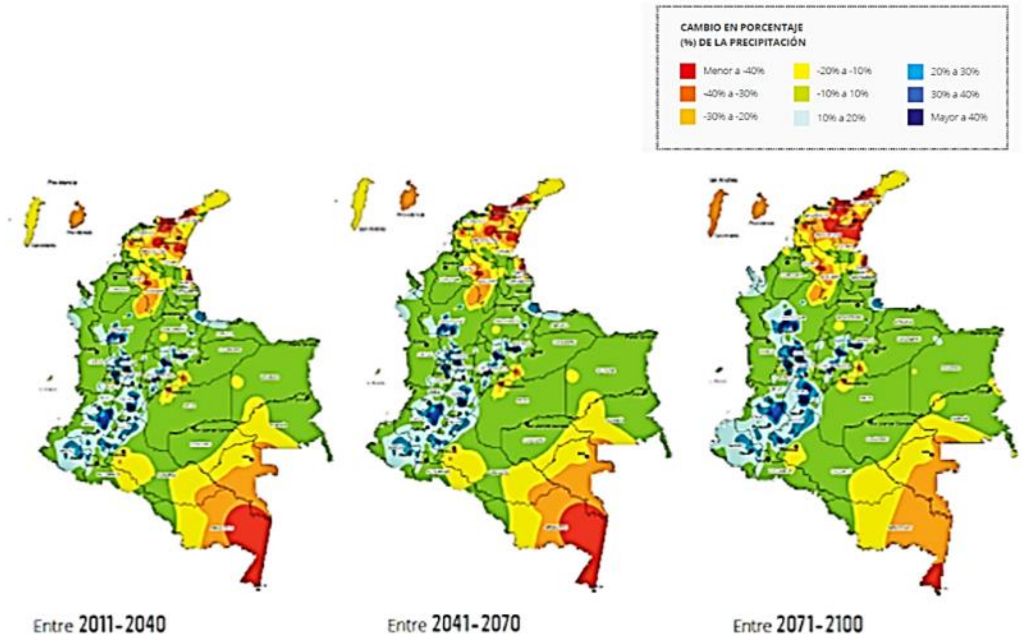
530 DNP 2018

531 IDEAM et al. 2017

532 IDEAM et al. 2017

533 IDEAM et al. 2017

Figure A67: RCP precipitation scenarios for the period 2011-2100 (with respect to the period 1976-2005) [534]



Source: IDEAM et al. 2017, p. 26.

The following table contains a summary of projected changes of other precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A18: Projected changes of precipitation-related climate variables in Colombia (at the national level), compared to 1986-2005

Variable	*RCP 2.6*				*RCP 4.5*				*RCP 8.5*			
	2020-39	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*
Days with rainfall >20mm	-1.20	-0.77	-0.82	-1.08	-0.08	0.71	0.74	1.00	1.14	2.04	3.12	3.81
Rainfall of very wet days (%)	-5.99	-2.97	-2.41	-3.30	7.61	12.41	14.88	17.09	13.12	20.41	28.99	36.02
Maximum daily rainfall (10 year RL) (mm)	2.31	3.52	3.46	2.75	3.15	5.03	5.60	5.25	4.18	5.30	8.66	13.17
Maximum daily rainfall (25 year RL) (mm)	3.25	4.49	4.39	3.77	4.09	6.21	7.37	6.26	5.46	6.69	11.37	16.95

534 This is the average of all 4 RCPs.

Projected change in annual rainfall (mm)	-40.10	-5.53	-62.84	-82.80	-26.74	-53.17	-51.13	-50.60	4.28	-34.66	62.51	45.11
Severe drought likelihood	0.05	0.05	0.05	0.07	0.07	0.07	0.11	0.11	0.04	0.08	0.12	0.20
Probability of heat wave	0.08	0.12	0.12	0.13	0.10	0.20	0.31	0.36	0.12	0.33	0.63	0.85

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Climate-related natural hazards

According with Colombia’s National Adaptation Plan (NAP), the following are expected impacts of projected climate-related natural hazards:[535]

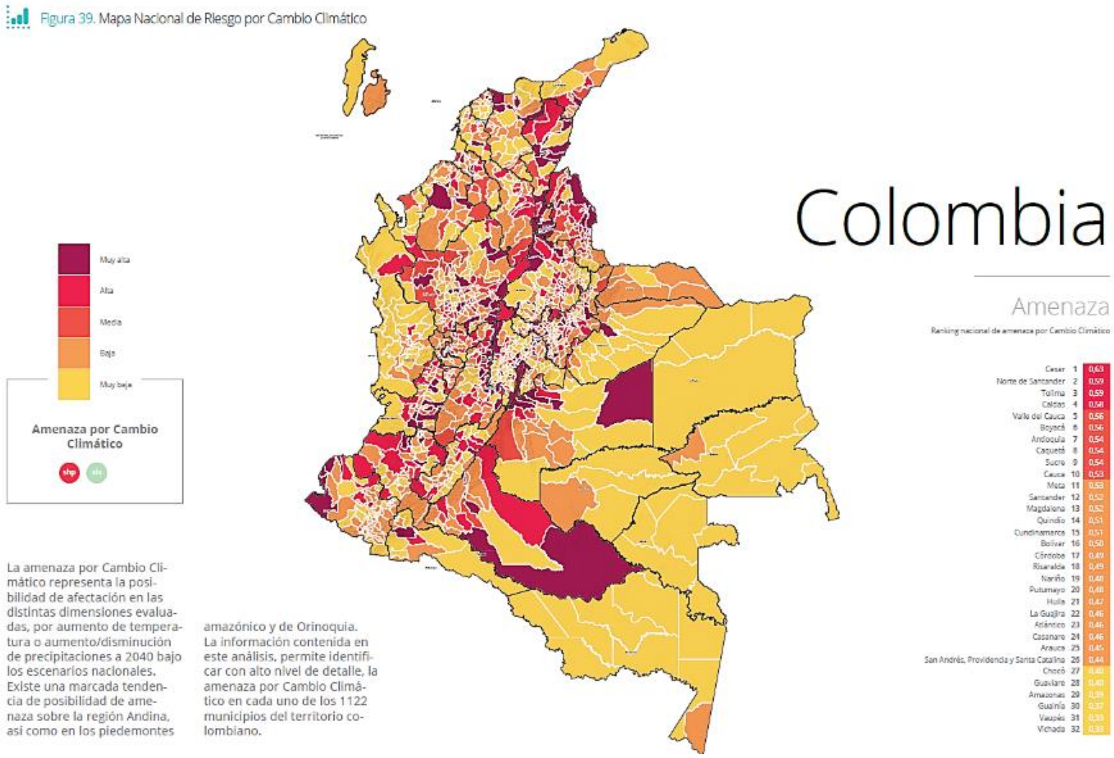
- Increased maximum temperatures and more hot days could represent: increased mortality rates among the elderly and poorer sector of the urban population; heat stress on the local fauna; increase of crop damage; decrease of water reservoirs’ quantity and quality; and, increase risk of wildfires.
- Increased events of intense precipitation could signify an increase of: flooding, landslides and avalanches; soil erosion; and, flash flooding.

Colombia´s Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) provides an overview of the departments and municipalities that are most at risk of climate change hazards (see Figure below).[536] Majority of high-risk municipalities are concentrated in the Amazon and Coastal regions, with the exception of Caquetá (which ranks 8th).

[535] DNP 2018

[536] IDEAM et al. 2017

Figure A68: Risk of climate change hazards in Colombia



Source: IDEAM et al. 2017, p.95

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:
In terms of sensitivity, there are various biophysical characteristics that make the region susceptible to flooding (slope, soils; Figure A69 and A70).[537] Colombia's Amazon region is, however, less susceptible to droughts than other regions of the Amazon,[538] and is also less susceptible than other countries due to the comparatively low reliance on agricultural activities in the region (Figure A71).[539]

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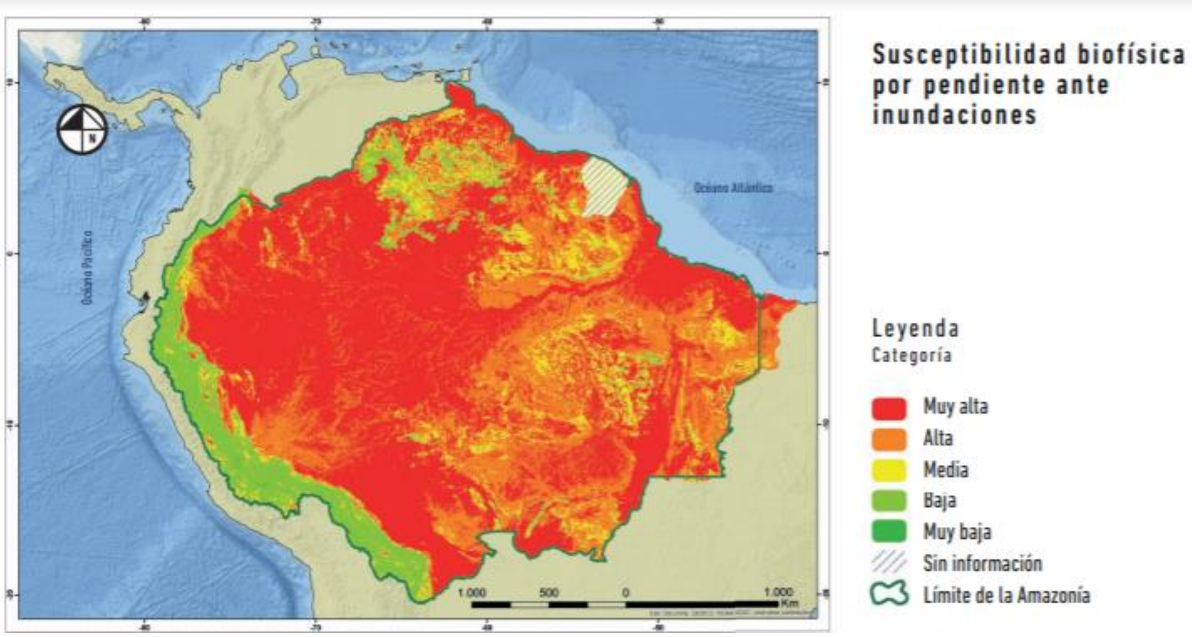
[537] Pabón-Caicedo et al. 2018

[538] Pabón-Caicedo et al. 2018

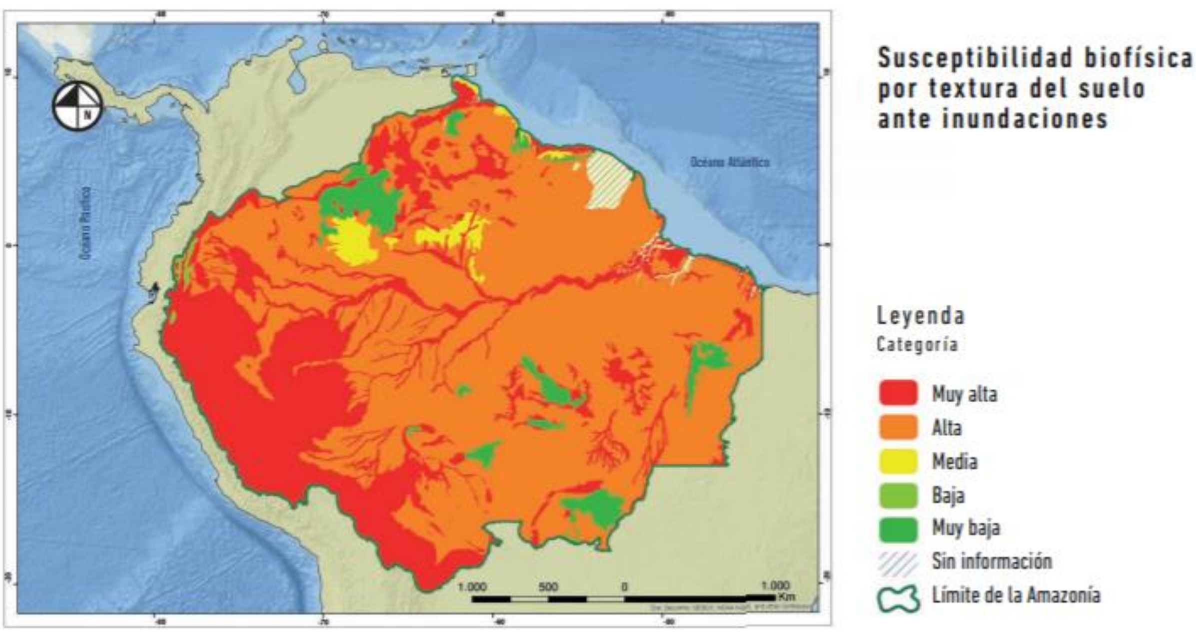
[539] Pabón-Caicedo et al. 2018

Figure A69: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin

a)



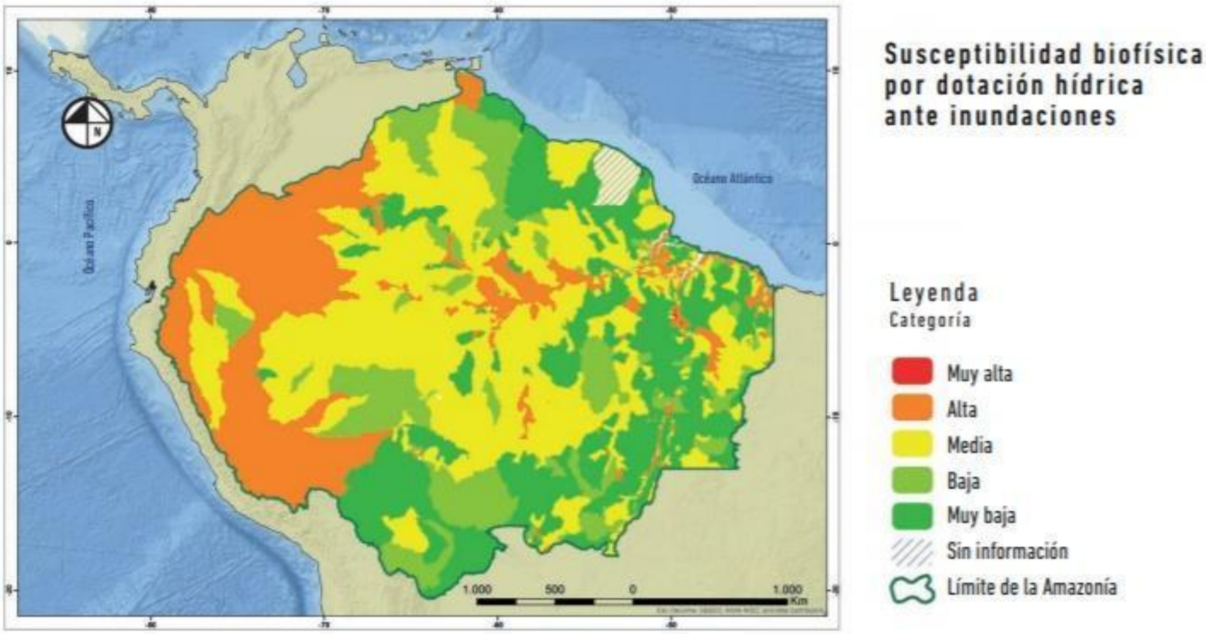
b)



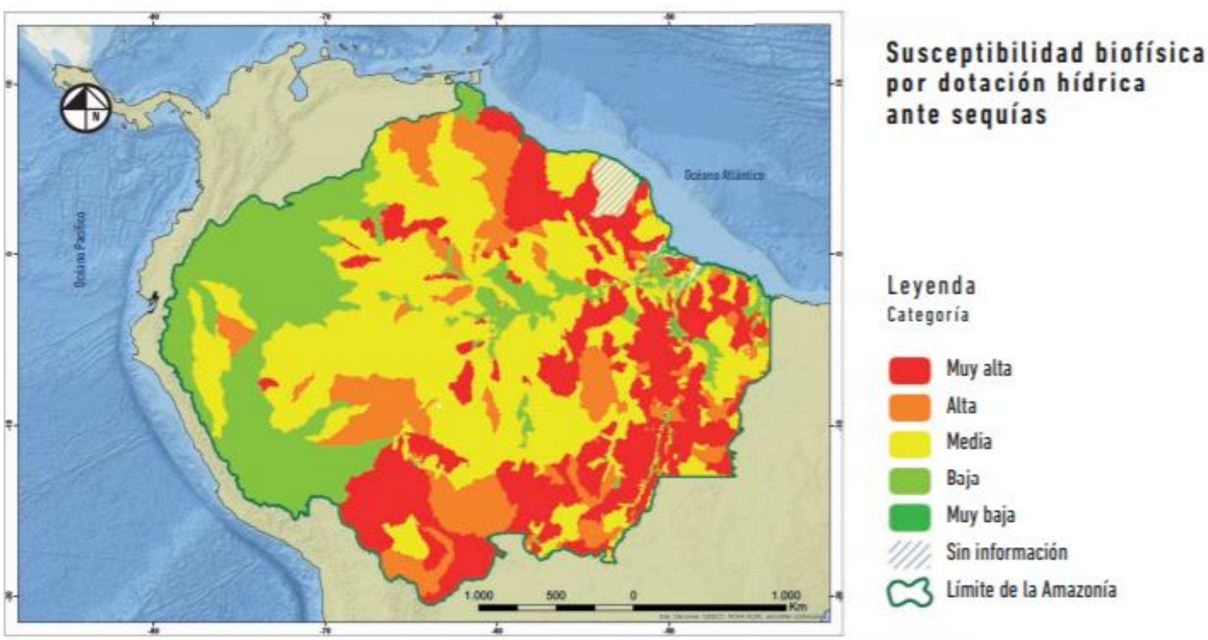
Source: Pabón-Caicedo et al. 2018, p. 42

Figure A70: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin

a)

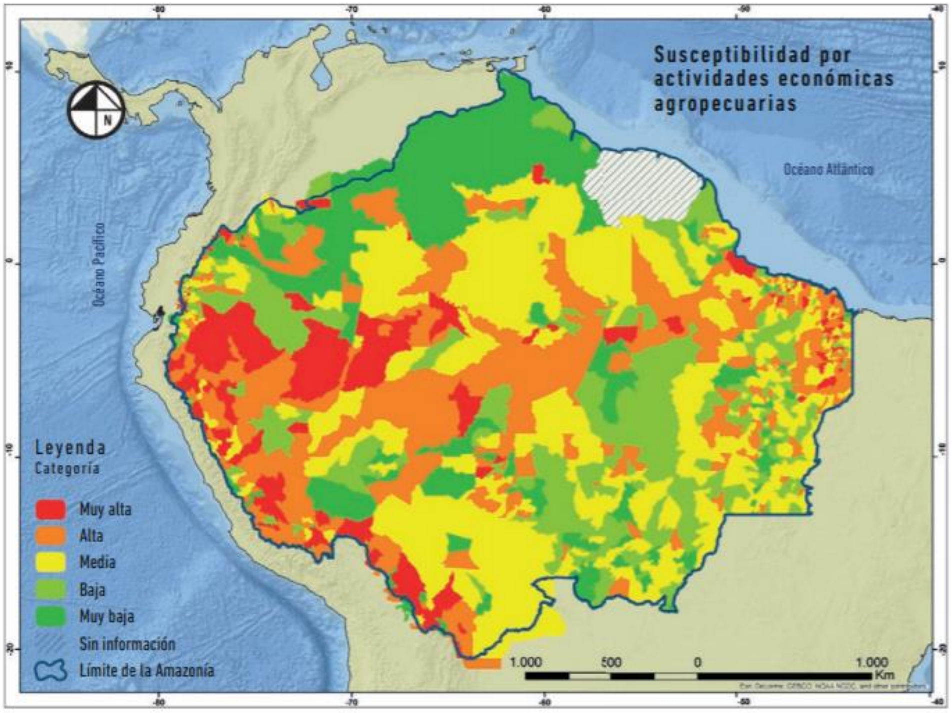


b)



Source: Pabón-Caicedo et al. 2018, p. 42

Figure A71: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector

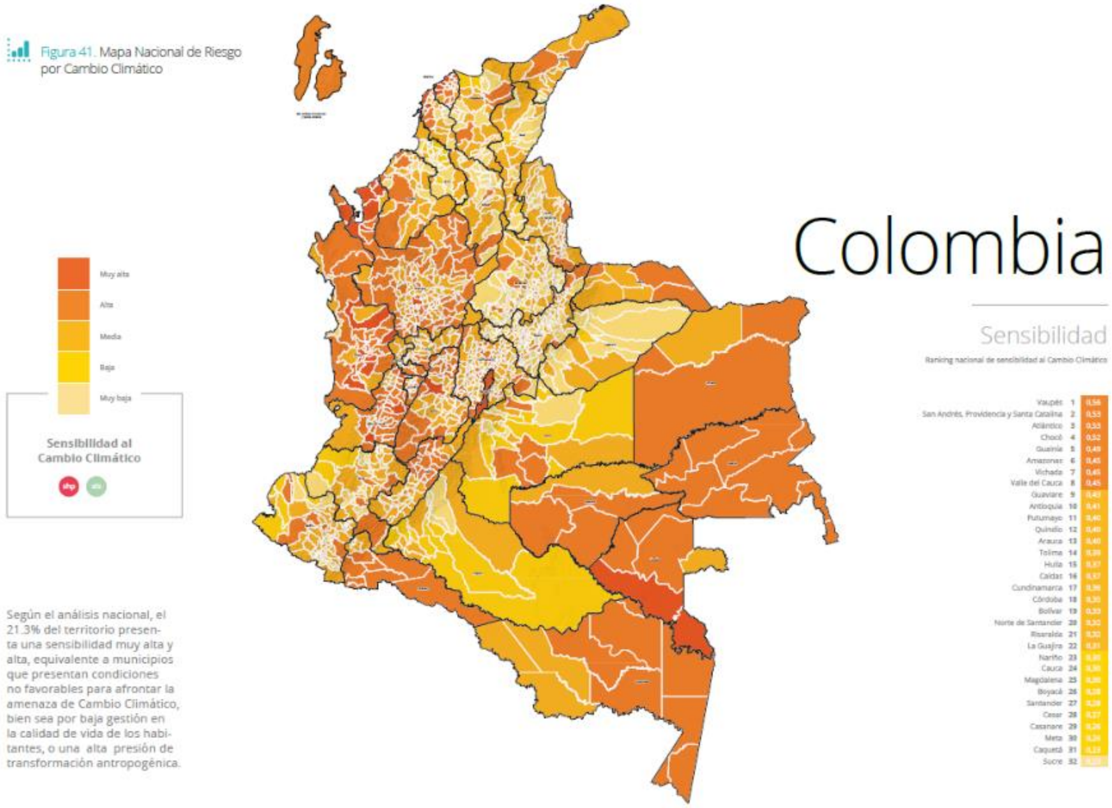


Source: Pabón-Caicedo et al. 2018, p. 41

This analysis is in line with the Analysis conducted by Colombia for their Third National Communication to the UNFCCC, which found departments and municipalities in the Amazon region were among those with the lowest adaptive capacity and highest sensitivity to climate change (see the following Figures below).[540] This is partly due to limited adaptation plans for municipalities in the region, a comparatively poor quality of infrastructure, quality of life and poverty, and a high anthropogenic pressure resulting in deforestation and the transformation of ecosystems.

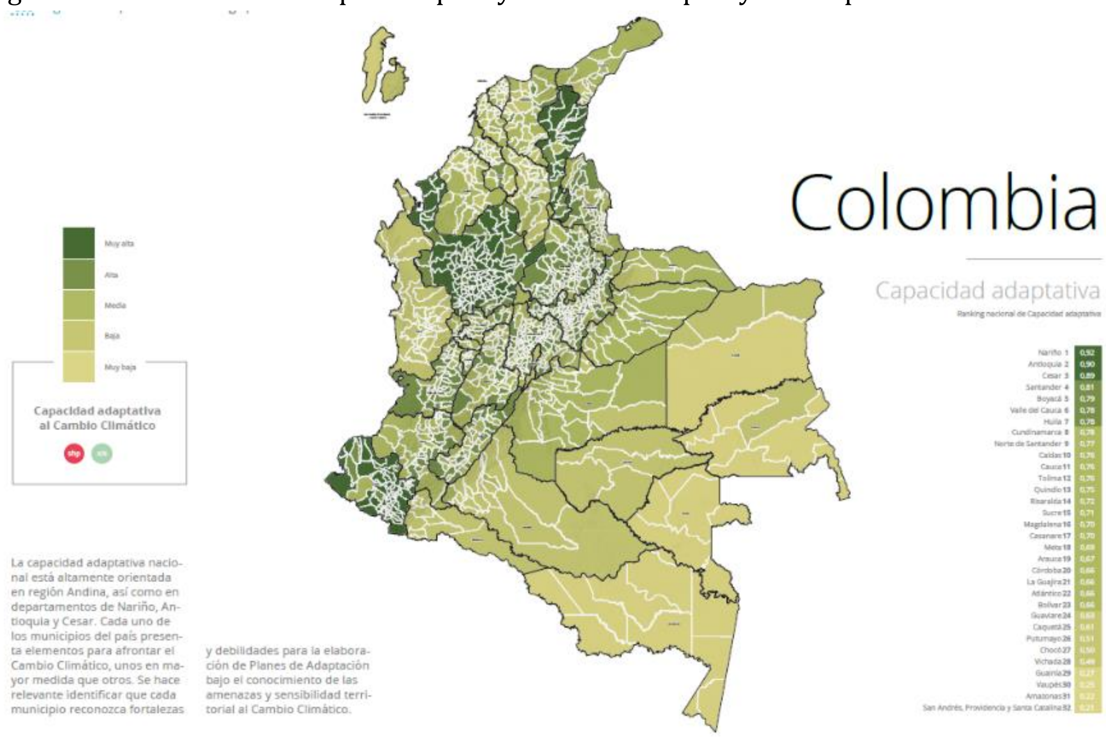
[540] IDEAM et al. 2017

Figure A72. Overview of sensitivity to climate change at the municipality and department level



Source: IDEAM et al. 2017, p.97.

Figure A73: Overview of adaptive capacity at the municipality and department level



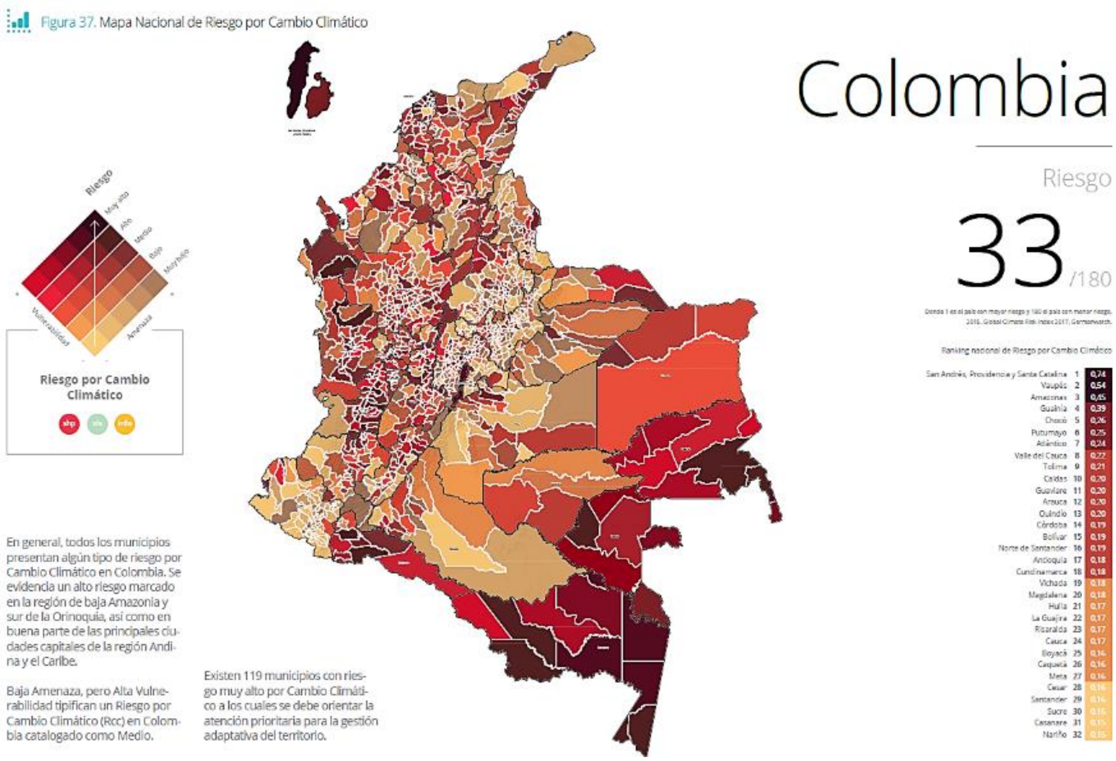
Source: IDEAM et al. 2017, p.96.

Climate risks and impacts on the bioeconomy and local livelihoods

Climate Risk Colombia

On the GermanWatch Climate Risk Index for 2020,[541] Colombia is ranked 28 in the world, and in terms of fatalities, it ranks 17. In 2019, Colombia experienced an estimated USD $37 million in economic losses, 64% losses per unit GDP, and 17 fatalities.[542] Additionally, 47% of the country was categorized as 'high risk' or 'very-high risk' of adversity to climate threats (see Figure below).[543]

Figure A74: Overview of climate risk per municipality and department in Colombia



Source: IDEAM et al. 2017, p.92.

It is projected that the effects of climate change in sectors such as agriculture, fisheries, livestock and transportation will result in average annual losses equivalent to 0.49% of GDP during the period from 2011 to 2100.[544] The National Planning Department (DNP, Departamento Nacional de Planeación) further estimates an average reduction of 7.4% in agricultural yields at the national level.[545] These effects will have consequences for all farmers. However, given their high exposure and low adaptive capacity, small-scale farmers are particularly vulnerable.

541 Eckstein et al. 2019

542 Eckstein et al. 2021

543 IDEAM et al. 2017

544 BID-CEPAL-DNP 2014

545 GDP would be 0.49% less than in a macroeconomic scenario without climate change; DNP-BID 2014

During the period from 1914-2018, it has been estimated that droughts caused approximately USD $67.9 billion in losses across the country, including crop damage of 680,120 ha, and affecting approximately 3.2 million people directly or indirectly.[546] During the same period, flooding resulted in losses and damages of up to USD $406 billion nationally, causing crop damage across 2.1 million ha, resulting in 77,057 lost livestock, and affecting over 20 million people either directly or indirectly.[547]

Climate Impacts and Risks for Colombia's Amazon region

The Amazon region is one of the most at risk regions in Colombia in terms of climate change. Vaupes and Amazonas departments ranked 2nd and 3rd nationally in terms of climate risk, and are considered as "very high risk". Guainía (ranked 4th nationally) and Putumayo (6th) are considered "high risk", and Guaviare (11) is considered "medium risk". Vichada (19), Caquetá (26), and Meta (27) are classified as low risk. The high risk in the Amazon region is particularly attributed to the low level of adaptive capacity and high sensitivity.[548]

Several adverse effects on the health and livelihoods of the population as well as vital ecosystems in the Amazon region can be inferred from the possible effects of climate change:

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. While majority of existing studies focus on the coastal and Andean regions of Colombia, potential impacts could include: changes in productivity, crop failure, increased or changing need for production inputs, losses and damages due to hazards (floods, droughts, fires), shifting production zones, pest and disease outbreaks, among others. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.).
- Climate change and climate-related hazards (such as extreme drought and flood events) may **limit access to food and foraging** in the Amazon region. Given the Covid-19 pandemic, this additionally puts indigenous communities and their elders at higher risk of contracting and spreading Covid-19.

Risk of injury, death and health impacts

- In addition, climate-related hazards (e.g., flooding, fires) could result in **injury, illness or death.**[549] Climate-related hazards, such as wildfires, also have indirect negative health impacts including poor air quality that contribute to an increased incidence of respiratory illnesses.[550] Increasing temperatures may also increase heat stress, particularly affecting the elderly.[551]
- Climate change has the potential to increase air and soil temperatures that could create the necessary conditions for a **wider distribution of disease transmitters** such as mosquitoes, ticks and rodents.

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546 UNDRR 2020

547 UNDRR 2020

548 IDEAM et al. 2017

549 WHO and UNFCCC 2015

550 WHO and UNFCCC 2015

551 WHO and UNFCCC 2015

Consequently, conditions for the spread of diseases (e.g., dengue fever, malaria and leishmaniasis) and epidemics would be more likely to occur.[552]

Risk of losses and damages to infrastructure and housing due to climate change and climate-related hazards

- **It is further expected to result in increasing losses and damages** to communities in the Amazon, as well as infrastructure (e.g., housing, small-scale farms, and tourism infrastructure) (DNP 2018). The aftermath of such events may have a particularly strong impact on internally displaced persons and women.[553]

Risk of loss and degradation to freshwater ecosystems and negative impacts on related livelihood activities

- **Annual recurring drought events threaten water quality and quantity for fisheries** of the Orinoco and Amazonas river basins; where 'Bagre' (catfish) represent 53% of the catch in the Orinoco basin and 65% in the Amazonas basin, 'Bocachico' (*Prochilodus magdalenae*) represent 27% in the Orinoco river basin, and 35% others in the Amazonas basin.[554]

Risk of ecosystem transformation and loss of ecosystem services

- Beyond this, **deforestation and forest degradation in the Amazon exacerbate the impact of climate change** on ecosystems and local communities. Deforestation leads to increasing erosion and sedimentation, which can in turn increase flood risks, and result in riverbed rise and riverbank cutting. The conversion of forests and savannah into grasslands potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness.[555] Forest degradation may also contribute to pest and disease outbreaks, and reduced provision of other key ecosystem services.[556] These areas are then more vulnerable to stresses such as increased wind speed, turbulence, elevated temperatures, reduced humidity, increased sunlight, increased drought and fire risk, etc. [557]
- The effects of **increasing climatic exposure** may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, open roads, and deforestation usually cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change (e.g., erosion and sedimentation could contribute to an increased risk of flooding, exacerbated by projected increases in precipitation).

The following Table provides a summary of potential climate impacts on the main sectors covered by the proposed GCF program:

[552] PNUD 2010 and Ruiz 2010 in

[553] E.g. UNFPA https://lac.unfpa.org/sites/default/files/pub-pdf/UNFPAversiones.pdf

[554] BID-DNP-CEPAL 2014

[555] Bovolo et al., 2009; Staal et al. 2020; TNC 2020

[556] BID-CEPAL-DNP, 2014

[557] Bovolo et al. 2011

Table A18: Overview of potential climate change impacts in Colombia´s Amazon region

Sector	Potential impacts
Agriculture	▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures ▪ Changes in crop yields and productivity of key crops[558] ▪ Cattle ranching is a driver of deforestation in the Colombian Amazon (with Caquetá having the 2nd largest cattle population in the country; Nature Conservancy, 2020). Cattle ranching in cleared spaces (low stocked), results in areas prone to degradation and reduces ecosystem resilience (soils prone to erosion, sedimentation, lack of vegetation increases flooding risk).
NTFPs	▪ Decrease in NTFP quality and availability due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks ▪ One study found the following native plant species for biocommerce use could be favored under climate change scenarios (BID-CEPAL_DNP, 2014): Totumo, Jagua, Seje, Prontoalivio y Gualanday. Less suitable species under climate change include: 'Bálsamo de Tolú' y the medicinal plant *Smilax mollis* (BID-CEPAL_DNP, 2014).
Aquaculture & Fisheries	▪ Water quality deterioration (changes in pH, oxygen, temperatures) ▪ The fishing industry in Colombia (national level) could experience a reduction of 5.3% of the annual 'unloaded' stock/cargo for the period 2011-2100 in respect with the baseline period 2006-2010 (BID-CEPAL-DNP, 2014).
Tourism	▪ Damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) ▪ Damage to forest resources due to wildfires ▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (malaria, dengue) ▪ Risk of decreased attractiveness of key tourism features (waterfalls) due to precipitation variability
Ecosystem regulation services	▪ Decrease in biodiversity (threatened species) due to changes in habitat and changing climatic conditions ▪ Decrease in opportunities for traditional hunting and consumption practices. ▪ Changes in ecosystem functions, including regulatory and cultural services ▪ Risk of biodiversity loss, endangered flora and fauna ▪ Risk of loss of key ecosystem functions including regulatory, production and cultural services ▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience)

[558] The agriculture sector could see a decrease of the average crop yield (corn, rice, and potato) of 7.4% for the period 2011-2011 in comparison with the period 1971-2010; therefore, this could represent a decrease of total production between 1.9% and 2.8% on average per year for the period 2010-2100 (BID-CEPAL-DNP, 2014).

	▪ Deforestation and forest degradation brings the Amazon closer to its "tipping point", where it is projected that the ecosystem will transition to a "drier savannah-like ecosystem" (TNC 2020). For more information, refer to the Amazon-level profile developed for the program.
Forests	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Inundation and siltation along rivers threaten forest resources ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume ▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities

Climate change benefits from bioeconomy investments

The proposed GCF program will help to catalyse private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g., country, region, site-conditions, etc.), many of the program´s investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g., agroforestry, ecotourism)

In 2019 Colombia published its National Circular Economy Strategy, which establishes concrete lines of action, as well as indicators and goals, for the implementation of the circular economy in the country. Although still under development, the circular economy is recognized as a key tool in the mitigation of GHG emissions in all economic sectors. Many of the measures presented in this update are heading in this direction. Colombia is in the process of quantifying the costs of implementing the NDC and the financial structuring required from the national, international, public and private levels. This process seeks to inform a first mapping of the allocation of resources that the Government will give from its national budget and to measure the participation of the private sector and the international support required by cooperating countries, whose contribution has been essential. International Cooperation related to the NDC - 2020 on issues such as the fight against deforestation, implementation of renewable energies, and sustainable mobility in cities, which has allowed Colombia to move towards a more ambitious NDC, with additionality and impact. The continuity of international cooperation and the participation of private parties will be key to continue on this path in all aspects of your NDC.

The program is further well aligned with Colombia´s climate policies, NAP and NDC, and will be complementary to existing programs and initiatives. For example, Colombia´s "Visión Amazonía" ´project envisions sustainable management that supports REDD+ and sustainable development in the amazon, and promotes sustainable investments in: rubber, cocoa, livestock (meat and dairy), timber and NTFPs and improved access to credit with incentives for conservation and sustainable management.[559]

Bioeconomy sectors and actors

Perennial agriculture and agroforestry

Includes the planting, harvesting, collection, processing and marketing of permanent native crops, such as cacao (*Theobroma cacao*). Native permanent crops can contribute to biodiversity conservation and carbon sequestration, thus contributing to the fulfillment of policies in line with Colombian Government goals for carbon reductions.

Cocoa

Ecuador, Colombia, Peru and Venezuela produce 70% of the world's fine and aroma cocoa. Colombia is among the top eleven producer countries with a production of 72,956 tons reported by the National Agricultural Survey (NAG, 2014). International databases show that Colombia ranks twentieth with a yield of 481 kg / ha, similar to the world average of 486 kg / ha; although the NAG reported a mean yield of 900 kg / ha. Colombia has enormous potential for expanding cocoa production, which according to the federation of cacao growers (FEDECACAO) the potential area apt for cocoa cultivation exceeds two million hectares.

According to the national agricultural census in Colombia the cocoa production system provides livelihoods to 52,000 peasant families; more than 90% of national production comes from small farms. The average price of cacao paste is US$2 per kilogram, although the price for organic cacao can be more than double that amount. There is an average of three harvest per year and there are several types of cocoa clones, as well as numerous “wild-types” and native varieties.[560]

Exports of chocolates candy and other food preparations amounted to 37% of national production (US$33.6 million), followed by unprocessed cocoa beans at ~20% (US$18.3 million) and cocoa butter at 13% (US$12 million).[561] The rest was consumed domestically. The geographies where cocoa is widely cultivated Huila - Tolima, Santander - Norte de Santander, Antioquia – Axis Cafetero, West Meta, and Atlantic Coast.

For the producer, the payment depends on the number of intermediaries on the value chain. The demand for cocoa beans comes from the local industry that uses this raw material for the production of table chocolate, chocolate drinks, and candies, among others. Despite the fact that international prices are higher than domestic ones, the country has not been able to increase its exportable supply, without compromising the supply of the local industry.

The country is implementing the Colombian technical standard 1252 that specifies bean quality in relation to cleaning, drying, fermentation and bean size, as well as sanitation qualities needed for a

[559] Visión Amazonía 2018

[560] USAID paramos and forest program / REDD+ 2019.

[561] Fedecacao 2018.

human consumption. The standard also establishes a fair payment for beans of a specific quality. The domestic market has established a premium of 3 to 5% over the normal market price, for beans that exceed the requirements expressed in the 1252 standard.

The commercialization of cocoa is carried out through cooperatives and producer associations; prices paid by agents are determined by traders who link the domestic and international market prices. Domestic price corresponds to approximately 90% of the price on the New York Stock Exchange.

Aquaculture

By 2013, aquaculture in Colombia had a growth comparable to the world average on this activity, growing by 13% annually over the last 27 years (AUNAP, 2013).[562] Aquaculture consists of growing fish in confined waters for productive purposes. A demanding industry, it requires producers to control nutrition, reproduction and genetics, economic and business investment (Amazonas, 2021). For fishing farming to be a success, some conditions must be met, such as:

- Meat has a good taste, texture, appearance
- Enjoy rapid growth, affordable feed and a tolerance for high-density populations.
- Resistant to the disease and easy to handle and manipulate from planting to harvest.

Some of the species that are cultivated in the region are gamitana, boquichico, paco, and pirarucu (Amazonas, 2021). Fish farming has growth potential, especially with native species whose consumption is just entering the market in advanced economies. According to a study made by bank Bancolombia in June 2020, fish exports represent between 10% and 15% of the local production of this activity and constitute an area of great potential in the future in the country.

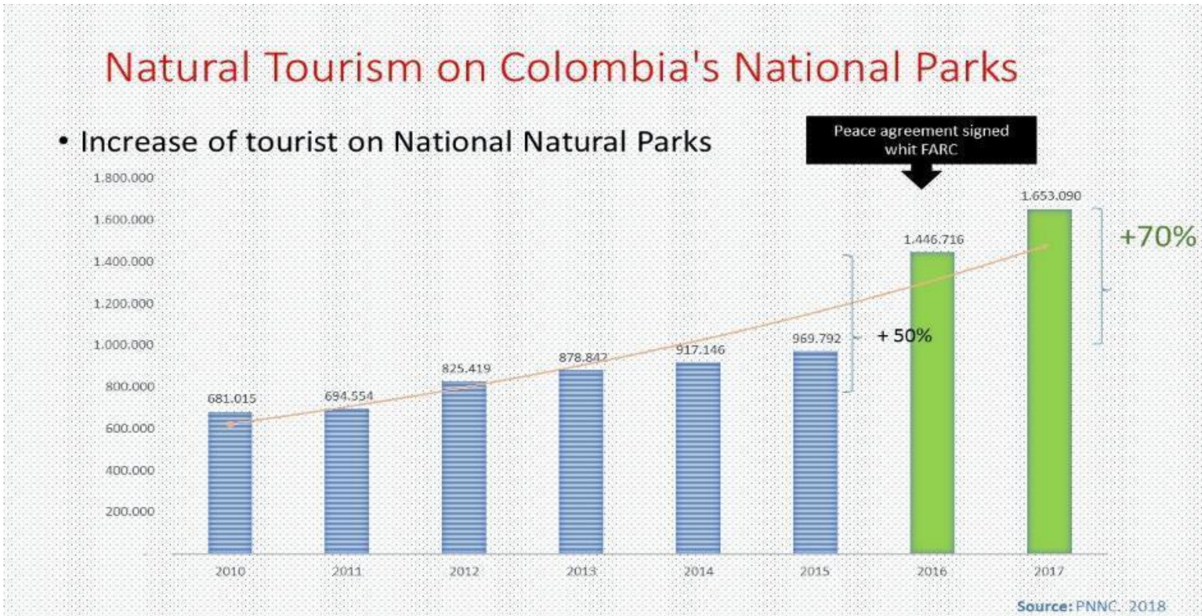
Nature tourism

This includes the conception, development and sale of different tourism services, particularly those associated with the conservation of Natural Protected Areas, protection forests, community forests, among others, with a vision of giving value to culture, community practices, biodiversity and the standing forest.

Colombia visitor numbers for nature tourism was skyrocketed since the signing of 2016 peace accord with the FARC guerrillas. According to the annual report of National Natural Parks of Colombia (PNN) visitors to protected areas have increased an average of 70%; in 2016 the Utría National Park had an increase in visitors in 2016 of 106%. Figure A75 represents the exponential increase of registered natural tourism.

Figure A75: Natural tourism in Colombia's national parks

[562] https://www.aunap.gov.co/wp-content/uploads/2016/04/25-Diagn%C3%B3stico-del-estado-de-la-acuicultura-en-Colombia.pdf.



According to ProColombia, the US is the largest potential market, with between 60% and 70% of existing visitors from North America. Before the pandemic in 2019, the arrival of non-resident visitors to Colombia reached 4,515,932, reflecting a growth of 2.7% compared to 2018. In 2019 there was a record in hotel occupancy of 57.8%, which translated into an increase in nominal revenues of 10.6%.

Colombia is the country with the highest number of birds in the world; it is home to more than 1,900 species representing 20% of the planet's species. "Birding" is a strategic subsector for nature tourism and Colombia as a global leader.[563] According to the Ministry of Commerce in 2017, this tourist niche generates foreign currency for of US$46.4 million. Some studies on birdwatching operator spends an average of US$310 per day, expecting around 15,000 observers per year for the amazon areas, which would contribute to generating about US$9 million in annual income and more than 7,500 jobs.[564] Surveys suggest that 280,000 US bird watchers would be willing to travel to Colombia and spends between US$2,500 and US$3,000 per trip.[565] Unfortunately, the pandemic and the resurgence of violence in several areas of Colombia has lowered the number of tourists in Colombia by more than 80% according to the Colombian Ministry of Commerce.

Provision of ecosystem services

Colombia has been a pioneer on the economic valuation of ecosystem goods and services and the deployment of instruments such as environmental taxes that monetize that value. The 2018 Colombian environmental economic assessment guide shows how to estimate the benefits and costs associated with changes in ecosystems that affect social welfare. Once quantified, these effects can be incorporated as indicators that provide information in the decision-making processes.

563 ONVS 2019.

564 ONVS 2018.

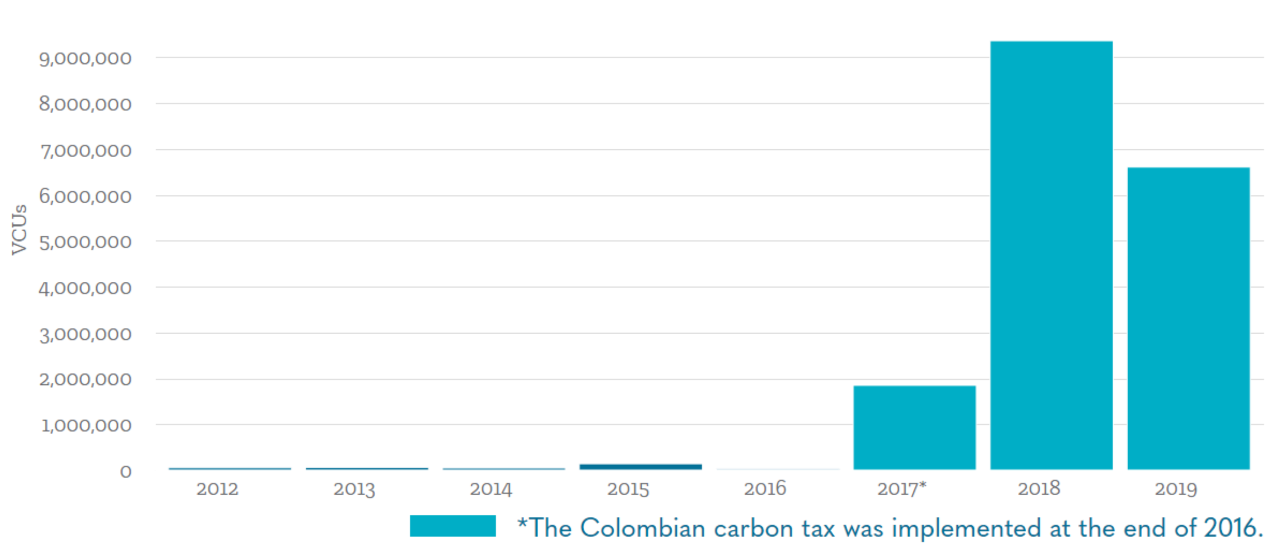
565 Viceministerio de Turismo 2017.

The information resulting from applying different methodologies and relevant studies based on the economic ecosystem valuations are essential for the design and modeling of economic instruments that are necessary for the preservation and conservation of natural resources. Between 2015 and 2018, several exercises related to environmental economic assessments, were used to design and estimate the effects or impacts of taxes in different aspects according to the decision they supported. Some of the most important decisions supported by these assessments were the creation of a carbon tax via Law 1819 in 2016. Subsequently, the Decree 926 of 2017 established the procedure for the exemption of this tax if carbon neutrality can be certified or offset using compensation investments (e.g. Verified Carbon Units (VCUs) from projects certified against the Verified Carbon Standard (VCS)). The revitalized a primary carbon market in Colombia with strong growth over the medium term; it is projected to generate about US$200 million in revenue by 2020.

The Colombian carbon tax mechanism has the potential to drive finance to projects that protect the environment and support poor and marginalized rural and indigenous communities. These projects are likely to generate sustainable development benefits, such as reduced poverty and the promotion of sustainable towns and communities. By leveraging existing high-quality standards programs like the VCS, Gold Standard, Icontec, and other standards and mechanism provides confidence in the results-based financing model embodied by carbon markets.

This graphic analysis made by the National Green Business Office (ONVS) shows up the impact and market dynamics after the implementation of carbon tax.

Figure A76: Impact and market dynamics of carbon tax



According with ASOCARBONO, the subsector has negotiated ~US$188 million since the implementation of the carbon tax (Table A19).

About 53 % of VCUs are from Agriculture, Forestry and Other Land Use (AFOLU) and 21 % for clean energy projects. These certified projects are generating sustainable income in periods of at least 30 years that can be extended, they can also mobilize important resources in strategic green/non-timber forest business for AFOLU projects allowing greater profit margins.

Of the 19 AFOLU projects, seven are located within the Amazon region. There are 50 companies on the whole country including Carbon project developers, Validators and carbon brokers among other Ecosystem Services registered business on the current Colombian market.

Table A19: VCUs and US$ millions negotiated on the Colombia market (no secondary markets yet developed)

Year	Projects Ton CO -Eq	Ton GHG negotiated	Unit price /Colombian carbon tax .$COP X Ton	Certification negotiated COP	US$
2017	31.790.800	7.706.800	15.000,00	115.602.000.000,0	$33.507.826,09
2018	18.654.720	11.913.604	15.764,00	187.806.053.456,0	$54.436.537,23
2019	27.465.954	14.535.193	16.422,00	238.696.939.446,0	$69.187.518,68
2020	17.134.493	6.268.850	17.211,00	107.893.177.350,0	$31.273.384,74
					$188.405.266,74

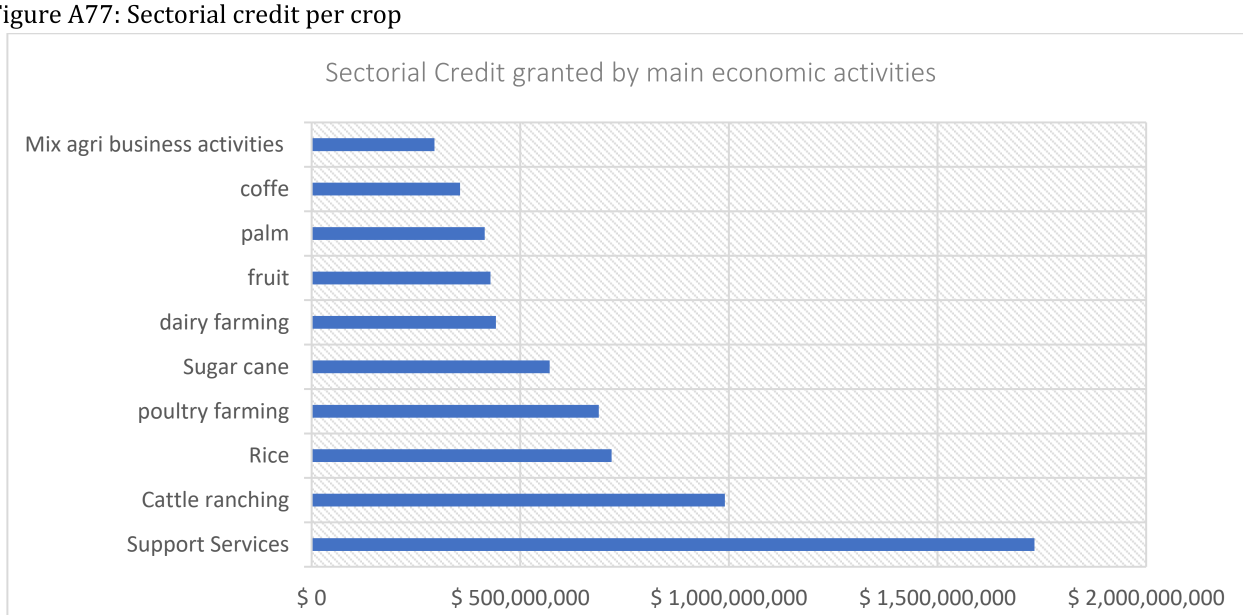
Source: ASOCARBONO, December 2020

Financial system and financing for bio-businesses

Credit for agribusiness sector shows that there is significant lending to SMEs and small rural entrepreneurs; they outnumber large entities. Nonetheless, the total value of loans are far greater for large companies.

Bancolombia and Davivienda are the banks with the largest presence in the entire national territory, Bancolombia has developed new green lines to support its operations in non-traditional businesses (Green Businesses). According to Finagro, the Participation in Associative Credit in the Amazon region is minimal with an average of only 1%[566].

Figure A77: Sectorial credit per crop

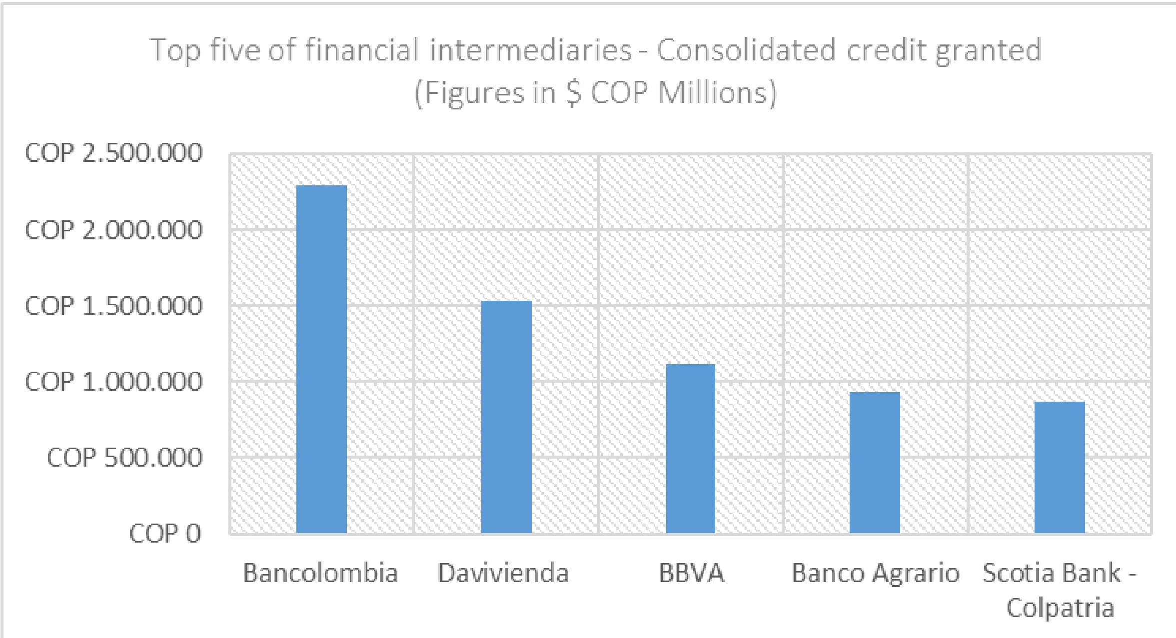


566 https://www.agronet.gov.co/estadistica/Paginas/home.aspx?cod=47.

Source: Agronegocios. May 2020

A large part of the credits is to support services for agricultural and livestock enterprises, with mixed agribusiness activities representing the lowest percentage, since there is a significant lack of knowledge on the part of the financial sectors in non-traditional businesses in the countryside.

Figure A78: Credit granted in 2020 by main banks in Colombia



Source: Agronegocios. May 2020

Development, research and technical assistance programs

Although there is still no national bioeconomy strategy which is being built, as mentioned above, National Green Business Plan and the Green Growth Policy of Colombia facilitate some national programs that directly and indirectly seek facilitating bio economy in Colombia.

Sustainable productive alliances. Ministry of Agriculture and Rural Development

The Project to Support Productive Alliances (PAAP) as an instrument for rural development and competitiveness. Its main objective is to link organizations of small rural producers with specialized markets. The program operates through annual calls in which 18-month alliance proposals are applied and receive funds of up to US$125,000 on financial support and technical advice. Each alliance enjoys a budget of US$600.000. The return on the financial investment is transferred to revolving cash funds managed by 205 producer organizations, currently totaling US$11 million.

This program has been successful in strengthening rural associativity and its links with the market. In the Colombian Amazon, 49 alliances have been promoted, whose participation is low compared to the national total (785). Within the Amazon, Caquetá has received 57% of the subsidies, Putumayo 20% and Guaviare 17%, during these nine years. The model of productive alliances has been identified as an instrument that can be adapted to the conditions of the Amazon to promote sustainable agribusinesses, which promote commitments to environmental management and reduction of deforestation. These alliances would offer the opportunity to strengthen existing chains and identify alliances that promote promising products from the Amazon, such as Amazonian fruit trees and other forest products. The support process will range from identifying new productive alliances to supporting them.

Amazon Vision

In order to reduce deforestation in the Colombian Amazon biome, the Amazon Vision program was created in 2016. Is a state program developed with the financial support of the Kingdom of Norway, the United Kingdom and the Federal Republic of Germany through the KfW bank, which seeks to reduce emissions from deforestation in the Colombian Amazon by promoting strategies for the protection of forests and the sustainable use of natural resources, while empowering local communities and indigenous peoples, generating development and productive alternatives that are low in deforestation.

The program focuses on creating enabling conditions in the region, creating payment schemes for environmental services, sustainable forest use schemes, agro-ecological schemes and the implementation of clean energy for indigenous communities. Unfortunately, the program has little inference on regional economy due to illicit drivers on the program area and lack of tangible real economic solutions for some amazon communities and hidden agendas of many actors of the Colombian Amazonia. The program budget in 2016 was US$200 million and has implemented 56% of the referencing budget.

Green and Sustainable Business Policy (National Green Business Plan) of the Ministry of Environment and Sustainable Development-MADS

The National Green Business Plan Policy is implemented by the Ministry of Environment and Sustainable Development; the program was launched in 2014. Its main purpose is to strengthen and facilitate the generation and commercialization of green businesses in Colombia; the policy was socialized with each environmental and sustainable development corporation and the general public. It has achieved important synergies with regional chambers of commerce, anchor companies of various productive chains, competitiveness committees, ProColombia among other institutions that have positioned this national plan as the most efficient sustainable strategy in the Environment and Sustainable Development sector. Since its inception, the National Green Business Plan (PNNV) has generated more than 21,000 direct green jobs, almost two thousand companies have been created, mostly on the bioeconomy sector and more than $170 million US dollars net sales average per year, including 18 new patents of biotechnology. To facilitate marketing of bio products from Colombian natural capital.

FINAGRO

Fund for the Financing developing Agricultural Sector, as a specialized financial entity, it has managed to create new strategic green lines for rural business transition for greener and sustainable practices.

INNpulsa Colombia

Accompanies the acceleration of high-potential ventures and innovative and financing processes that allows companies in the country to scale up to generate more economic development, equity and opportunities for all Colombians. It is also aligned with sustainable/ green objectives set by the current development plan and seeks to contributes to the sustainability transition of Colombian economy.

Bancóldex

Finally, and perhaps one of the most important is Bancóldex, the Colombian development bank that operates as a "second-tier bank", whose main purpose is to finance the needs for working capital and fixed assets of projects or viable companies of all sizes and all sectors of the Colombian economy. As a state development bank, its lending policies are aligned with the objectives of the country's sustainability and green growth pact.

International cooperation

Many of the green entrepreneurship in Colombia have the support of international cooperation entities, programs and initiatives, the main international cooperation entities are:

The German Federal Government Agency GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH) supports state and regional co-financing initiatives in order to facilitate green entrepreneurship in the various regions of Colombia

The United States Cooperation agency USAID has several programs that seek to catalyze entrepreneurship in various areas, especially in areas that have had a direct impact due to Colombian violence and regions vulnerable to drug trafficking, it has also had several programs that seek to generate business on green areas on high rate of deforestation regions, as well as support for the Colombian carbon market

The European Union and its sustainable local development program, among other programs, is one of the main funders of the green business policy in Colombia, the EU supports technology transfer and commercialization of green products in the different countries that make up the European Union

The Inter-American Development Bank supports various economic, financial and market mechanisms that Colombia requires for cleaner growth throughout the country.

The World Bank contributes to the diagnosis and formulation of a taxonomy for the financial economic sector of the state to identify credit lines that contribute and / or strengthen the transition to a green economic model for Colombia.

In December 2020, a national mission for bioeconomy was established. It has five major challenges; 1) Use of biodiversity for sustainable development, 2) Smart Colombia that understands and takes advantage of its biodiversity, 3) Productive and sustainable agriculture that builds social fabric, 4) Biomass 100: more value, zero waste, and 5) Advanced technologies for health and welfare. The Mission will analyze more than 500 bio products that include new active principles, and extensions of registries to new National and International markets, with an investment of $50 billion pesos.

It is important to emphasize of the 102 indigenous peoples in Colombia, 62.7% are in a critical humanitarian situation due to the violation of their human and territorial rights. According to Corpoamazonía, there is approximately 120 reservations throughout the Colombian Amazon, the projects that work within each indigenous reservation must be agreed upon through the prior consultation mechanism with the indigenous communities.

Corporativism

According to data from the *Confederation of Cooperatives of Colombia (Confecoop*), in Colombia 3,205 cooperatives generate 139,000 jobs, associate more than six million people, and expect revenues of COP $30 billion, at the end of 2020. This model is present in 25 sectors of the economy, including health, housing, education, recreation, tourism, savings, credit, transportation, culture, and public services. Cooperatives in the financial sector have the most associates, 3.6 million and 1.6 million, respectively. It is followed by business, social and personal services with 429,393 and business, social and personal services with 233,694.

Social, political, economic and environmental risks for and arising from the bioeconomy

There is a need to define concrete actions to overcome common or cross-sectoral sustainability challenges and include them in the forthcoming national bioeconomy strategy. The challenges include[567]:

Use and conservation of biodiversity

Relying on biodiversity is not synonymous with biodiversity conservation. If biodiversity is only seen as a competitive commercial advantage, there is a risk that biodiversity losses of less-commercial varieties will be generated in the medium or long term, or of overexploitation of the species of greatest commercial interest. In Bolivia, for example, quinoa biodiversity is being lost due to the preference of the international market for quinoa "real" over other endemic varieties.

Sustainability standards and results

While this is an important step in the transition to a bioeconomy, care must be taken that the establishment of standards does not divert interest away from monitoring sustainability results or outcomes. In addition, the impacts of the bioeconomy on land use change, deforestation and climate change are not just the responsibility of the primary production sectors. A sustainable bioeconomy

[567] Canales and Gómez. 2020. Policy dialogue on a bioeconomy for sustainable development in Colombia. Stockholm Environment Institute.

strategy must also consider how the demand for greater resources from other sectors of the bioeconomy will affect the sustainability of ecosystems and their services.

Employment

It is important that social elements are considered not only in primary production, but also in processing and in commerce, which is where more new jobs would be expected to be created. Some potential conflicts regarding employment were not considered in the discussions. For example, the expansion of precision agriculture would reduce the number of jobs in the agricultural sector. To achieve the SDGs, decent jobs would not only be needed from the primary sectors, but also from sectors that require specialist labor.

Rural development

To ensure equal access to resources for the bioeconomy, one of Colombia's most important challenges will be to resolve land ownership issues, especially in rural areas. In Colombia, 60% of rural properties lack formal property rights[568]. This can be partially explained by deficiencies in the land allocation process. For example, approximately 36% of land title records began with a false claim, that is, the right to the property was transferred by a person who was not the registered owner. The lack of property titles makes it difficult to invest in agriculture, to get access to credit or to gain access to subsidies and rural development programs. The National Development Plan, 2018–2022 sets goals to increase formal land titles from 1,000 to 24,000, and to update the cadastral survey from 20% to 60% coverage of land titles.

Infrastructure

Road infrastructure is also of the utmost importance for the development process in the bioeconomy. The situation for road infrastructure in Colombia, especially in rural areas, must be significantly improved to guarantee flows of biomass and related products. Currently, 75% of tertiary roads are in poor condition. The National Development Plan sets goals to adapt tertiary roads to regional integration. However, road construction could generate large-scale deforestation, especially if roads are connecting areas with primary forests.

Decentralization

The proposal to prioritize regions that already have relatively developed capabilities must be complemented by a long-term strategy to avoid excluding less developed regions, which are paradoxically the most biodiverse in the country. Such a strategy should include the development of innovative capacities in these less developed regions, such as for processing and adding value to bioresources. Without this, there is a risk of perpetuating the role of less developed regions as merely raw materials producers supplying resources to more developed regions where value will be added,

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568 https://semanarural.com/web/articulo/banco-mundial-asegura-que-mas-de-la-mitad-de-colombia-cuenta-con-predios-informales/1192

and most of the benefits will be generated. The bioeconomy should have a regional development focus to avoid increasing the gap between departments.

Enablers and barriers for bioeconomy development

Colombia has favorable conditions for the development of bioeconomy, taking into consideration the wide availability of biomass associated with its condition as a megadiverse country; a science and technology system in consolidation, mainly in biological sciences, engineering, and ICTs; the presence of concrete bioeconomy experiences in key sectors, such as the pharmaceutical industry, cosmetics, bio-inputs, GMO use, biofuels, and food; and a developing innovation ecosystem (especially the agricultural sector).

However, there is no single or unified bioeconomy vision in Colombia. Instead, different visions of the bioeconomy coexist, each posing different challenges for ensuring its sustainability. Historically, biotechnology, bioenergy, and biohealth have been the major topics in the bioeconomy policy background of Colombia. Nonetheless, the bio-resources vision is currently predominant, although different sectors combine elements of the different visions according to their sectoral development and context. Examples of sub-sectors within these sectors are: sugar-based bioethanol, palm oil-based biodiesel, cosmetics, and pharmaceutical. In that context, it has been recognized that 80 % of the analyzed Colombian biocompanies were set up as self-funded or private-bank-funded family businesses, where most of them exhibit product or process innovation, and export to places like Latin America, Europe, and Asia. These companies operate in highly regulated sectors, and acknowledge the importance of value chains, voluntary certifications, and the implementation of social and environmental responsibility schemes within their operations. They are, however, still very incipient on the management of aspects such as the recognition of intellectual property as a mechanism of protection for their own innovations, in addition to the university-business partnership, and their respective representation within their trade associations.[569]

[569] Henry. 2017. Bioeconomy: An engine for integral development of Colombia. CIAT.

Appendix 6 – Ecuador Bioeconomy Context

Overview of policy, regulations, and norms

Ecuador's political constitution, in effect since 2008, grants rights to nature. Article 71 states, "Nature or *Pacha Mama*, where life is reproduced and occurs, has the right to integral respect for its existence and for the maintenance and regeneration of its life cycles, structure, functions and evolutionary processes." Article 72 declares that nature has the right to be restored, and Article 74 states that persons, communities, peoples, and nations shall have the right to benefit from the environment and the natural wealth, enabling them to enjoy a good way of living.

Article 250 states that the territory of the Amazon provinces is part of an ecosystem necessary for the planet's environmental balance. Current distribution of protected areas and indigenous territories in the Ecuadorian Amazon are shown in Figure A79. This territory shall constitute a special territorial district, for which there will be integrated planning embodied in a law and including social, economic, environmental, and cultural aspects, with land-use development and planning that guarantee the conservation and protection of its ecosystems and the principle of *sumak kawsay* (*Living well*). Article 259 declares that in order to safeguard the biodiversity of the Amazon ecosystem, the central state and the decentralized autonomous governments (DAGs) shall adopt sustainable development policies, which shall additionally offset disparities in their development and consolidate sovereignty.

Article 283 states the economic system is socially oriented and mutually supportive; it recognizes the human being as a subject and an end; it tends toward a dynamic, balanced relationship among society, state, and market, in harmony with nature; and its objective is to ensure the production and reproduction of the material and immaterial conditions that make *Living well* possible. The economic system shall comprise public, private, mixed, social, and solidarity forms of economic organization, and others as established by the Constitution. The social and solidarity economy shall be regulated in accordance with the law and shall include the cooperative, associative, and community sectors.

Article 395 says the Constitution recognizes the following environmental principles: The state shall guarantee a sustainable model of development, one that is environmentally balanced and respectful of cultural diversity, conserves biodiversity and the capacity for natural regeneration of ecosystems, and ensures the satisfaction of the needs of present and future generations.

The National Development Plan 2017-2021, currently in effect, has nine national development objectives under three main pillars: *rights for all; economics at society's service; and more society, better state*. Objective 7, *to guarantee the rights of nature for current and future generations*, mentions bioeconomy and bioknowledge as part of the sustainable use of renewable biological resources. The same objective mentions that Galapagos and the Amazon will be a national priority in conservation strategies, promotion of bioknowledge, good use of natural resources, and the bioeconomy. It establishes the possibility of carrying out differentiated territorial plans for the Special Territorial Circumscription of the Amazon, for the Galapagos Special Regime, and for the coastal marine space.

The Organic Code on the Environment establishes in its Article 23 that the Ministry of the Environment will be the National Environmental Authority, and in that capacity, will guide, plan, regulate, control, manage, and coordinate the National Decentralized System of Environmental Management. Article 24 establishes the attributions of the Environmental Authority: (1) issue the environmental policy; (2) establish guidelines, directives, norms and control, and monitoring mechanisms for the conservation, sustainable management, and restoration of biodiversity and natural heritage, among others. In Article 30, paragraph 9, it mentions its contribution to the socioeconomic development of the country and the strengthening of the popular and solidarity-based economy, based on the conservation and sustainable use of the biodiversity and its components, and by promoting bio trade and other initiatives.

The entity in charge of the territorial planning of the Amazon is the Technical Secretariat of the Amazon Territorial Circumscription (SCTEA), which is responsible for planning, executing, and monitoring the CTEA, its conservation, and the change of its productive matrix. To do this, it developed the Integral Amazon Plan (PIA) 2016-2035, which is currently being updated. Table A20 explores the plan´s main objectives. Many of these issues are still valid; the goals have not been achieved, and in the update of the Integrated Amazon Plan (PIA), they will continue to be relevant.

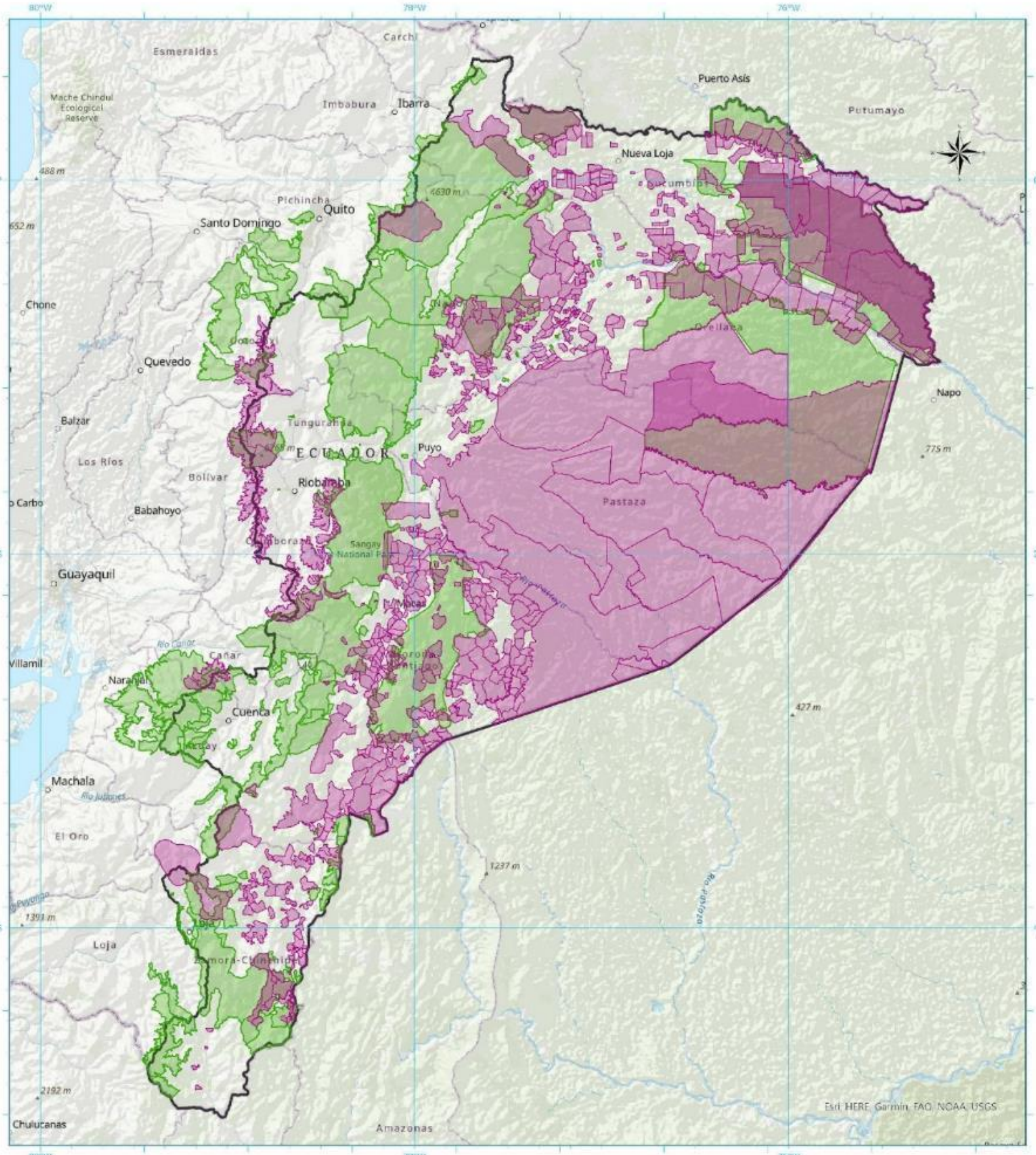
Table A20: Main Objectives. Comprehensive Amazon Plan 2016-2035

OBJECTIVE	MAIN LINES
• Strengthen all levels of state institutionality to guarantee access to basic and social services with territorial relevance	• Improve deconcentration and decentralization • Expand the coverage of basic services • Consolidate a multimodal public transport system
• Guarantee individual and collective rights, with emphasis on priority attention groups, vulnerable peoples and nationalities, and strengthening the construction of the intercultural and plurinational state	• Promote integrated planning • Promote participation processes • Formalize land tenure • Implement mechanisms that seek improvements in the quality of life
• Revalue ancestral knowledge and bioknowledge, based on the high Amazonian diversity, generating capacities and opportunities for local development	• Generate mechanisms to recover and exchange traditional and ancestral knowledge for its scientific application and the generation of technology, biotechnology, and innovation • Invest in bioknowledge research, the generation of local human talent, and the development of new technologies aimed at conservation, remediation, and ecological restoration, in order to reduce anthropic pressure on the ecosystem and contribute to the change of the productive matrix as an alternative to primary-export production
• Strengthen comprehensive security, with an emphasis on cross-border security, disaster risk management, and citizen security	• Ensure access to justice • Strengthen the capacities of Decentralized Autonomous Governments • Conserve ecosystems that allow increasing resilience against the negative effects of disasters
• Promote productive diversification, responsible and sustainable use of renewable and non-renewable resources, and specialization of human talent in activities that generate added value with territorial	• Improve production chains, prioritizing endogenous potential and the development of technological innovation and research

relevance; guarantee equitable access to the means of production	• Strengthen the social and solidarity economy through technical training, diversification, and promotion, generating associativity, inclusive chains, and fair trade • Promote comprehensive management of productive enterprises that consider equitable and inclusive access to the means of production throughout the market chain; compatibility of land use; optimization of resources; and environmental, cultural, and social relevance • Develop local capacities for the supply of goods and services related to national projects of a strategic nature and basic industries, boosting the local economy and generating employment
• Reduce habitat degradation, ecosystem fragmentation, and overuse of soil; prioritize the conservation of ecologically important areas and the control of extractive activities	• Improve coordination between levels of government in special planning processes around strategic projects, ensuring that income contributes to the populations' quality of life and conservation of biodiversity • Apply incentives for agricultural and industrial production systems, based on agroecological principles and the use of clean energy and technologies in order to reduce the overuse of soil and pollution by waste • Promote research and the use of alternative energy, aimed at the availability of nonrenewable resources and the resilience of ecosystems • Expand incentive programs for forest conservation and restoration
• Promote the integration of the countries that are part of the Amazon basin	• Articulate planning among the countries that make up the Amazon basin for a balanced, corresponsive, and sustainable development • Promote the conservation of shared ecosystems, for the protection and sustainable use of natural and water heritage, risk management and biosecurity, in coordination with neighboring countries • Promote complementarity in the trade negotiations of the countries that make up the Amazon basin, promoting potential sectors and protecting vulnerable sectors

Source: Plan Integral para la Amazonia 2016

Figure A79: Protected areas and indigenous territories in the Ecuadorian Amazon



Protected areas and indigenous territories in the Ecuadorian Amazon

- Indigenous territories
- Protected areas
- Amazon Study Area

The total area of each of the two main categories (Indigenous Territories and Protected) is equal to the number shown in the table plus the overlay with the other category:
Indigenous Territories: IT + IT-PA overlap
Protected Areas: PA - IT-PA overlap

Land Rights	Extent (Hectares)
Indigenous Territories (IT)	5,262,917
Protected Areas (PA)	2,951,507
IT - PA overlap	2,256,759
Private land rights or rights not yet awarded	2,797,824
Total	13,269,007

Sources:
Amazon Study Area: RAISG, 2020.
Indigenous Terrories: EcoCiencia, 2019
Protected Areas: Ministerio de Ambiente y Agua del Ecuador (MAAE, 2020)

Geographic Projection
Datum: WGS84 Scale: 1:2,200,000

0 25 50 100 150 Km

GDP, income and productivity

According to data from the Central Bank, gross domestic product (GDP) grew between 2015 and 2019 from US$99,37 million to $108,108 million. In the last 5 years, 2017 was the year with the highest growth, with a rate of 2.4%. The average growth in these 5 years was 1.18%. In 2020, due to the COVID-19 pandemic, it is estimated that GDP decreased by 7.8%[570]. For the year 2021, however, according to the Central Bank, a growth of 3.0% is expected for the economy, especially for shrimp, agriculture, and communications. Inflation has also been declining, and some economists speak of it as a symptom of the economy's stagnation. The trend in the last 5 years has been downward, with 3.4% inflation in 2015 and -0.07% in 2019. For 2020, a negative inflation rate is estimated due to the COVID-19 pandemic.

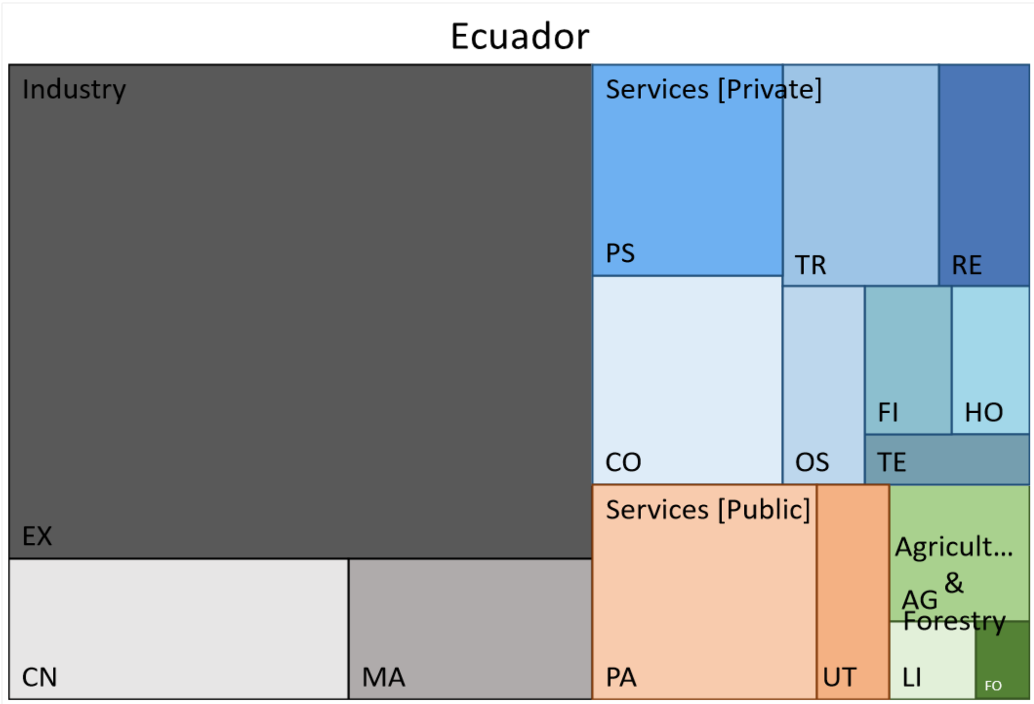
Exports in the period 2016 through 2019 had a sustained increase. They went from US$7,413 million in 2016 to $22,773 million in 2019. Of these, oil represented between 31% and 38% in 2019, while traditional products (bananas, coffee, cocoa, tuna and seafood) went from US$6,457 million in 2016 to $8,337 million in 2019. For the January-October 2020 period, exports were US$16,458 million (i.e., a decrease of 10% compared with the same period in 2019); however, non-oil exports grew by 10.5%. The products that grew the most in 2020 were cocoa, bananas, and tuna. Oil exports fell by 42.2% due to the international situation and low prices but also due to the rupture of the oil pipeline, causing production stoppage in the Amazon.

Imports, however, have also grown, and the difference between exports and imports of goods and services was minimal, negative in 2017 and 2018, with a small surplus in 2019. For the year 2020 until October, imports reached US$13,770 million, which was a decrease of 24% compared with the same period in the previous year. The trade balance until October 2020 was US$2,688 million. For the Amazonian provinces, the GDP in 2017 reached US$7,341 million, of which 60.8% was oil and gas. For the year 2019, the GDP of the Amazon reached US$8,273 million, of which 64.3% was oil and gas, 4% construction, 4% education, 3% commerce, 3% public administration, and 3% transportation. Bananas, coffee, and cocoa reached 1%[571]. Relative contribution of sectors and subsectors to GDP from the Amazon jurisdiction is shown in Figure A80.

[570] Banco Central del Ecuador.2021. La pandemia incidió en el crecimiento 2020: La economía ecuatoriana decreció 7,8%. Boletín de prensa. https://www.bce.fin.ec/index.php/boletines-de-prensa-archivo/item/1421-la-pandemia-incidio-en-el-crecimiento-2020-la-economia-ecuatoriana-decrecio-7-8

[571] Banco Central del Ecuador.2021. La Economia Ecuatoriana decreció 12,4% en el segundo trimestre de 2020. Boletín de prensa. https://www.bce.fin.ec/index.php/boletines-de-prensa-archivo/item/1383-la-economia-ecuatoriana-decrecio-12-4-en-el-segundo-trimestre-de-2020

Figure A80: The relative contribution of sectors and subsectors to the GDP of the Amazonian jurisdictions of Ecuador



Note: Agriculture and Forestry: Agriculture (AG), Fisheries and Aquaculture (FI), Forestry (FO), Livestock (LI); Industry: Extractives (EX), Manufacturing (MA), Construction (CN); Services (Private Sector): Real Estate (RE), Commerce (CO), Transportation (TR), Hospitality (HO), Telecommunications (TE), Finance (FI), Professional Services (PS), Other services (OS); Services (Public sector): Public Administration (PA), Utilities (UT); Illicit Activities: Coca/Cocaine (CC), Artisanal Gold (Au).
Source: Banco Central del Ecuador, Dirección Nacional de Síntesis Macroeconómica, https://www.bce.fin.ec/index.php/cuentas-nacionales

The external public debt has increased. This increased from US$20,225 million in 2015 to $41,495 million in 2019 and $40,430 million in August 2020, although in the last months of 2020, several disbursements were received from international credit organizations, including US$2 billion from the International Monetary Fund. With this, the fiscal deficit was expected to be around US$8.6 billion up to December 2020. Tax collection decreased as of November 2020 by approximately 14%, compared with 2019 data, and reached US$10.76 billion in that month[572].

Social and environmental context

The Amazon region starts in the Andes foothills, with elevations up to 5,000 meters above sea level on the western flank[573]. It has an area of approximately 13,3 million hectares (1.75% of the Amazon

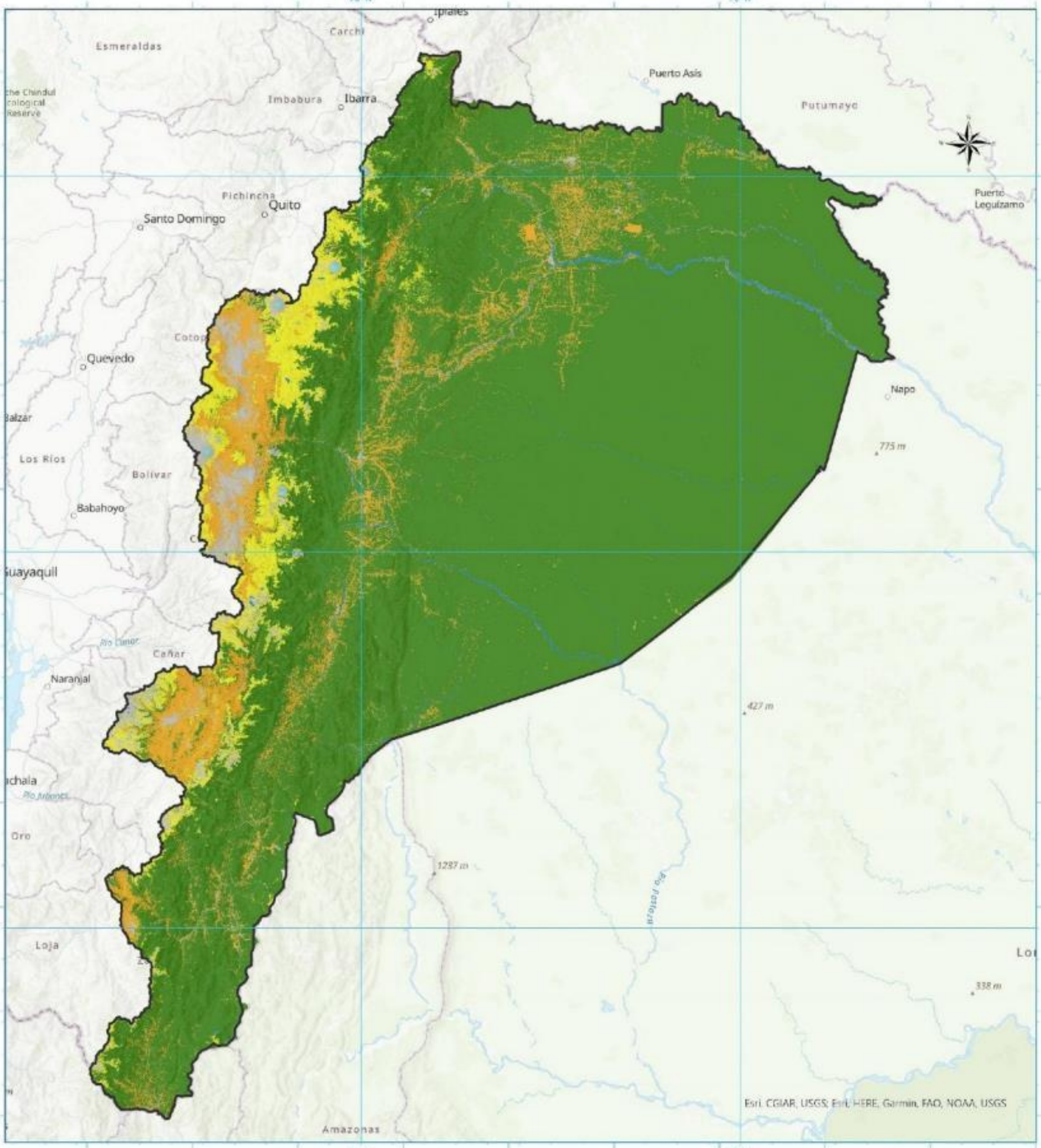
[572] +Prosperidad. 2019. Boletín de deuda pública Interna y Externa. Ministerio de economía y finanzas Ecuador

[573] ECURED. Amazonía (región de Ecuador). 2020. https://www.ecured.cu/Amazon%C3%ADa_(regi%C3%B3n_de_Ecuador)

Biome)[574] and covers just over 46% of the country, including six provinces: Sucumbíos, Orellana, Napo, Pastaza, Morona Santiago, and Zamora Chinchipe. For the Amazon of Ecuador, 81% of the region is forest, with 10.7 million hectares; 10% is under agricultural use, with 1.34 million hectares; and 5% is non-forest vegetation and savanna (Figure A81).

[574] Prüssmann J., Suárez C., Guevara O. and A. Vergara. 2016. Vulnerability and climate risk analysis of the Amazon biome and its protected areas. Amazon Vision, REDPARQUES, WWF, UICN, FAO, PNUMA. 48 pp. Cali, Colombia

Figure A81: Land cover in the Ecuadorian Amazon



Land cover in the Ecuadorian Amazon

Amazon Study Area

Land Cover Class	Extent (Hectares)
Forest	10,700,973
Floodplain forest and wetlands	107
Non forest vegetation and savanna	721,044
Agricultural mosaic	1,342,316
No vegetation	367,567
Lakes and rivers	129,754
Glacier	7,246
Total	**13,269,007**

Sources:
Amazon Study Area: RAISG, 2020.
Land cover: RAISG, 2020

Geographic Projection
Datum: WGS84
Scale: 1 : 2 200 000

0 25 50 100 150 Km

From 1990 to 2018, the average annual deforestation area steadily declined from 1990 to 2018. The average from 1990 to 2000 was 129,944 hectares per year; from 2000 to 2008, it was 108,667 hectares per year, from 2014 to 2016, it was 94,353 hectares per year; and from 2016 to 2018, it reached 82,529 hectares per year.[575][576] Ecuador was the recipient of GCF Results Based Payment award for this historic deforestation reduction. Among Ecuador´s efforts and initiatives *Socio Bosque* stands out as an effective financial incentive mechanism to conserve forests and key ecosystems. Through it, the country was able to protect 1.6 million hectares of native forests until July, 2019[577]. Figure A22 shows the deforestation pattern in the Ecuadorian Amazon over the past decades. The crops that replaced forests in the period from 2008 to 2014 are shown in Table A21.

Table A21: Crops that replaced forests 2008-2014

Land use	Percentage
Grassland	65%
Agricultural mosaic	12%
Cocoa	4%
Corn	3%
Oil palm	3%
Coffee	2%
Other uses	11%
Total	100

Source: Ministry of Environment and Water, Deforestation report 2008-2014[578]

A study of the influence and relationship between roads and deforestation in the Amazon of Ecuador concluded that 90% of deforestation occurs within 10km from roads and the tendency to build new roads did not decrease.[579] Small-scale deforestation is predominant, rather than large conjoined areas of deforestation, as shown on the map in Figure A82.

Currently, according to the Ministry of non-renewable resources, oil exploration is being promoted in new areas south of Yasuní National Park. Although this type of business takes time to establish, it could lead to the construction of new roads and facilities for the exploration and later the exploitation of oil in the area. In the oil areas around Lago Agrio in Sucumbios province and Coca in Orellana province, spills or accidents have polluted rivers and water sources in communities and cities. Mining has already been installed in the province of Zamora, with large projects especially in the Cordillera

575 Ministerio del Ambiente, (2017). Deforestación del Ecuador continental periodo 2014-2016. Quito – Ecuador.

576 FAO.2020.Evaluación de los recursos forestales mundiales: Ecuador. Roma.

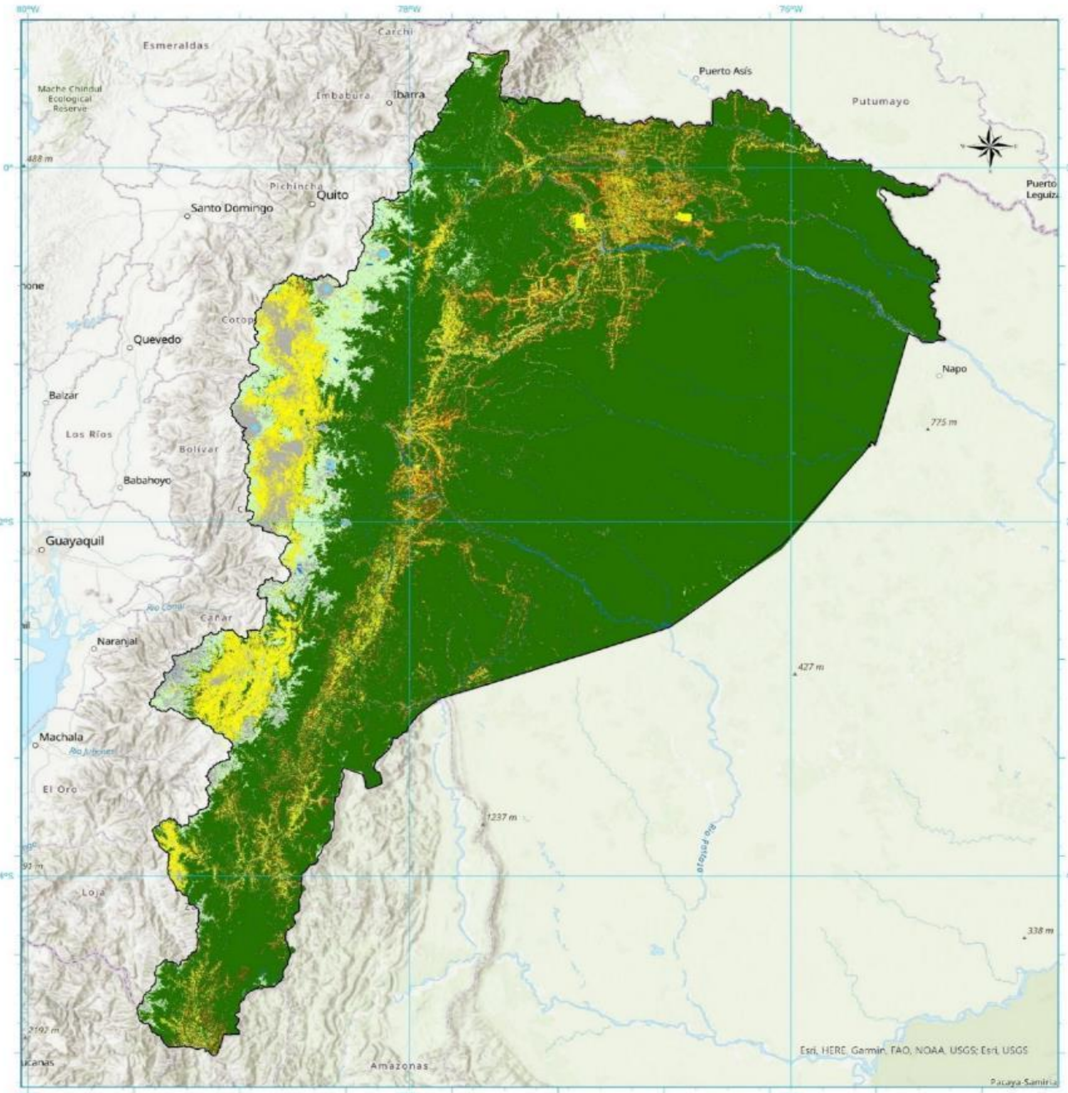
577 UNDP Latin American and the Caribbean.2019.Ecuador receives US$18.5 million for having reduced its deforestation. UNDP. https://www.latinamerica.undp.org/content/rblac/en/home/presscenter/pressreleases/2019/ecuador-receives-us--18-5-million-for-having-reduced-its-defores.html.

578 Nepstad, D.; Ardila, J.P.; Bezerra, T.2019. Evaluación del Impacto de políticas públicas destinadas a reducir la deforestación y degradación y acciones destinadas a la gestión sostenible de los bosques del Ecuador. Earth Innovation Institute. PNUD http://proamazonia.org/wp-content/uploads/2020/01/EIIProductoDos-Evaluacio%CC%81n-de-Impacto-Ecuador_P2-min.pdf.

579 Gonzalez, JC. 2014. Carreteras y Deforestación: Entendiendo el Capital Natural en la Zona de la Amazonía Ecuatoriana. http://repositorio.puce.edu.ec/handle/22000/6873?show=full.

del Cóndor, in the southern zone, and close to the border with Peru. This has already generated several complaints about contamination and conflicts with indigenous communities in the area [580].

Figure A82: Deforestation patterns in the Ecuadorian Amazon



Deforestation Patterns in the Ecuadorian Amazon

Land Cover Classes
- Forest
- Floodplain forest and wetlands
- Non forest vegetation and savanna
- No vegetation
- Lakes and rivers
- Glacier
- Amazon Study Area

Deforestation periods
- deforestation before 2000
- 2001- 2010
- 2011 - 2020

Deforestation period	Total year	Deforestation period	Total year
2001	46,329	2010	24,022
2002	57,699	2011	38,383
2003	35,198	2012	28,020
2004	36,166	2013	34,377
2005	32,005	2014	13,209
2006	43,151	2015	35,224
2007	40,742	2016	13,097
2008	34,777	2017	42,368
2009	36,356	2018	34,479
Total		625,602	

Sources:
Land cover classes: RAISG, 2020
Deforestation: RAISG, 2020
Amazon Study Area: RAISG, 2020

Geographic Projection
Datum: WGS84 Scale: 1:2,200,000

0 25 50 100 150 Km

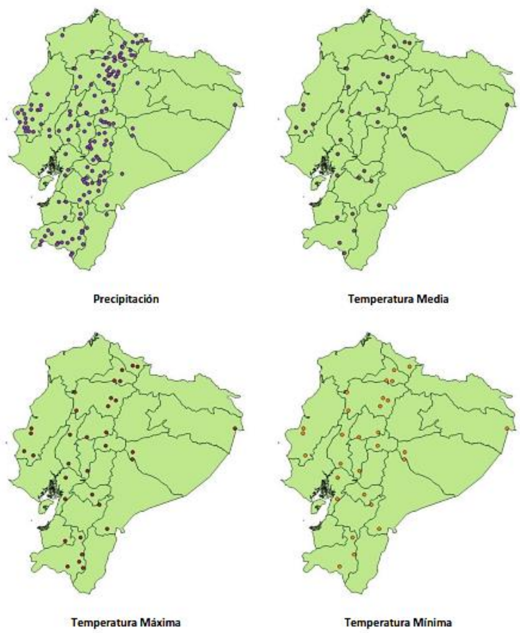
[580] Ministerio de Energia y Recursos Naturales no Renovables. 2018. Mapa de bloques petroleros de Ecuador. https://www.recursosyenergia.gob.ec/wp-content/uploads/2021/02/Bloques_11022021_COPY-scaled.jpg.

Climate Profile

Data and knowledge gaps

The report provides information at the national level, and where possible tries to focus on the Amazon region – the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[581] Nonetheless, it is important to note information on climate risk and vulnerability varies per region, and remains an area where substantial additional research is needed. In particular, climate risk and vulnerability studies are limited in the Amazon, where most studies focus on the national level, or in more densely populated regions in the Andes and Coast. Majority of climate-related studies in the Ecuadorian Amazon focus primarily on deforestation, forest degradation and REDD+.
Additionally, this document tries to close the informational gap on climate trends and projections, particularly for the Amazon region. The data and information available are based on weather stations from the National Institute of Meteorology and Hydrology of Ecuador (INAMHI). The meteorological network is concentrated mainly in the Andean and Costal region, leaving an empty record for the Amazon (see Figure below).[582] These limitations restrict the implementation of a high precision and wide territorial coverage study, since regions such as the Amazon region, which covers no less than 40% of the total surface area of Ecuador or the Insular region, have a minimum number of stations.

Figure A83: Distribution of stations with data for the period 1981-2010



Source: MAE 2017, p.390.

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581 see list of references

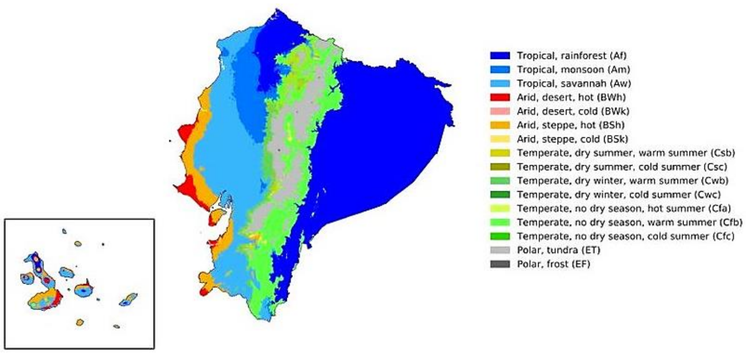
582 MAE 2017

As such, it is important that the following information builds on existing information, and should be interpreted whilst acknowledging the aforementioned gaps related to the low density hydro-meterological stations and lack of climate risk and vulnerability studies tailored the unique context of Ecuador´s amazon region.

Overall climatology

Mainland Ecuador is classified into Andean, Amazon, and Coastal regions.[583] Most of the national territory has a humid and tropical climate, although it varies with altitude and region, due to proximity to the equator (see figure below). The Amazon region starts in the Andes foothills, therefore it also presents a variation in temperature, since at the western end of the region you can find elevations of up to 5,000 meters above sea level.[584] Areas in the Coastal region are influenced by the cold Peru Current (Humboldt) and more significant variations related to the movement of the Intertropical Convergence Zone (ITCZ) and ENSO (El Niño-Southern Oscillation).[585] The weather at the higher elevations of the Andes is subject to the local convectional process.[586]

Figure A84: Köppen-Geiger climate classification map for Ecuador (1980-2016)



Source: Beck et al. 2020.

Temperature and precipitation

In the Andean region there are two seasons: winter (October to May) and summer (June to September). Rainfall generally peaks at the equinoxes, with a long dry season from June to September. As altitude increases, temperatures decrease at a rate of approximately 5-6°C per 1,000m. The average annual temperature in this region ranges between 10 and 18°C (see figure below). The coastal regions have temperatures that slightly vary between seasons. Daytime highs range from 29 to 33°C, while at night temperatures drop to between 20 and 24°C.[587]

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583 MAE 2017

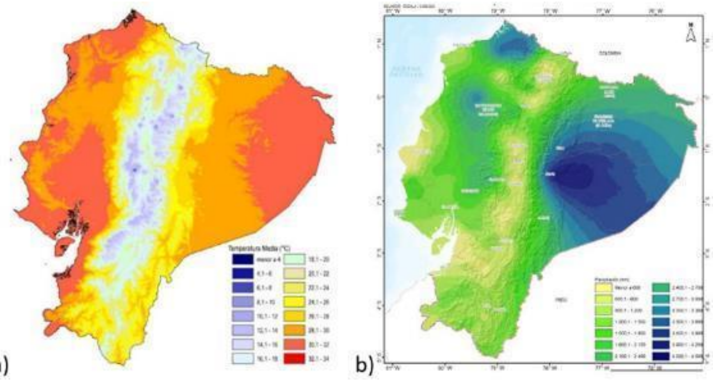
584 ECURED 2020

585 El Niño is an unpredictable cyclical phenomenon (3-8 years) that tends to last for periods of 12-18 months, and has different impacts in different parts of the country including: intense rainfall, warm weather and warm ocean currents in the coast (increasing flood and landslide risk) and reduced rainfall in the Andes and Amazon region (increasing drought and fire risk). La Niña events, on the other hand, occur between El Niño events. La Niña often led to inverse conditions, especially in terms of temperatures: cold deviations and drought in the coast whereas the Andes and the Amazon region get warmer wetter (MAE 2017; Foley et al. 2002).

586 Moran-Tejeda et al. 2016

587 Armenta-Porras et al. 2016

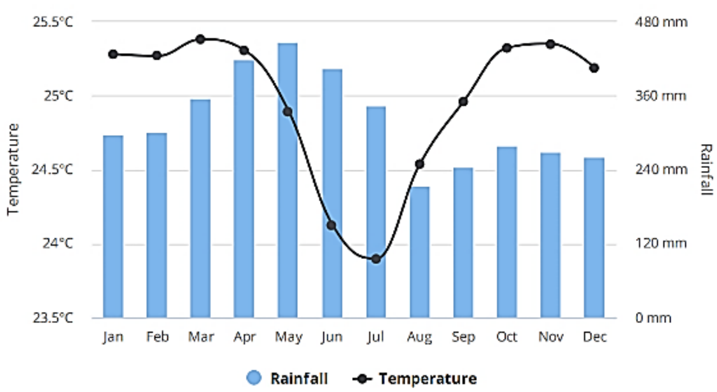
Figure A85: Meteorological data of: a) average temperature (ºC), and b) annual precipitation (mm), for the period 1981-2005



Source: Armenta-Porras et al. 2016, p.39, 97.

The months of August-December have a drier and warmer period (see figure below). Daytime highest temperature ranges between 29°C to 33°C, while night temperature drops to 20°C and 24°C, with changes depending on altitude; additionally, the distinct tropical climate experiences continuous and abundant rainfall with an average annual rainfall that varies from 3,500 to 4,000mm.[588]

Figure A86: Average Monthly Temperature and Rainfall of Ecuador for 1901-2016 in the Amazon region (Nuevo Rocafuerte station, central Amazon region)



Source: World Bank 2021.

<u>Climate-related natural hazards</u>

Climate-related natural hazards are common in Ecuador, especially: flooding, landslides, extreme heat, drought, and wildfires (see Table below). In the Amazon, the risk of river floods, landslides and wildfires are medium to high, and extreme heat poses a medium risk in all provinces, with the exception of Zamora Chinchipe in the Southern Amazon, which displays a low risk.

[588] FAO 2015

Table A22. Overview of climate-related natural hazards risk in Ecuador and its Amazon region

	River flood	Landslide	Extreme heat	Wildfire	Water scarcity
National					
Ecuador	High	High	High	High	Very Low
Province level (for provinces located in the Amazon region)					
Sucumbíos	High	High	Medium	High	Very Low
Orellana	High	Medium	Medium	Medium	Very Low
Napo	High	High	Medium	Medium	Very Low
Pastaza	High	High	Medium	Medium	Very Low
Morona Santiago	High	High	Medium	High	Very Low
Zamora Chinchipe	High	High	Low	High	Very Low

Source: GFDRR n.d.

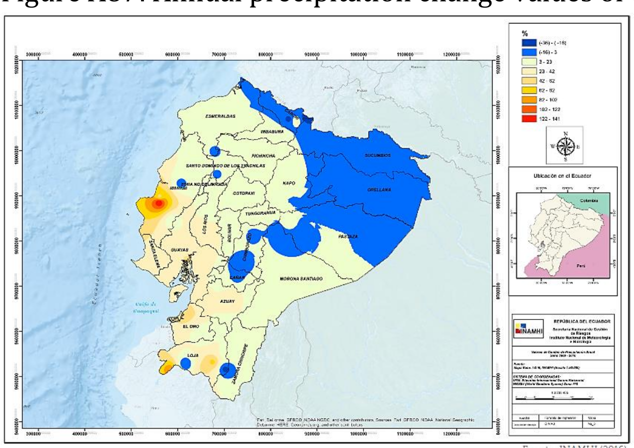
Observed trends of climatic variables

Temperature and precipitation

During the period 1960-2010, it has been recorded changes in precipitation, mean temperature and absolute maximum and minimum temperatures. These changes include an increase in temperature, and spatial and seasonal variations in precipitation throughout the national territory.[589]

During the same period, the Amazon region has displayed different precipitation patterns. In general, there was a decline in precipitation in the northern Amazon region, and an increase in the southern region (see Figure 6). On average, precipitation display a change of -1%, whilst, the mean temperature change was positive, with an average value of 0.9ºC (see figures below).[590] In general, higher temperatures were observed in the Central Amazon region, including areas of Morona Santiago, Pastaza, Orellana and Napo. On average, the change value for the mean temperature at the monitored stations is 0.9°C.[591]

Figure A87: Annual precipitation change values of the series 1960 – 2010



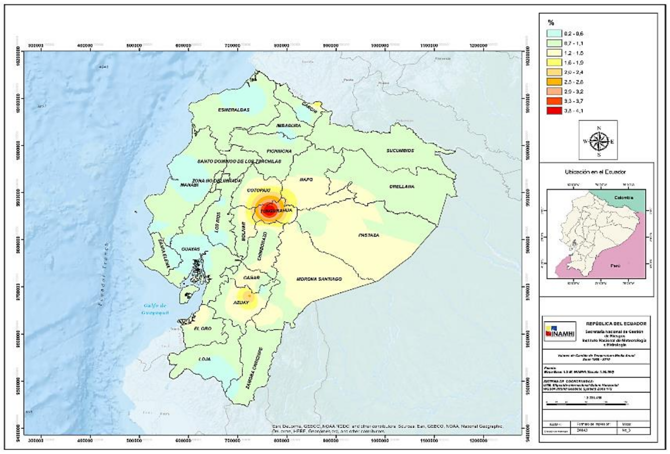
Source: MAE 2017, p. 275.

[589] MAAE 2019

[590] MAE 2017

[591] MAE 2017

Figure A88: Annual mean temperature change values for the series 1960 – 2010

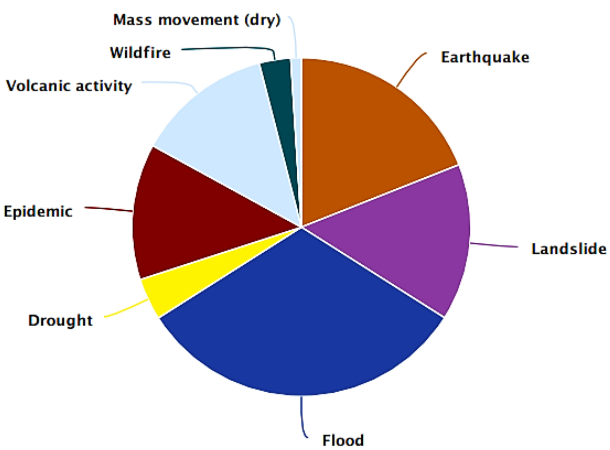


Source: MAE 2017, p. 275.

Climate-related natural hazards

During the period 1900-2018, the most predominant climate-related natural hazards in Ecuador were (in order from most-significant to least significant): floods, landslides, drought and wildfires (see below).

Figure A89: Average Annual Natural Hazard Occurrence for 1900-2018



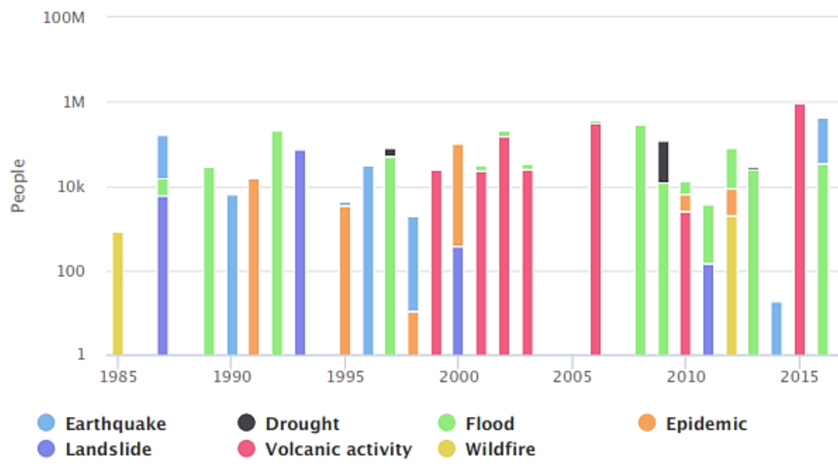
Source: World Bank 2021.

Floods and landslides (climate-related) show repetitive appearance and represent greater impact on people over the years (see figure below). Available data shows a mild increasing tendency in climate-related natural hazards between 1999 and 2012.[592] Landslides have had particularly affected the provinces of Napo, Pastaza, Morona Santiago and Zamora Chinchipe, especially in March and April.

592 UNDRR 2021

Zamora is one of the cantons reporting the greatest number of impacts, as this is an area where large-scale landslides have occurred over the years.[593]

Figure A90: Key Natural Hazard Statistics for 1985-2018 by number of people affected.



Source: World Bank 2021.

Climate change projections

Information on all four RCPs was available for the Ecuador analysis, using studies by MAE (2017, referencing the period from 1991-2005) and Armenta-Porras et al. (2016, referencing the period from 1981-2010). Both studies utilize the CMIP5 model, which is described in greater detail within the Feasibility Study.

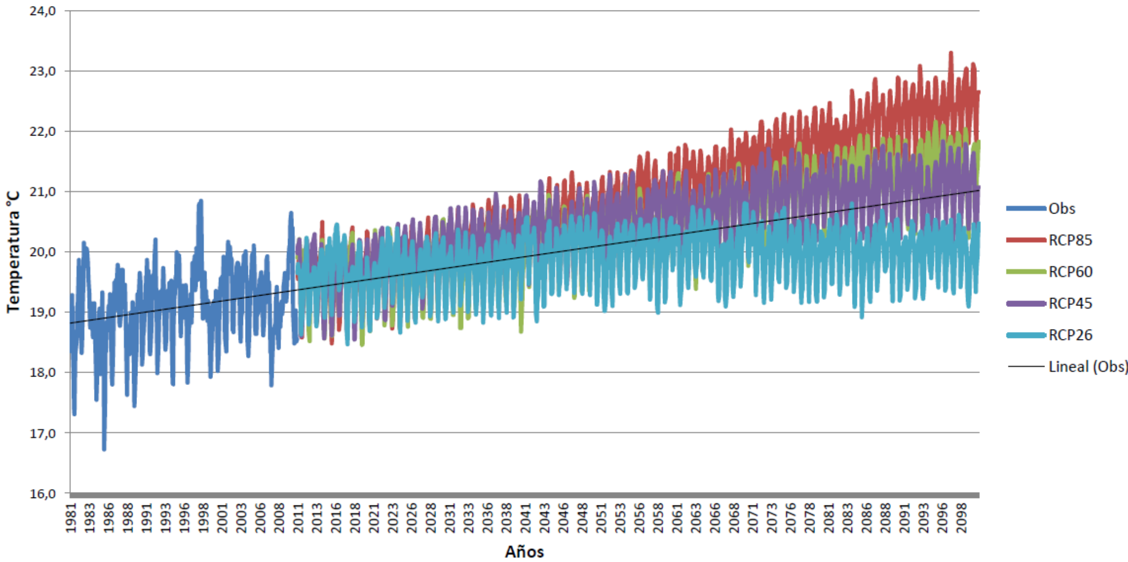
Temperature

The average temperature of Ecuador could reach different levels, depending on each of the RCP scenarios. In a study conducted by Armenta-Porras et al. (2016), the average temperature could display the following projections by the end of the 21st century (see figure below): between 22°C to 23°C for the RCP8.5; between 20°C to 22°C for the RCP6; between 20°C to 21.5°C for the RCP4.5; and, between 19°C to 20°C for the RCP2.6.[594]

[593] UNDP 2013

[594] Armenta-Porras et al. 2016

Figure A91: Average temperature of Ecuador for the period 2011-2100



Source: Armenta-Porras et al. 2016, p. 59.

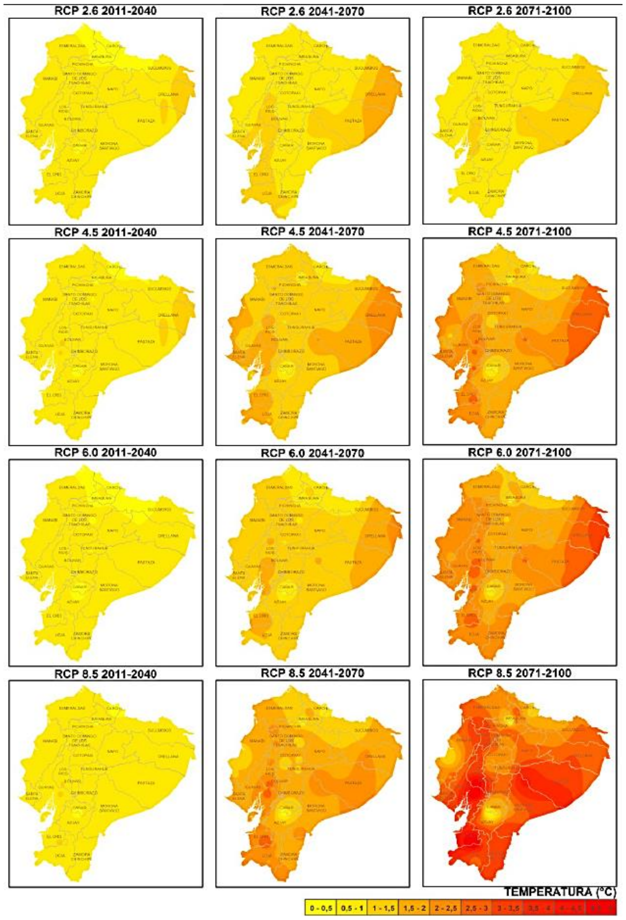
According with the RCP4.5 (intermediate scenario where GHG emissions peak around 2040 and then start to decline) and RCP8.5 (GHG emission continue to rise throughout the 21st century), the Amazon and Galapagos regions could experience the highest increase of mean annual temperature, particularly for the mid and late century (see Figure A92). These would represent that the Amazon region could be between 2.32°C and 3.46°C warmer and the Galapagos region could be between 2.37°C and 4.39°C warmer, by the end of 2100s (see Figure A93).

Figure A92: Mean annual temperature anomalies per region for the periods 2011-2014, 2041-2070, and 2071-2100.

2011-2040	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Amazonía	0,86	0,9	0,75	0,9
Costa	0,78	0,91	0,73	0,87
Galápagos	0,74	0,99	0,79	1
Sierra	0,56	0,64	0,54	0,66
ECUADOR	0,64	0,74	0,62	0,75
2041-2070	**RCP 2.6**	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
Amazonía	1,36	1,78	1,62	2,13
Costa	1,1	1,62	1,54	1,85
Galápagos	1,24	1,59	1,53	2,45
Sierra	0,78	1,16	1,09	1,54
ECUADOR	0,93	1,35	1,27	1,71
2071-2100	**RCP 2.6**	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
Amazonía	1,28	2,32	2,54	3,46
Costa	1	2,2	2,41	2,91
Galápagos	1,17	2,37	2,45	4,39
Sierra	0,72	1,53	1,71	2,49
ECUADOR	0,86	1,8	1,99	2,76

Source: MAE 2017, p. 392.

Figure A93: Annual mean temperature anomalies for four RCPs



Source: Armenta-Porras et al. 2016, p. 53.

The following table contains a summary of projected changes of temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A23: Projected changes of temperature-related climate variables in Ecuador (at the national level), compared to 1986-2005

Variable	***RCP 2.6***				***RCP 4.5***				***RCP 8.5***			
	2020-39	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***
Maximum daily temperature (°C)	1.02	1.33	1.40	1.34	0.82	1.38	1.72	1.99	1.17	2.04	3.04	4.09
Minimum daily temperature (°C)	0.77	1.10	1.16	1.12	0.98	1.58	1.96	2.05	1.17	2.10	3.35	4.59
Hot days (above 35°C)	7.94	9.63	11.16	10.12	6.44	12.38	17.93	22.88	9.37	21.05	50.96	88.64

Hot days (above 40°C)	0.11	0.10	0.11	0.11	0.02	0.11	0.27	0.33	0.10	0.32	1.06	3.70

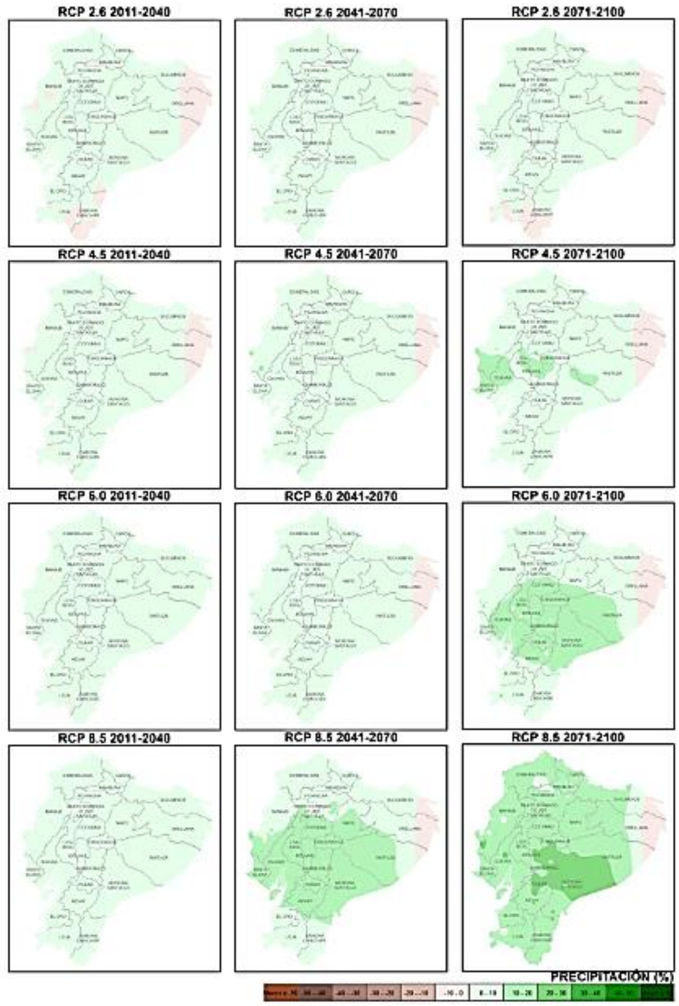
Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

Projections by Armenta-Porras et al. (2016) suggest that precipitation could show an increase between 2% and 10% in precipitation in most of the national territory during the period from 2011 to 2100, with the exception of RCP 8.5 -where precipitation could increase in 20% (see figure below). Nonetheless, the eastern Amazon region and the Galapagos archipelago may experience increases in climate variability, and potentially extreme rainfall events.[595]

[595] Armenta-Porras et al. 2016

Figure A94: Spatial distribution of precipitation change projected by the four RCP scenarios, with respect to the reference period 1981-2005.



Source: Armenta-Porras et al. 2016, p. 98.

What is particularly interesting, is that for the late century the Amazon region could experience a varied range of changes; where the easter part could have a reduction on precipitation of 2% to 10%, whilst the center and western part of the Amazon region could display increases in precipitation between 10% and 20% (see Figure 13).[596]

The following table contains a summary of additional projected changes of precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

[596] Armenta-Porras et al. 2016

Table A24: Projected changes of precipitation-related climate variables in Ecuador (at the national level), compared to 1986-2005

Variable	*RCP 2.6*				*RCP 4.5*				*RCP 8.5*			
	2020-39	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*
Days with rainfall >20mm	1.46	1.29	1.46	1.27	2.62	3.57	3.90	4.63	2.64	4.97	6.41	8.22
Rainfall of very wet days (%)	16.39	19.58	18.97	19.25	25.65	41.05	42.21	43.05	25.30	53.42	80.03	118.26
Maximum daily rainfall (10 year RL) (mm)	4.71	6.02	6.43	5.29	5.31	8.08	9.05	9.78	5.74	9.52	15.80	19.14
Maximum daily rainfall (25 year RL) (mm)	5.22	6.52	7.52	6.18	6.33	9.29	9.90	11.17	7.02	11.93	20.13	23.56
Projected change in annual rainfall (mm)	-43.74	-65.92	-87.09	-95.49	27.24	-63.56	6.42	-86.42	30.19	132.62	105.83	133.63
Severe drought likelihood	0.02	0.04	0.06	0.04	0.03	0.02	0.02	0.03	0.02	0.03	-0.01	-0.01
Probability of heat wave	0.08	0.14	0.15	0.18	0.13	0.27	0.42	0.48	0.15	0.42	0.74	0.92

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Climate-related natural hazards

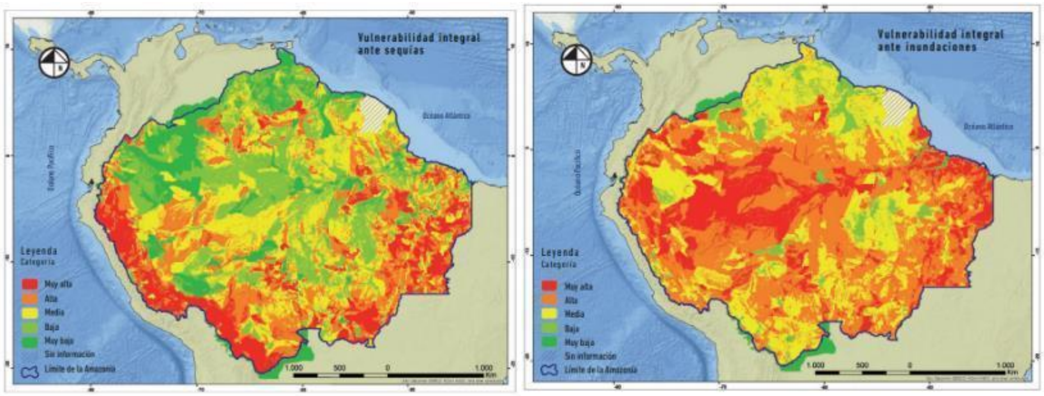
Climate change is expected to further increase variability and the incidence of extreme weather events, such as droughts, floods, and intense rainfall events.

- **Drought:** Increasing temperatures and changing precipitation regimes imply that much of the Amazon will become increasingly dry (increased length of the dry period), and increasingly exposed to droughts and extreme heat.[597] Pabón-Caicedo et al. (2016) further the Andean foothills in Ecuador, Peru and Bolivia are also at risk of drought (Figure A95).[598]

[597] Marengo et al. 2013 in Prüssmann et al. 2016; USAID 2018

[598] Pabón-Caicedo et al. 2016

Figure A95: Vulnerability to drought (left) and floods (right) in the Amazon basin



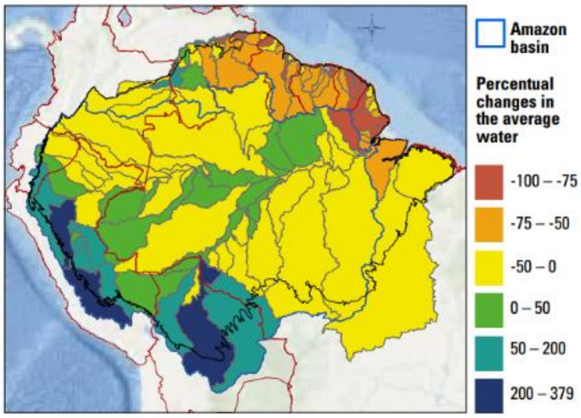
Source: Pabón-Caicedo et al. 2016, p. 45

- **Floods:** Floods are projected to increase in the future, in terms of frequency and intensity.[599] Ecuador and other countries in the Western Amazon region is expected to experience more frequent and intense flooding in the rainy season (see Figures below).
- **Landslides:** There is limited information on landslide risks and projections; however, deforestation on sloped areas, combined with increasing seasonal precipitation is likely to increase the occurrence of landslides, especially in the Andean foothills of Ecuador.
- **Wildfires**: Wildfires are expected to increase due to increasingly dry conditions, and continued use of fire for clearing forest in the Amazon.[600]
- **Water scarcity**: While Ecuador has a very low risk of water scarcity, it is possible under climate change that changes in water yields could be observed, especially in northern provinces.

[599] Marengo et al. 2013 in Prüsmann et al. 2016

[600] USAID 2018

Figure A96: Projected percentual changes in future water yields under RCP 8.5



Source: Skansi et al. 2013 in Prüssmann et al. 2016

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:

In terms of sensitivity, there are various biophysical considerations:

- **Flooding:** The susceptibility of slopes against flooding is considered low (in steep areas along the slopes and foothills of the Andes) to very high (flatland), whereas the susceptibility of soils to flooding ranks high in the Amazon region of Ecuador (see following two figures).[601] In terms of hydrological endowment, the region is considered to have moderate to high susceptibility to floods (Figure 15a)[602]
- **Droughts:** Ecuador's Amazon region is also susceptible to droughts when considering its hydrological endowment, with high to very high susceptibility.[603]

In terms of dependence on agricultural activities, Ecuador's Amazon region ranks from low to high susceptibility (see Figure A99).[604] This is largely due to the concentration of agricultural activities in the coastal and Andean regions of the country.

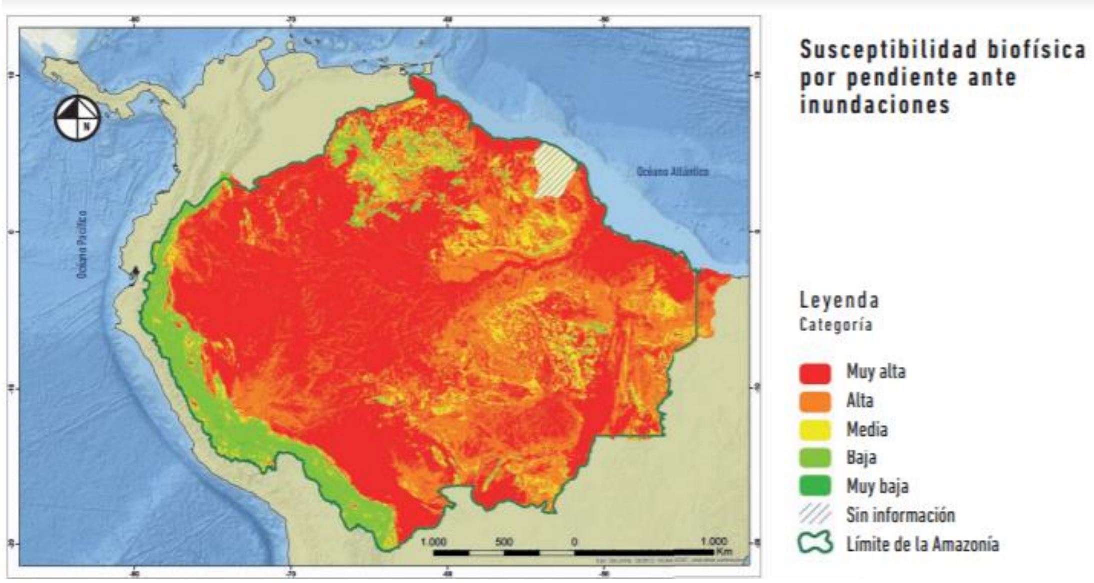
[601] Pabón-Caicedo et al. 2018

[602] Pabón-Caicedo et al. 2018

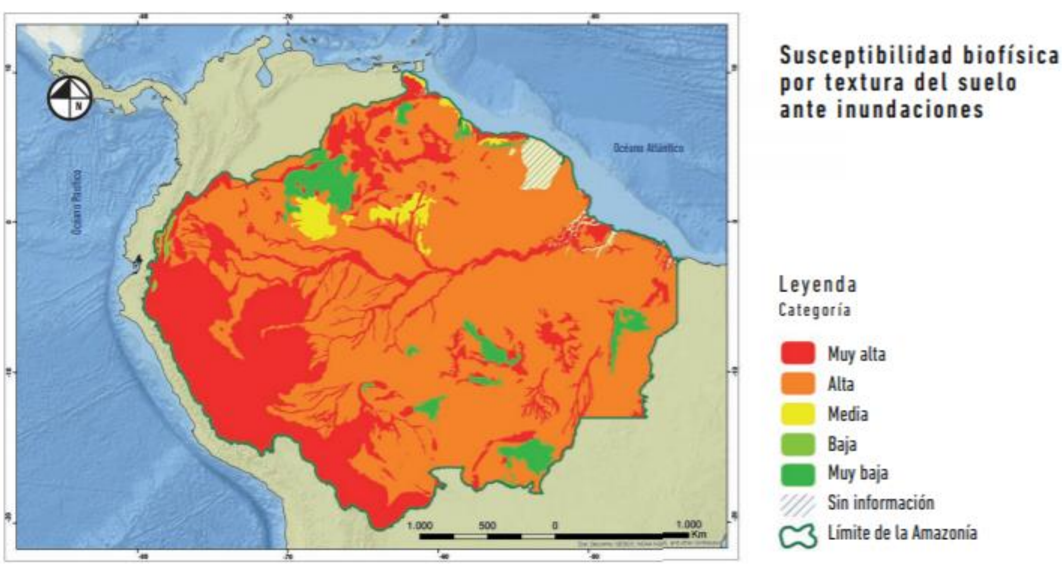
[603] Pabón-Caicedo et al. 2018

[604] Pabón-Caicedo et al. 2018

Figure A97: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin



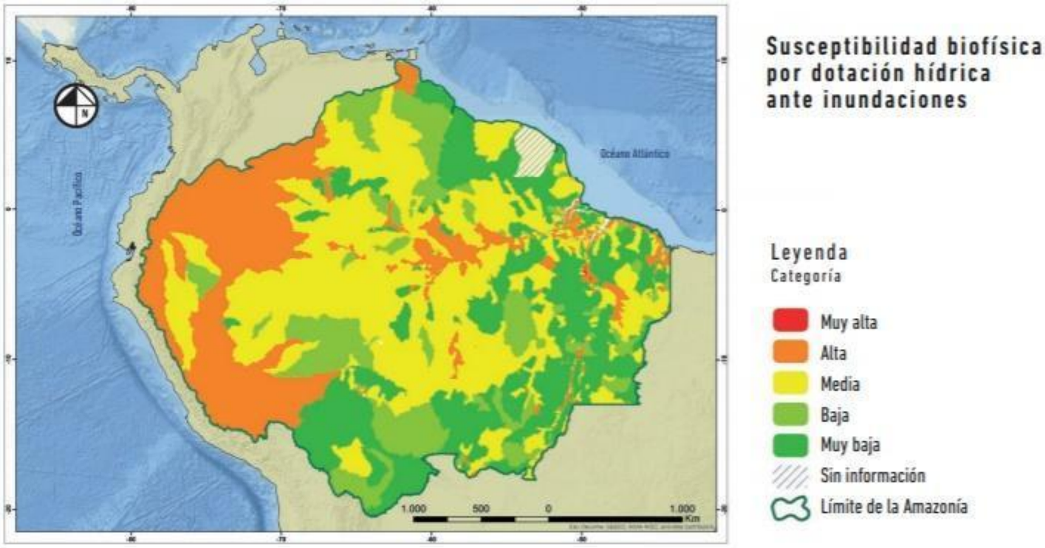
a)



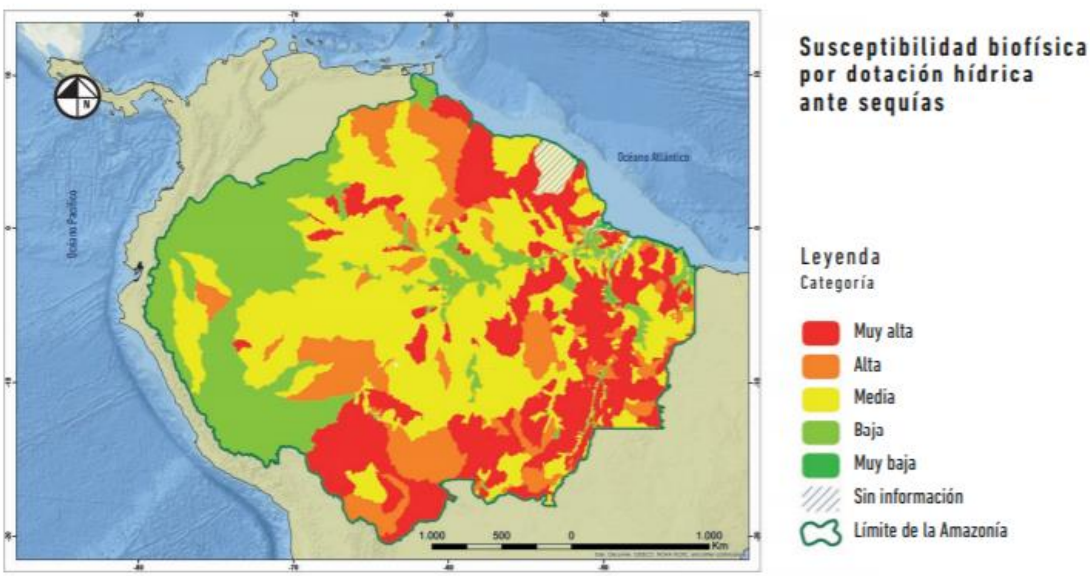
b)

Source: Pabón-Caicedo et al. 2018, p. 42

Figure A98: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin



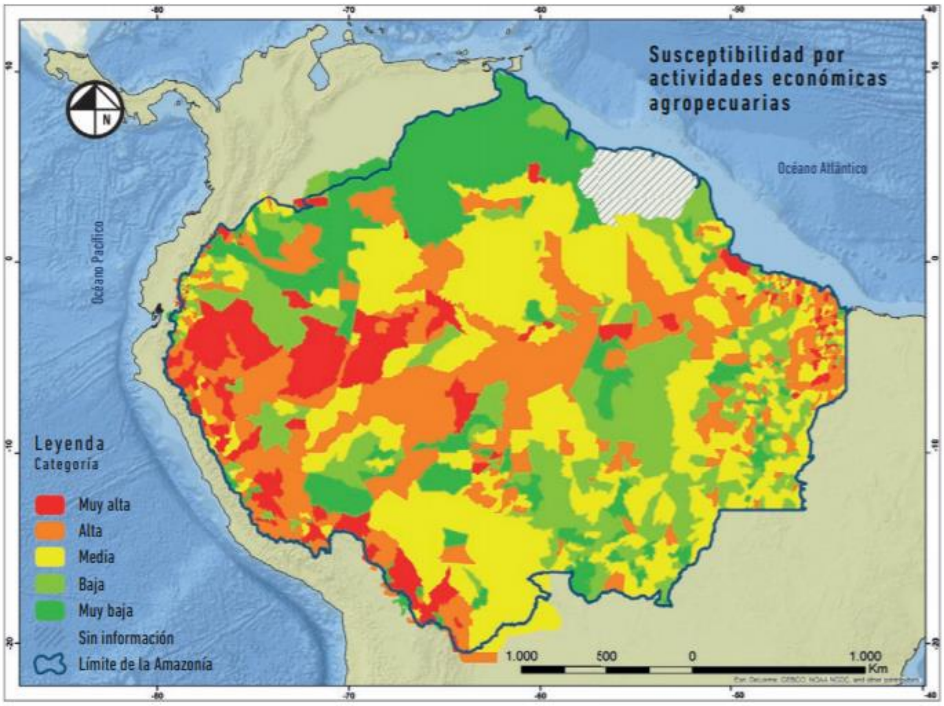
a)



b)

Source: Pabón-Caicedo et al. 2018, p. 42

Figure A99: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector



Source: Pabón-Caicedo et al. 2018, p. 41

In terms of capacity, there is limited information on the specific adaptive capacities and coping capacities in Ecuador's Amazon region. The First NDC notes the relevance of building adaptive capacities and resilience building, however there is limited information on the capacities at the regional level.[605]

Fernandez et. al (2015) conducted a vulnerability assessment for Ecuador taking into account climatic and socioeconomic indicators into a composite vulnerability indicator. By assessing vulnerability through the AR4 approach, considering exposure, adaptive capacity and sensitivity, the Amazon region ranked high in exposure to climate change, low in adaptive capacity, and high in sensitivity (see Figure below). The author noted the region´s high vulnerability is due to the absence of land tenure in rural areas, dependence on agriculture, poverty, low coverage of public services, and the lack of government-funded environmental and climate change monitoring schemes, among other factors.[606]

[605] MAAE 2019

[606] Fernandez et. al 2015

Figure A100:Components of vulnerability by canton

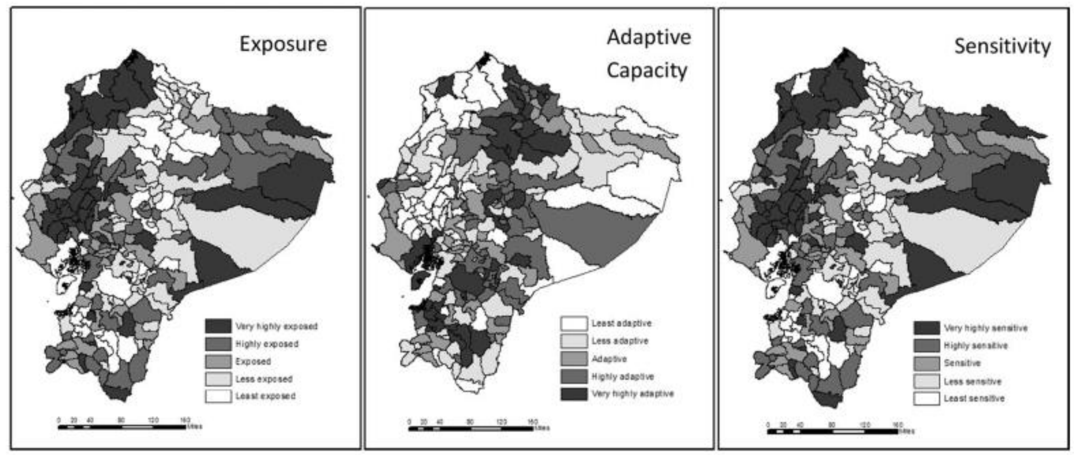


Fig. 4 Components of vulnerability

Source: Fernandez et. al 2015 p. 12

Climate risks and impacts on the bioeconomy and local livelihoods

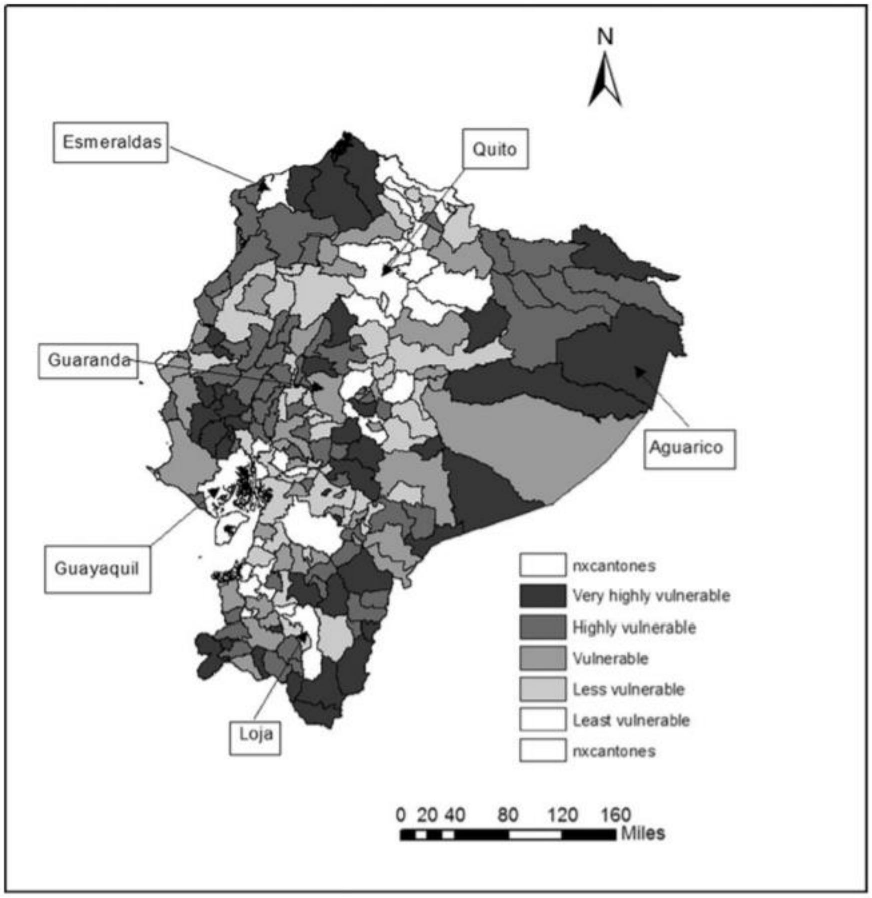
Climate Risk Ecuador

Ecuador has a Climate risk index score of 92.83 and is ranked in place 100 of 180 countries in terms of climate risk and vulnerability.[607] While not considered one of the most vulnerable countries in the world, climate change nonetheless poses a major risk to Ecuador. An assessment of climate vulnerability in Ecuador (using the AR4 approach where vulnerability is comprised of hazards, adaptive capacity and sensitivity), the Amazon region ranked among the most vulnerable regions in Ecuador (see Figure below). The most vulnerable regions in the Amazon were the provinces of Orellana and Pastaza, however majority of cantons in the Ecuadorian Amazon were ranked as highly or very highly vulnerable to climate change.[608]

607 Eckstein et al. 2020

608 Fernandez et al. 2015

Figure A101: Climate change vulnerability in Ecuador based on exposure, adaptive capacity and sensitivity



Source: Fernandez et. al 2015 p. 11

According to the Country Report on Climate Risk Management (USAID 2013), climate risks caused combined damages and losses of USD $5 billion during the period from 2000 to 2010, including around USD $4 billion in damages from droughts, and USD $1 billion from flooding (UNDP 2013). UNDP (2013) estimated that according with IPCC's climate prediction's timeframes, at least USD $450 million could be lost to climate risk on an annual basis, and this will increase exponentially as more and more development assets are exposed.

An increase in temperature (as projected by climate change scenarios) could mean that certain diseases (such as: Arbovirus, Malaria, Leishmaniosis, and Chagas) and their respective disease transmission vectors could disappear partially form certain areas of the Coastal region, but proliferate in other Andean or Amazon areas.[609]

Ecuador`s national adaptive capacity is low due to its oil-based economy, and low institutional capacities of the government, among other factors. Changes in global petroleum prices, such as the drastic declines seen since 2015, further limit the available budget to invest in climate action and other key social services in the country. Coupled with other economic shocks, such as the global covid-19 pandemic, the country has less coping ability in the face of climate change, and climate-related natural disasters.

609 Mato et al. 2019

The country´s National Climate Change Strategy[610] highlights the following priority sectors:[611] human settlements, water security, natural heritage, productive and strategic sectors, health, food sovereignty, agriculture, livestock, aquaculture and fisheries. The bioeconomy is covered by many of these sectors, given the potential impact climate change poses on ecosystems, production systems, and the livelihoods who depend on them.

Climate Risk for the Amazon

Several adverse effects on the health and livelihoods of the population as well as vital ecosystems in Ecuador´s Amazon region can be inferred from the possible effects of climate change:

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. While there are limited studies available on the Ecuadorian amazon region, potential impacts could include: changes in productivity, crop failure, need for inputs, losses and damages due to hazards (floods, droughts, fire, landslides), changing production zones, pest and disease outbreaks, among others. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.).
- The expansion of monocultures, with the consequent use of pesticides and fertilizers, and the expansion of agriculture for put **food security and sovereignty at risk**, since the interest of small farmers in being part of the production chains implies an abandonment of multi-cropping and self-consumption crops, increasing their vulnerability to climate change and affecting their environment through loss of genetic diversity, reduced ecosystem resilience and high chemical use.[612]
- Changes in average air and soil temperature, coupled with changes in water availability, can have an effect on the **increase of pests and the loss of cultivable land**.[613] In addition, studies show a negative correlation between growth rates of trees and increases in annual average temperature, annual maximum temperature and intensity of the dry season. This will result in stress and reduced net primary production and, causing impacts on ecosystem structure.
- Climate change and **climate-related hazards (such as floods)** may **limit access to food and foraging** in the Amazon region. Floods in the Amazon region in 2020 were reported to have affected the food security of indigenous peoples in the Ecuadorian Amazon, where people were unable to forage and instead had to travel into cities to buy food. Given the covid-19 pandemic, this put indigenous communities and their elders at higher risk of contracting and spreading covid-19.[614]

Risk of damages and losses to infrastructure and other economic sectors

[610] MAE 2012

[611] Ecuador is in the process of developing its National Adaptation Plan, which should be finalized by 2022.

[612] MAE 2017

[613] MAE 2017

[614] Mongabay 2020

- Climate-related hazards (e.g. flooding, fires) could result in **increasing losses and damages** to communities and houses in the Amazon, as well as infrastructure (e.g. tourism infrastructure roads, public buildings).[615]

Risk of injury, illness, death and adverse health impacts

- With an expected increase in intense rainfall and flooding, the need for large-scale evacua
- Climate change is expected to generate negative health impacts, including: death and injury from climate-related hazards, air pollution (incl. from forest fires), increased cardiovascular and respiratory disease due to increased temperatures (particularly affecting the elderly), among others.[616]
- Climate change has the potential to **increase air and soil temperatures** that could create the necessary conditions for a wider distribution of disease transmitters such as mosquitoes, ticks and rodents. Consequently, conditions for the spread of diseases (e.g. dengue fever, malaria and *leishmaniasis)* and epidemics would be more likely to occur.[617]
- Chagas could be another disease that could appear in the Amazon region, and in areas where it is currently absent. These scenarios could put indigenous communities (particularly Quichua, Shuar, Huaorani, Cofan, and Secoya) in a more vulnerable state, as their current mortality and morbidity rates are 30% to 60% higher than non-indigenous populations.[618]

Risk of ecosystem transformation, and loss of ecosystem services and biodiversity

- Biodiversity and ecosystem functions are highly sensitive to climate change. Considering that Ecuador is a mega-diverse country, **potential impacts and damage to natural heritage** are expected, including in the Amazon region.[619]
- The effects of increasing climatic exposure may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, open roads, and deforestation usually **cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change**.[620]
- **Deforestation and forest degradation in the Amazon exacerbate the exposure to climate hazards, and overall impact of climate change on ecosystems and local livelihoods.** Deforestation and forest degradation can contribute to: soil degradation, erosion and sedimentation, reduced soil moisture, soil organic matter and soil organic carbon, biodiversity loss, reduced forest health, pest and disease outbreaks, and increased exposure to floods and fires, among others. In addition, the conversion of forests into grasslands or cropland, potentially contributes to climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness.[621] The Ministry of Environment notes that there is a strong expansion of

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[615] MAAE 2019

[616] MAAE 2019

[617] MAE 2012; Mato et al. 2019

[618] Mato et al. 2019

[619] MAAE 2019

[620] Clark and Clark 2010; Eguiguren-Velepucha et. al. 2016; Hautier et. al 2015

[621] Bovolo et al., 2009; Staal et al. 2020

agriculture in the Amazon region, resulting in deforestation and forest degradation that further exacerbates climate risk and vulnerability in the region.

Risk of negative impacts on freshwater ecosystems affecting local livelihoods and energy security

- Ecuador, despite being a country with abundant water, changes caused by climate change could trigger potential conflicts, competition among users and emergencies related to floods and landslides. On that note, hydroelectric plants located in the Paute, Coca, and Pastaza watersheds are highly vulnerable due to the increased frequency and intensity of climatic hazards and extreme events (e.g. generating landslides, or bringing more sediment into reservoirs), situations that pose a great risk to the energy sector, infrastructure, as well as the agricultural and service sectors.[622]

The following Table presents a summary of potential impacts in key sectors in Ecuador´s Amazon region.

Table A25. Overview of potential climate change impacts and projected risks on key in Ecuador´s Amazon region

Sector	Potential impacts and risks
Agriculture	▪ Small-scale and subsistence agriculture is particularly vulnerable to extreme weather events and irregular climatic variations (MAE 2017; UNDP 2013). ▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures ▪ Changes in crop yields and productivity of key crops in inland areas
NTFPs (e.g. Guayusa)	▪ Decrease in NTFP quality and availability due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks
Aquaculture & Fisheries	▪ Annual recurring drought events threaten water quality and quantity for fisheries sector ▪ Water quality deterioration (changes in pH, oxygen, temperatures)
Tourism	▪ As critical climate change parameters like temperature alterations, rainfall variability, sea level rise and extreme events, could pose threats to regular undertakings and infrastructures (UNDP 2014). E.g. Damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) ▪ Damage to forest resources due to wildfires. ▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (malaria, dengue) ▪ Risk of decreased attractiveness of key tourism features (waterfalls) due to precipitation variability

[622] MAAE 2019

Ecosystem regulation services	▪ Decrease in biodiversity (threatened species) due to changes in habitat and changing climatic conditions ▪ Decrease in opportunities for traditional hunting and consumption practices. ▪ Changes in ecosystem functions, including regulatory and cultural services ▪ Risk of biodiversity loss, endangered flora and fauna ▪ Risk of loss of key ecosystem functions including regulatory, production and cultural services ▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience)
Forest	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Deforestation-drought cycles will increase the risk of increasing intensity and frequency of wildfires, resulting in biodiversity loss, and the loss of ecosystem functions ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume ▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities ▪ Changes in ecosystems and biodiversity

Sources: World Bank 2020; MAE 2017; UNDP 2013

Bioeconomy sectors and actors

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g. country, region, site-conditions, etc.), many of the program's investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g. agroforestry, ecotourism)

A brief overview of bioeconomy sectors and actors in Ecuador is provided below.

Coffee

For the year 2019, the area planted with coffee (called gold grain) nationwide was 48,097 hectares, of which 22,143 hectares, or 46%, were located in the Amazon; 37.2% were on the coast; and 16.8% in

the highlands[623]. National production was calculated at 8,141 MT, of which 3,312 MT, or 40.7%, were produced in the Amazon; 35.4% were produced on the coast; and the remaining 23.9% in the highlands. The yields per planted hectare were 0.19 MT/ha in the Amazon, 0.22 MT/ha on the coast, and 0.32 MT/ha in the highlands. Yields were lower in the Amazon due to high rainfall; soil quality, inadequate agricultural practices to improve soil, control diseases, and maintain plantations.
Of the 22,143 hectares planted in the Amazon, 95.5% were located in the provinces of Sucumbíos (with 13,070 hectares, or 59%) and Orellana (with 8,092 hectares that represent 36.54%). Notably, 90.9% of the cultivated hectares were exclusive coffee monocultures, and 9.1% were cultivated in association with other crops and in agroforestry systems.

Ecuadorian high-quality coffee is a product with several market niches, and approximately 100,000 families are growing this product. The specialty coffee market accounts for 20% of the total volume of world trade but accounts for around 50% of the value of world sales (around US$40 billion). Of the 3,312 MT of Amazonia coffee produced, approximately 400 MT corresponds to this type of specialty coffee. Nevertheless, it does not have competitive advantage with prices from Vietnam, Colombia and Brazil, amongst others. Most of specialty and gold grain coffee is sold nationally. Coffee exports have steadily declined since its peak on 2011. In 2018, 2023.9 MT were exported, and by 2019, this figure had dropped to 17.8 MT[624]. Furthermore, as coffee farmers wait for better prices, they pause cultivation and harvesting on the plantations as to decrease overall costs.

Cacao

In 2019, Ecuador had 601,954 hectares of cocoa planted nationwide, of which 58,343 hectares, or 9.6%, were in the Amazon, while 77% of the hectares were cultivated on the coast.[625] On the other hand, national production was calculated at 283,680 metric tons (MT), with the Amazon production reaching 18,110 MT (i.e., it contributed 6.4%, while the coast participated with 79.3% of the total). Yields per planted hectare reach 0.31 MT/ha in the Amazon and 0.48 MT/ha on the coast. The yield data per harvested hectare was higher because not all hectares are harvested yearly, due to the age of the plants, and reached 0.37 MT/ha harvested in the Amazon and 0.55 MT/ha harvested on the coast. The lower yields in the Amazon, compared with the coast are evident, and were due to the quality of the soils, the high rainfall in the Amazon, inadequate agricultural practices, care of plantations, and soil management.
Of the 58,343 hectares planted in the Amazon, almost 80% are located in the provinces of Sucumbíos (with 27,072 hectares, or 46.4%) and Orellana (with 18,699 hectares, equivalent to 32%). Another characteristic is that 93% of the total cultivated hectares are exclusive cocoa monocultures, and only 7% are cultivated in association with other species. There is great potential for yield improvements related to agroforestry and fertilization best practices.

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[623] INEC. 2019.Encuesta de Superficie y Producción Agropecuaria Continua, ESPAC. https://www.ecuadorencifras.gob.ec/estadisticas-agropecuarias-2.

[624] Gestion Digital. 2019. El café ecuatoriano va en caída libre. https://www.revistagestion.ec/economia-y-finanzas-analisis/el-cafe-ecuatoriano-va-en-caida-libre.

[625] Op. Cit INEC.

Exports of cocoa and its derivatives reached more than US$869 million in 2020 and grew in 2019 by around 11%; the main destination was Indonesia, with 26%, the United States, with 17.1%; the Netherlands, with 15.4%; and Malaysia, with 11.0%. Ecuador is the third largest exporter of cocoa beans worldwide, with 7% of total world exports. It is also important to mention that 60% of the world production of fine aroma cocoa comes from Ecuador. This variety constitutes 5% of world production[626].

The main exporting companies are OLAM Ecuador, Agroarriba S.A., Grandsouth S.A., Nestlé Ecuador S.A., and Inmobiliaria Guangala S.A. These companies represent almost 40% of cocoa sales.

Forestry

In the Amazon, according to SIPA-MAG, there are a total of 340.4 thousand hectares of cultivated pastures and 97.7 thousand hectares of natural pastures.[627] This yields a total of 438.1 thousand hectares of pasture. Many hectares are degraded, abandoned, or no longer part of productive systems. The establishment of forest plantations for the extraction of wood is one of the projects most closely related to the natural vocation of the Amazon, which is to have forests. At the moment, more than 10,000 hectares are under restoration, managed by communities; this is expected to reach 15,000 hectares over the next couple of years. These actions are located near riverbanks, on steep slopes, and in other areas where restoration is essential to protecting the soil.

Local governments have goals regarding reforestation and restoration, but their initiatives cover only small areas. One of the objectives of this restoration proposal is to be able to concentrate and manage large areas with commercial plantations. Several indigenous communities are interested in sustainable forest management, which is a good indication of the potential interest in this type of action[628].

Since there are potential areas for reforestation and restoration in the Amazon, especially in places where there are degraded pastures, bamboo cultivation is an alternative. Bamboo is a species that provides several ecosystem services, highlighting the carbon sequestration of up to 69.9 MT/ha per year for the G. angustifolia species. Proper bamboo treatment guarantees a construction life of at least 50 years. Ecuador has more than 600,000 hectares of bamboo, with 47 registered species and at least 30 introduced species.[629][630]

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626 Gestión Digital. 2021. Ecuador tiene en el cacao una oportunidad de oro. https://www.revistagestion.ec/economia-y-finanzas-analisis/ecuador-tiene-en-el-cacao-una-oportunidad-de-oro.

627. Sistema de información pública agropecuaria.2019. Cifras agroproductivas. Ministerio de Agricultura y Ganadería http://sipa.agricultura.gob.ec/index.php.

628 Secretaria técnica Planifica Ecuador.2021. Planes de Desarrollo y Ordenamiento Territorial – Provincias. https://multimedia.planificacion.gob.ec/PDOT/descargas.html.

629 Romero, M.A. 2015. Estudio de la cadena desde la producción al consumo del bambú con énfasis en la especie (Guadua angustifolia) en Ecuador. Red Internacional De Bambú Y Ratán, INBAR. Quito.

630 INBAR. Bioconstrucciones sostenibles con bambú: Region Amazónica en las provincias de Orellana, Napo, Pastaza y Morona Santiago. INBAR, Nota conceptual.

A proposal from the Ministry of the Environment in conjunction with the Ministry of Foreign Trade would involve an investment of US$200 million through a public-private association management model, and the participation of private companies, local governments, and research centers. The objective is to generate bio-enterprises at different scales, creating employment and income in rural and urban sectors, with an emphasis on the coast and the Amazon.

In the case of balsa wood, exports of this product exceeded US$127 million in 2018, $219 million in 2019, and $570 million in 2020. This is due to the unusual increase in its price, which went from US$3,893 per ton in April 2019 to $7,463 in June 2020. To date, the balsa plantation business has developed in the coastal provinces of Guayas and Esmeraldas, due to the better transport infrastructure and logistical savings arising from being closer to the Pacific coast port facilities, from where it is exported to key clients in Asia.

Non-timber forest products (NTFPs)

For many years, indigenous Amazonian communities have been using Morete (Mauritia flexuosa), ungurahua (Oenocarpus bataua), and Amazonian cinnamon (Ocotea quixos) for different purposes, such as food and oil production. At the moment, PROAmazonia, together with the Private Technical University of Loja (UTPL), is conducting a series of studies on the large-scale production of plant oils for both cosmetics and consumption. According to other studies, there are large national and world markets for this type of oil, but no suppliers. This type of production is being supported because it also benefits the conservation of the forests and wetlands where these species grow. The data presented come from a partial study that was submitted to PROAmazonia. The study is still in progress, so provisional data are presented and calculated for a larger number of communities.

PROAmazonia is fomenting the idea of a program for the sustainable use of these species, involving indigenous families from the southern Amazon of Ecuador. UTPL is analyzing the business model’s feasibility and associations with national and international companies that demand plant oil, with the intention of creating a larger model to support more producers of these products.

The small indigenous communities use their territories for gathering, hunting, and agricultural activities. The program proposes support of US$10,000 per community, and incorporates 200 communities to improve the management of their forests and the supply of these products. This is an investment of US$2 million.

Sites would be built for the storage and correct handling of the fruits. The idea of having three medium-size oil extraction centers, located in the northern, central, and southern parts of the Amazon, has also been developed. These centers would buy the raw material from the communities and extract the oil. The costs of each center are estimated at US$500 thousand, with which the investment reaches US$1.5 million. The total investment would reach US$3.5 million.

The world market for organic cosmetics is US$11.78 billion, and its annual growth is almost 7%. The main markets are with the United States, Germany, and France, and more recently, China. The most popular products are solid perfumes, bar soaps, shampoo bars, facial waxes, and anti-wrinkle creams.

Finally, consumer demand is inclined toward products with natural ingredients that are produced in a sustainable way and have organic or fair-trade certifications. This is estimated to achieve annual sales of US$7 million and costs of US$4 million[631].

Tourism

Tourism had a direct contribution of 1,9% to national GDP, or US$490 million in 2019. In June 2018 and 2019 Ecuador registered 448,995 and 477,117 international arrivals respectively. In June 2020 only 8,100 international arrivals were registered. COVID-19 severely impacted the tourism sector in Ecuador and LAC. According to the Ministry of Tourism, in January 2020, tourism sector holds 6,1% of all employees in the economy, placing it within the 6 industries with greatest economic contribution to jobs at a national level[632].

Case Study: Nature tourism at Kapawi Ecolodge, Ecuador

Kapawi, one of Ecuador´s best known ecolodges, stands out for being a novel joint venture between a private tour company, Canodros, and an entire federation of 5,000 Achuar Indians, and because it is a luxury lodge that accommodates over 1,000 tourists per year. It is now 100% owned and operated by the Achuar Nation of Ecuador (NAE). In 1993, Canodros and NAE signed an agreement by which the company agreed to co-design, construct, and operate an ecolodge for 40 guests in the remote Achuar territory. The terms of the 15-year agreement stipulated a monthly rent to the Achuar Federation of US$2,000, with an increase of 7% per year. A US$10 fee was charged to every visitor for the exclusive benefit of the Achuar community. In 2002, the terms were renegotiated with NAE at a higher, fixed rent. In 2008, the lodge passed entirely to the Achuar.

The main selling points for the Kapawi start-up investment were (1) the lodge would be located in an isolated lowland tropical rainforest, (2) Canodros promised a socially responsible partnership with NAE, (3) the lodge would be environmentally friendly, and (4) Canodros already had a proven track record with tourism in Galapagos. Canodros promised to employ a majority of Achuar people and to purchase supplies for the lodge, including food, wood, palms, and fibers, from the Achuar. More broadly, Canodros agreed to pass know-how to the Achuar co-owners through apprenticeship and training in all aspects of the operation. In exchange, the Achuar agreed to provide knowledge about their culture and environment, materials and traditional techniques for building the lodge, and access to their existing airstrip. They also agreed to restrict hunting in the areas within the ecotourism zone. In total, Canodros spent $2 million and two years to build Kapawi. Debuting as the ecotourism project with the highest capital investment in the Ecuadorian Amazon, Kapawi opened for operation in April 1996. The lodge consists of 21 cabins that accommodate a maximum of 70 people, including guests and staff—not coincidentally, about the size of a typical Achuar village. Most tourists at Kapawi seek easy to moderate levels of activity, and come from the United States (55%), Europe (35%), Asia (5%), and Ecuador (5%).

[631] Instituto para el Ecodesarrollo Regional Amazónico. 2016. Plan integral para la Amazonía. Secretaria Nacional de Planificación y Desarrollo

[632] Editores Grupo Faro. 2020. Sector Turismo en Ecuador : Retos después del COVID-19

Though Kapawi is remote, it is also one of the most accessible ecotourism lodges in Ecuador. Tourists fly east 240 kilometers from the capital city of Quito for 2 hours in a single-engine plane. After landing on a dirt airstrip in one of the Achuar communities on the Capahuari River, guests board a six-passenger motorized dugout canoe (with four-stroke outboard engine, to minimize noise and pollution) for a two-hour ride downstream to the lodge. Once reaching the Kapawi dock, tourists walk along a raised boardwalk that weaves through the forest.

Kapawi is different from other community-based ecotourism and ethnotourism lodges in Ecuador in various respects. First, the company has been careful to respect the privacy of Achuar families. They do not offer overnight stays in Achuar homes. They also do not encourage "cultural programs" that include dances, theater, staged or real shamanic ceremonies, or ready-made photo ops, as these are perceived as inauthentic to everyday life among the Achuar. A third distinguishing characteristic is the fact Kapawi is not so much a community-based lodge as a federation-based lodge that incorporates over 58 Achuar communities living in 7,000 square kilometers of indigenous territory. Some communities are just an hour's walk from lodge, while others are five days.

Kapawi's economic impact has been significant. Sixteen of 52 Achuar communities base most of their income on ecotourism. In these communities, up to 45% of their total income comes from direct employment at the lodge. A rotating staff of 22 employees at Kapawi are from Achuar communities. When Kapawi passed entirely to the hands of the Achuar in 2008, Canodros had paid nearly US$700,000 in rent and US$150,000 in accumulated tourist fees to the Achuar, along with helping leverage several hundreds of thousands of dollars in NGO contributions. Tourists per year were averaging 1,000. Annual 2018 revenue was approximately US$480,000. Beyond contributing new income to remote communities, Kapawi has helped NAE protect Achuar territory from encroachment and connected the communities with the NGO Pachamama, which provides technical expertise and funding for a variety of Achuar projects. Between March 2018 and August 2019, Kapawi closed to the public to complete a renovation and reconstruction. The expected sales objective for 2020 was 400 visitors. Due to COVID-19, however, the company reached only 96 visitors between January 1 and March 14, and then was shut down. During this time, the company received a new capital investment of US$700,000 for the reconstruction process. Currently, all revenues go to Kapawi's new administrative structure, where Kapawi is owned by three communities. The fee per visitor has increased from US$10 to US$50 and is transferred to the ANE for reinvestment.

Financial system and bioeconomy businesses

From 2017 to 2019, the number of credit operations in Ecuador was approximately 20,000 per year, and the average amount of credit was US$5,000. Private banking represented 29% of operations in those three years, and 24% of the total credit.

The volume of consumer credit from January to October 2020 decreased by 15%, from US$6,256 million to $5,299 million. Non-consumer loans decreased in the same period by 6.5%, from US$14,720 to 13,765 million. The reference interest rates remained relatively stable, even in 2020. In June 2019, the deposit rate was 6.17% and the active rate was 2.61%, while as of December 2020, the deposit rate was 5.89% and the active 2.61%.

BanEcuador, a public bank, is the main actor of the credit systems in the Amazon. As of 2019, its assets reached US$2,170 million, with a loan portfolio of $1,572 million. Most of BanEcuador's loan portfolio was for microenterprises, making up 91% of its operations, with only 8% for commercial loans and 1% for consumer loans. Interest rates for microenterprises were around 10%. This rate was maintained for the commercial sector, while the consumer sector averaged 15%.[633]

BanEcuador has agencies in all the cities (cantons) of the Amazon provinces, which makes it the bank with the largest operations nationwide. In recent years, it has developed a series of specialized credit lines for each type of possible beneficiary: associative productive units, family productive units, community productive units, small and medium-sized production, marketing and service companies, and for entrepreneurs.

Credit for microenterprises (defined as natural persons or legal entities that have annual sales of less than US$100,000)

- Term: up to 10 years for fixed assets, and up to three years for working capital
- Grace period: up to three years for fixed assets, and up to 1 year for working capital
- Amount: from US$50 to $150,000
- Interest rate: 11.25% for production, or 15.3% for commerce or services

Credit for small and medium-sized companies (defined as those that have sales greater than US$100,000)

- Term: up to 10 years for fixed assets, or up to 3 years for working capital
- Grace period: up to three years for fixed assets, and up to 1 year for working capital
- Amount: from US$5,000 to $3 million
- Interest rate: adjustable from 9.75%

Tables A25 and A26 present statistics for credit in the Amazon and exclusively for agricultural activities.

Table A25: Private credit, Amazon agricultural sector

Year	No. operations	Credit amount US$
2017	4887	20,377,523
2018	5668	25,746,000
2019	6420	28,873,356
to July 2020	2128	9,480,444

Source: Superintendent of Banks and Superintendent of Social and Solidarity Economy

Table A26: Public credit, Amazon agricultural sector

Year	No. Operations	Credit amount US$
2017	14,558	72,929,226
2018	14,721	80,519,971
2019	12,585	84,092,581
to Dec 2020	6,762	33,651,186

Source: Superintendent of Banks and Superintendent of Social and Solidarity Economy

633 www.BanEcuador.fin.ec.

BanEcuador has made several efforts to shorten the period for loan applications and conducts credit delivery campaigns directly with associations or individual producers. It is the largest bank for the agricultural sector. In 2017, the most important institutions were BanEcuador, the CACPE YANTZAZA Cia Ltda. Small Business Savings and Credit Cooperative, The Juventud Ecuatoriana Progresista Cia Ltda. Savings and Credit Cooperative, Banco de Loja, and BP Bancodesarrollo.

Development, research and technical programs

There are various efforts by both national or state programs, as well as international cooperation in the field of bio-initiatives. Those relevant to the Amazon are the following:

PROAmazonia

It is a UNDP-MAG-MAE program with more than US$53 million in funding[634]. For Bioeconomy it has the following areas of action:

- Direct support for bio-enterprises through small donations. There is a fund of US$950,000 to support bio-enterprises that are in operation with up to $40,000.
- In 2019, an agreement was signed with the Universidad Técnica Particular de Loja for US$500,000 to work on the management plans and business plans of Morete, Ishpingo, Ungurahua, and seeds for oil in the southern region of the Amazon, Morona, and Zamora provinces.
- Improvement of coffee and cocoa collection centers work in deforestation-free production with the partners of approximately 10 centers (approximately US$1 million).
- Best practices and sustainable management are being promoted with 20,000 coffee, cocoa, palm oil and livestock producers (US$12 million).

Forest and Farm Facility (FFF-FAO)

FFF-FAO has a budget of US$1.2 million, of which $950,000 will be used to promote a strategy of competitive funds for bio-enterprises and markets, and to generate initiatives that favor adaptation, mitigation, and resilience to climate change.

Small Grants Program (PPD)

PPD is a UNDP project, coordinated with the MAE. It works with communities throughout the country and also has several work zones in the Amazon. Its new stage will have US$2 million so that communities that currently receive financing for conservation through Socio Bosque can expand their income sources with bio-enterprises, including strengthening community capacities in the application

[634] ProAmazonia. 2017. Sustainable Development of the Ecuadorian Amazon: Integrated management of multiple use landscapes and high value conservation forests. Project Document. GEF-UNDP https://www.proamazonia.org/wp-content/uploads/2021/04/Prodoc-GEF-firmado_SPA.pdf

of integrated production methods and techniques, improving market access strategies, strengthening organizational processes, and promoting strategies to link communities with private companies.[635]

Conservation and sustainable use of natural heritage

This project is executed by the German cooperation GIZ and MAE, with a three-year duration and approximately 10 million Euros in financing. It aims to improve the conservation conditions of protected and conservation areas, and the sustainable use of biodiversity. This will be done by improving the technical capacities of NGOs and universities to promote value chains of bioeconomy products and to strengthen links with the private sector and with high-value markets. The interventions will be regional and local and will be located in two Amazonian provinces, Pastaza and Morona Santiago, and three areas of the coast.

Enablers and barriers

The Bioeconomy implementation and development in Ecuador is underlined in the National Strategy for Biodiversity[636]. According to the MAE database on bioeconomy initiatives in the country[637], there is a list of 388 companies, associations or groups countrywide engaged in bioeconomy activities. However, this database is incipient and does not include micro and small actors and enterprises.

Some associations work with the concept of organic and also deforestation-free products. PROAmazonia is one of the UNDP Programs with the Ministry of Agriculture and MAE that work on the deforestation-free concept. Among the associations or projects that are working in the arena of deforestation-free value chains are: Rukullakta, Chankuap, Wiñak, Kallari, Tsatsayacu, Fortaleza del Valle, Apeosae, Acrim, and Nawe. These actors have signed a letter of commitment with the MAE and MAG to incorporate internal control systems so that their associates do not expand the agricultural frontier, and consequently their products can have a "deforestation-free" seal with which to commercialize internally and also export, whether these are raw materials (cocoa or coffee) or processed.

On the other hand, a potential barrier that includes climate change preparedness is Ecuador`s low national adaptive capacity due to its oil-based economy, and low institutional capacities of the government, among other factors. Changes in global petroleum prices, such as the drastic declines seen since 2015, further limit the available budget to invest in climate action and other key social and financial services in the country, such as transitioning towards a biodiversity conservation-based economy. Coupled with other economic shocks, such as the global COVID-19 pandemic, the country has less coping ability in the face of climate change, and climate-related natural disasters.

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[635] Moncada, M.P. 2019. Programa Ecuador BioEmprende. Nota conceptual.

[636] Ministerio del Ambiente del Ecuador. 2016. Estrategia Nacional de Biodiversidad 2015-2030. 1ra Edición, Quito-Ecuador. http://maetransparente.ambiente.gob.ec/documentacion/WebAPs/Estrategia%20Nacional%20de%20Biodiversidad%202015-2030%20-%20CALIDAD%20WEB.pdf

[637] This inventory is for internal use only and was made available to the author by MAE.

The country´s National Climate Change Strategy (MAE 2012) highlights the following priority sectors:[638] human settlements, water security, natural heritage, productive and strategic sectors, health, food sovereignty, agriculture, livestock, aquaculture and fisheries. The bioeconomy is covered by many of these sectors, given the potential impact climate change poses on ecosystems, production systems, and the livelihoods who depend on them.

Risks of bioeconomy financing in Amazonia

The risks for bio-enterprises can be categorized as follows:

- **Risk of informal, structures for bio-enterprises**. Generally, bio-enterprises born of solidarity, in small groups of people or community coming together, exhibit informality, are voluntary, and depend on resources from national or international cooperation. They tend to be leadership based and not process oriented. More mature, specialized structures, require formal accounting, a form of managerial or directive structure, adequate and timely quality and quantity management. There is a risk that those same structures with which bio-enterprises were born will inhibit their future growth.
- **Risk of access to markets.** Normally bio-enterprise associates are not familiar with medium or larger markets, or interact with them indirectly. Large cities, or international markets, are as yet too remote for bio-enterprises to reach. This knowledge and access to markets is critical to growth and innovation.
- **Risk of not achieving professionalization or maturity**. Bio-enterprises do not as yet place enough emphasis on consistency; they have flaws in the processes of quality and even quantity. Stable or long-term markets are not adequately served due to failures in processing, manufacturing and distribution nodes across several value chains, damaging market uptake and making long-term business growth difficult.
- **Short-term benefits expectations.** Bio-enterprise associates may have an initial phase of great expectation and momentum. When expectations are not met in the short or medium-term, perhaps due to one of the aforementioned risks, associates tend to sell their products to other suppliers and/or even return to previous, less sustainable, economic activities.
- **At the macro scale**, small or isolated initiatives fail to make structural change in a sector of the economy, a geographical area and even in consumer trends towards circular economy and overall well-being. This inability to become new trends that replace polluting products or processes may perpetuate them as agro-industrial projects without technological development.

[638] Ecuador is in the process of developing its National Adaptation Plan, which should be finalized by 2022.

Appendix 7 – Guyana Bioeconomy Context

Overview of policy, regulations and norms

Although several strategy documents have been produced over the years to guide national development, a milestone was reached in 2019 when the Cooperative Republic of Guyana (hereinafter Guyana) launched its Green State Development Strategy (GSDS). The GSDS is an effort to integrate existing policy tools under a holistic roadmap for 2040. Previous strategy documents have either been stand-alone sector oriented or more broadly focused horizontal ones. Today, the main relevant laws governing forest uses are: the Mining Act 1989 and Mining (amendment) Regulations 2005, the Forest Act 2009 (1953), the Guyana Lands and Commissions Act 1999, the State Lands Act 1903 and the Protected Areas Act 2011. As over 16% of Guyana's land area is under indigenous ownership (Figure A102), the Amerindian Act (2006) is also important; indigenous communities practice rotational farming, the impacts of which are considered negligible; however, some communities do also practice commercial mining and forestry on their lands. Relevant policies and planning instruments to consider for the development of a bioeconomy in Guyana are summarized as follows:

Green State Development Strategy: Vision 2040

The GSDS is Guyana's twenty-year, national development policy that reflects the guiding vision and principles of a green economy. The central objective is *an inclusive and prosperous Guyana that provides good quality of life for all its citizens based on sound education and social protection, low carbon and resilient development, providing new economic opportunities, justice and political empowerment* [639]. Guyana's vision for sustainable development is elaborated through the eight integrated and interconnected development objectives, and its 213 policy priorities. It emphasizes three key messages[640]:

Manage natural resources wealth

- natural capital, ecosystem services and traditional livelihoods are preserved through institutionalized and prudent management (land, forests, minerals and water)
- oil wealth is channeled into productive public investments to deliver sustainable development benefits for the whole of society and into the future

Support economic resilience

- a diversified and high value-add basket of economic sectors supports broad-based development and environmental responsibility
- resilient infrastructure reduces risks and business costs
- energy supply is reliable, low-cost and low-carbon

Build human capital

- citizens are healthy and well educated, enjoy acceptable standards of living and the rights of vulnerable groups are protected

[639] Government of Guyana. 2019. Green State Development Strategy: Vision 2040, Diversified, Resilient, Low-carbon, People-centered.

[640] Government of Guyana. 2019. Guyana First Voluntary National Review of the Sustainable Development Goals. Ministry of Finance.

- Guyana is governed by inclusive, transparent, and accountable institutions, that efficiently manage the natural patrimony and encourage citizen participation

Low Carbon Development Strategy 2009 - 2015

Guyana's Low Carbon Development Strategy (LCDS) was launched in 2009. It was the predecessor to the GSDS. The LCDS outlined Guyana's vision to promoting economic development, while at the same time combating climate change. Revised versions of it were launched in 2010 and 2013. Before the LCDS it was estimated that the Economic Value to the Nation (EVN) of the conversion of forest for agriculture, mining and other uses could be the equivalent of a US$580 million annuity, whereas the EVN of REDD+ at that time was zero. To demonstrate that the LCDS could be a model for forested nations, in 2009 the Governments of Norway and Guyana agreed in partnership to implement the LCDS, and Guyana set up the Guyana REDD+ Investment Fund (GRIF) to receive revenue flows, including a first commitment of US$250 million from Norway (2010–2015) for avoided deforestation once certain performance indicators are met. As a result, the LCDS stablished how to create economic incentives to increase the EVN of REDD+ so that it could start to make forests worth more alive than dead, while at the same time generating the necessary capital to invest in Guyana's low carbon economy[641]. The LCDS comprised seven key projects in the first phase, namely.

- Investing in strategic low carbon economic infrastructure, including a hydro-electricity plant at Amaila Falls; improved access to arable, non-forested land; and improved fiber optic bandwidth to facilitate the development of low carbon business activities.
- Nurturing investment in high-potential low carbon sectors, such as fruits and vegetables, aquaculture, business process outsourcing and ecotourism.
- Reforming existing forest-dependent sectors, including forestry and mining, where necessary, so that these sectors operate at the standards needed to sustainably maintain the forest.
- Expanding access to services, and creating new economic opportunities, for Amerindian communities through improved social services (including health and education), low carbon energy sources, clean water and employment which does not threaten the forest.
- Improving services to the broader Guyana citizenry, including improving and expanding job prospects, promoting private sector entrepreneurship, and improving social services with a particular focus on health and education.
- Protecting Guyana's people and productive land from changing weather patterns. Investments in priority climate adaptation infrastructure can reduce the 10% of current GDP which is estimated to be lost each year as a result of flooding.

National Strategy for Agriculture in Guyana 2013-2020

Guyana's vision for agriculture in 2020 was to change the view that agriculture is for subsistence livelihood while it also seeks to promote agriculture as a wealth generator and entrepreneurial engine, producing food and non-food commodities to meet local and export demands. The strategy is based upon the F-5 strategic approach for agriculture, which covers: (a) Food Security - consolidating the

[641] Government of Guyana. 2013. Low Carbon Development Strategy Update: transforming Guyana's economy while combating climate change. Office of the President.

end of hunger in Guyana, ensuring everyone has enough food in every community; (b) Fiber and Nutritious Food Accessible by citizens - nutrition security for all; (c) Fuel Production - helping to develop alternative fuel sources, reducing dependency on fossil fuel and creating a bio-energy industry; (d) Fashion and Health Products – an agro-process industry which creates a new industry in Guyana[642]; and (e) Furniture and crafts.

The strategy seeks to make agriculture more productive and sustainable. Agriculture shall be based upon 25 Priority Areas, which include: a new focus on farming systems and techniques, biotechnology and precision-agriculture; a strengthened focus on infrastructure development for the agricultural sector. One of the Priority Areas is the support and expansion of Guyana's Agro-Diversity Policy and Program. In particular, Priority 18 concerns environmental sustainability through the agricultural sector, including climate change issues. The strategy seeks to enable more inclusive and efficient agricultural and food systems. Agriculture will further contribute towards wealth generation, providing entrepreneurs with investment opportunities, promoting employment, helping to eliminate inequity and poverty, building Guyana's export portfolio. These objectives shall be achieved through accelerated modernization and diversification of the agriculture sector in Guyana. Priority 21 seeks to make land availability, land zoning and land tenure for agriculture easier for farmers and entrepreneurs. Priority 25 is a Program of Financing Mechanisms for Agriculture. Regarding the increase of resilience of livelihoods to disasters, Priority 19 commits Guyana to further develop its Agriculture Risk Reduction and Disaster Management Program.

Guyana National Tourism Policy and Strategic Action Plan: 2019-2025

The National Tourism Policy is the overarching document that defines the path that Guyana has chosen for the development of its tourism industry. It examines the current status of tourism development, sets out the growth poles which are expected to be the drivers of tourism over the long term and elaborates a strategic marketing policy aimed at boosting visitor arrivals into Guyana[643].

- **Vision:** To be recognized internationally, by the year 2025, as a leading green destination.
- **Mission:** To bring more visitors to Guyana and to enhance the impact of the industry on the Guyanese economy and, in particular, the impact of nature-based tourism on hinterland economies and livelihoods.

The Guyana Tourism Strategic Action Plan is aligned with the GSDS, draft National Tourism Policy, and other relevant strategies (e.g., Ministry of Business Strategic Plan 2016-2020), plans and budgets in order to support the achievement of the UN SDGs.

National Adaptation Plan and Climate Resilience Strategy and Action Plan (2016)

Considering the ongoing impacts of climate change and future projections, the Government of Guyana (GoG) has developed a Climate Resilience Strategy and Action Plan (CRSAP) that provides a

[642] Government of Guyana. 2013. National Strategy for Agriculture in Guyana 2013-2020: Agriculture our vehicle for sustained economic and social prosperity. Ministry of Agriculture.

[643] Government of Guyana. 2018. Living Guyana Tourism Strategy Action Plan: 2018-2025. DRAFT. Ministry of Business.

comprehensive and overarching framework for building resilience to climate change. The CRSAP describes how to address the most significant climate risks and required resilience actions across 15 key sectors. The Action Plan prioritizes four fast track projects for climate change adaptation: building climate resilient agricultural systems, the enhancement and maintenance of Guyana's sea defense, public health adaptation to climate change and strengthening existing drainage and irrigation systems. Also proposes a roadmap for the next five years, and a set of capacity building actions that enhance Guyana's capacity for national adaptation planning and to advance climate resilience[644].

The Forest Act (2009), National Forest Policy and Plan (2018)

In 2009, the 1953 Forest Act was revised in alignment with changes to the National Forest Policy Statement (1997) and the National Forest Plan (2001). In 2018, a new review of the National Forest Policy Statement and the associated Plan was undertaken, to reflect Guyana's movement away from valuing forests simply for timber, but as a cornerstone of the country's national patrimony which provides a wide range of products and services. Ownership, access and management of forest resources are vested in the people of Guyana. Guyana's National Forest Plan guides the administration and management of forested areas on State Lands, which includes the State Forests as well as the inland waterways, protected areas, and research areas. It does not apply to private property and Amerindian Titled Lands. However, the Policy can accommodate the participation of indigenous communities, once options are developed to facilitate the genuine participation of Amerindian Titled Lands[645]. The overall objective of the current National Forest Policy is conservation, protection, management and utilization of the nation's forest resources, while ensuring that the productive capacity of the forests for both goods and services is maintained or enhanced. Within this goal are found four specific objectives (SOs) that drive all activities within the Plan[646]. These SOs are:

- Deriving development benefits from the forest (economics)
- Conserving, protecting and sustaining the forest (conservation)
- Governing the forest to ensure current and future benefits (governance)
- Building human and institutional capacity for management of activities in the forest (capacity)

The Forest Plan accompanies the Policy Statement and provides activities to operationalize the four SOs identified in the Policy Statement. The SOs are subdivided into eight Policy Goals:

- Forest Extraction, looking at increasing efficiency of forestry operations and reducing deforestation from extractive industries
- Promote Value
- Added products and non-timber goods and services
- Conservation and Protection Strategies
- Ensure forest health through preventative and restorative measures
- Institutional Strengthening and coordination

[644] UNDP. 2017. National Adaptation Plan of Guyana – Inception Report. Japan-Caribbean Climate Change Partnership; Government of Guyana. 2015. Climate Resilience Strategy and Action Plan for Guyana. Ministry of the Presidency.

[645] Government of Guyana. 2019. Revised National Forest Policy Statement; Government of Guyana. 2019. National Forest Plan.

[646] Winrock International. 2019. Guyana Proposed REDD+ Strategy DRAFT 3. Technical Cooperation No. ATN/FP-14161-GY. FCPF.

- Improving Participation and Transparency
- Forestry Research and Information
- Education and Training

Guyana's National Forest Policy exist under the leadership of Guyana's Forestry Commission, with the support of a variety of other Ministries and sector agencies, and covers the period 2018 to 2028 and will be reviewed in 2023 at the halfway stage.

National Land Use Plan (2013)

The National Land Use Plan (NLUP) provides a strategic framework to guide land development in Guyana. The Plan is not a definitive or prescriptive document, but it provides support to decision making, through looking at development options and constraints throughout the country. The purpose is for it to be incorporated into the lease decision process, with the objective of encouraging decisions which optimize the use of Guyana's resources for the benefit of its people. The Plan itself does not make any such decisions. The NLUP is built upon a number of national policies and strategies that have a direct relevance for land use and land management. A main objective of the NLUP is to enable financial resources to be targeted at optimal land uses at the regional level. The NLUP is not prescriptive in that it does not aim to zone areas of the country for particular land uses, rather it aims to suggest a number of options for particular areas that can then guide decision-makers and attract inward investment. In conjunction with the above, a further aim of the NLUP is to provide a spatial element to development planning, to show on one map, or a series of maps, what the current situation is, where resources are located, where potential exists and what linkages may be necessary to develop those resources[647].

National Biodiversity Strategy and Action Plan (2012-2020)

The NBSAP is the response to Guyana's obligations under the Convention on Biological Diversity (CDB). The plan's vision is that by 2030, *biodiversity is sustainably utilized, managed and mainstreamed into all sectors contributing to the advancement of Guyana's bio-security, and socioeconomic and low carbon development.* It includes priority actions and targets to comply with CDB goals and Aichi Targets. These actions and targets are aligned supported by those included in Guyana's REDD+ Strategy currently drafted.[648]

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[647] Idem

[648] Idem

GDP, income and productivity

Guyana's real GDP in 2020 is estimated to have expanded by 43.5%, reaching US$6.2 billions, driven primarily by developments in the oil sector (with production averaging 74,300 bbls/day). As a result of significant oil discoveries and initiation of production, Guyana had the world's highest GDP growth in 2020. The impact of the oil sector expansion was partly countered by a contraction of 7.3% in the non-oil economy due to COVID-19 impacts (which is heavily affecting the service sector, reducing urban employment in particular). Also, in 2020, the national gross income per capita in Guyana amounted to around US$7.9 thousand, up from US$4.7 thousand per person in 2018. The inflation rate in 2019 was 2.1%, primarily on account of higher food prices[649]. Before the oil production Guyana's productivity was mainly driven by higher output of rice, gold, and other crops. In contrast, there were lower outputs of sugar, fishing, livestock, forestry, and bauxite. In 2019, Guyana exported a total of US$3.98 billion, making it the number 127 exporter in the world. During the last five reported years, the exports of Guyana have changed by US$2.58 billion, from $1.4 billion in 2014 to $3.98 billion in 2019. The most recent exports are led by special purpose ships ($1.08 billion), gold ($752 million), shipping containers ($510 million), excavation machinery ($295 million), and aluminum ore ($271 million). The most common destination for the exports of Guyana are Trinidad and Tobago ($1.23 billion), Canada ($450 million), Portugal ($435 million), Ghana ($324 million), and Norway ($243 million)[650].

Guyana's private sector is small, less open to international trade, most firms are family owned and have a high dependence on imported inputs. The private sector consists of mainly micro, small, and medium-sized enterprises with a few large enterprises operating in the extractive industries. The Small Business Bureau's database included 6,756 businesses. About 73% of registered businesses in Guyana employ fewer than 5 people, while 22.3% employ 5-15 people and 4.7% employ more than 159. Most of these firms sell their goods and services only to the domestic market; with only 8% reporting that they export compared to 17% for the rest of the Caribbean. Also, majority of firms are family owned, 37.5% are sole traders and 33% are private limited companies; and depend on imported inputs, 73% compared to 57% for the rest of the Caribbean[651].

SMEs' contribution to GDP is estimated to be 28% and around 22,000 small and micro firms were in business in 2009[652]. The business environment is highly unfavorable. Guyana rank 134 (out of 190 countries) in the 2020 Doing Business Report. The main decline observed was made trading across borders more expensive by increasing the fees for mandatory inspection through scanners for exports, thereby increasing the cost of export border compliance; other areas with historically low performance are price of electricity, getting credit, starting a business, dealing with construction permits, paying taxes, and protecting minority investor.

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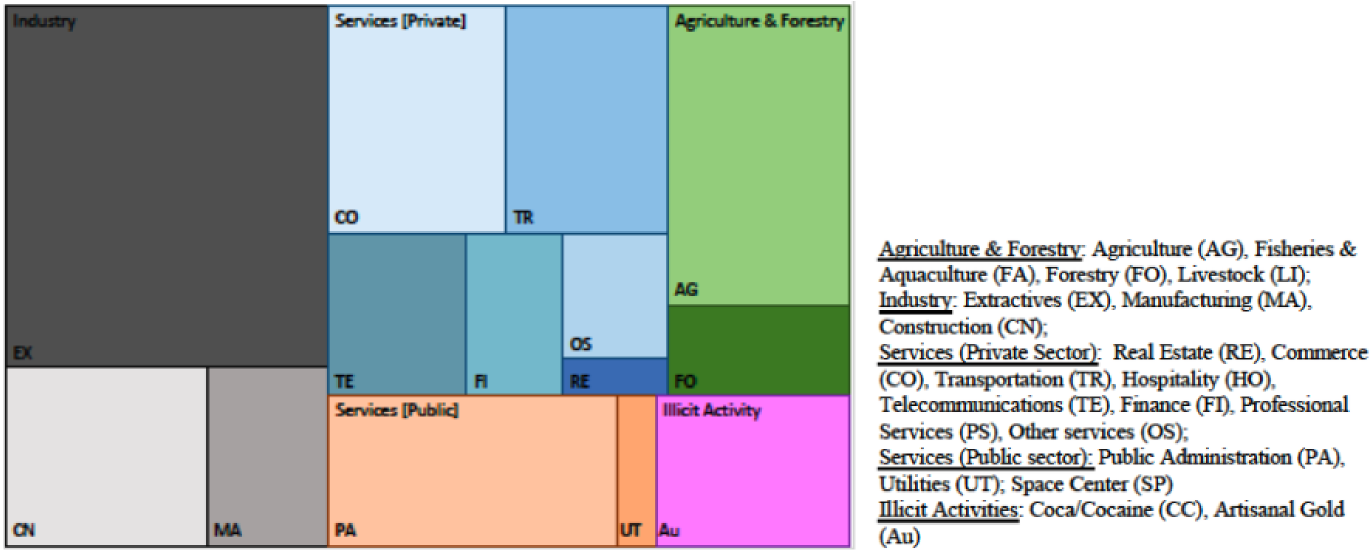
[649] World Bank. 2020. Macro Poverty Outlook – Guyana; Bank of Guyana. 2020. Annual Report 2019.

[650] https://oec.world/en/profile/country/guy

[651] IDB. 2014. Guyana Private Sector Assessment.

[652] IDB. 2016. Guyana country development challenges.

Figure A103: The relative contribution of the various sectors and subsectors to the GDP of Guyana



Source: Killeen (2021)[653]

Social and environmental context

Guyana is considered a medium human development country. In addition, Guyana's Human Development Index value of 0.670 in 2018 implies that the country is in the medium human development category, positioning it at 123 out of 189 countries. Despite the fact that the latest value shows an improvement of 0.87% when compared to the value in 2000, the country has been stagnated in the same ranking position since 2008. Further, the 2016 State of the Environment Report notes that the proportion of people living in extreme poverty in Guyana fell from 28.7% to 18.6% between 1993 and 2006, and that during the same period, the percentage of people living in moderate poverty fell from 43.2% to 36.1%. Moreover, according to the National Health Strategy for Guyana 2013-2020, poverty in the rural interior is significantly higher than in the rest of the country. While poverty has declined since 1999, it remains particularly marked among Amerindian and rural interior populations, children and young people below 25 years old[654].

The country of Guyana is approximately 21 million hectares with 87% covered in tropical forest. The country is broadly broken into two geographic areas: the coastal plains that stretch along its 430 kilometers of coastline in the north (making up 5% of the country), and its interior highlands, a series of plateaus, flat-topped mountains, and savannahs that extend from the coastal plains to the country's southern borders. According to the Guyana's National Land Use Plan (2013) Guyana recognizes three main types of land tenure: Private Land, Amerindian Land, and State and Government Land. Within the State and Government Land are Protected Land, State Forest and concessions including logging, mining, and agriculture.

[653] Killeen. 2021. A Perfect Storm in the Amazon Wilderness: Success and Failure in the Fight to Save an Ecosystem of Critical Importance to the Planet. The White Horse Press.

[654] Government of Guyana. 2020. Guyana's National Drought Mitigation and Adaptation Plan. Guyana Lands and Survey Commission.

The indigenous population of Guyana, the Amerindians, account for approximately 9% of the population and own approximately 15% of land, more than three million hectares, forming the majority of land not held centrally by the state. In Guyana, there are nine indigenous groups: the Akawaios/Kapon, Arawaks/Lokonos, Arekunas/Kamarakoto, Karinya/Caribs, Makushis/Macuxi, Patamonas, Wai Wais, Wapishanas, and the Warraus. Migration from Brazil and Venezuela have put further pressure on existing land and the economy in Guyana. There are currently around 116 titled communities spread across all regions in Guyana, with the majority in the south and west of the country, and in or around forested areas. There are also 46 satellite communities. A major current issue regarding Amerindian lands is the extension of existing titled lands. Several communities have applied for land extensions and are awaiting approval. Amerindian communities are generally amongst the poorest in Guyanese society. Factors contributing to higher than national average measurements of poverty and inequality in these regions are: limited opportunities for income-generating livelihoods; sparse location and dispersed communities; lack of historical cultural livelihood strategies; limited access to basic services such as education and health; and costly and limited transport infrastructure options. With that said, ample opportunity exists to invest in green economic development initiatives and skills development for the hinterland. One of them being ecotourism, another option is REDD+ (indigenous groups have been included in participatory processes related to REDD+ processes thus far in Guyana). Such investments will reduce community dependence on unsustainable logging and mining activities, provide viable employment options and preserve the rich biodiversity and cultural heritage of the region[655].

Historical deforestation in Guyana has been very low (0.02% to 0.079% per year over the past 22 years), but this trend may change in the future as deforestation increases to meet growing demands for agriculture, timber, minerals, and human settlements. Guyana is therefore considered to be a High Forest cover Low Emission/Deforestation rate (HFLE/D) country, with forests covering approximately 85% of the country (18.5 million hectares) and containing an estimated 19.5 billion tons (or Gt) of CO_2 in live and dead biomass pools. These forests are suitable for logging and agriculture, and are underlain with significant mineral deposits. Concession land makes up the largest area of land in Guyana (40%), and predictably has the highest rate of deforestation (0.3% y-1). On average 95% of all deforestation is from mining, logging and agriculture[656]. The mining sector's impact over the last 3 years represents on average 89% of total forest loss. Without proper environmental considerations this activity tends to have severe environmental consequences including forest and habitat loss, water body contamination by mercury, and river sedimentation; mercury has been found both in nearby mining areas as well as seemingly untouched areas.[657]

Guyana’s Green State Development Strategy (GSDS) reconcile the country previous low-carbon growth strategy with the significant discovery and extraction of oil.[658] Given the dire predictions of sea-level

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[655] ILO. 2018. Skills for Green Jobs in Guyana.

[656] Winrock International. 2019. Guyana Proposed REDD+ Strategy DRAFT 3. Technical Cooperation No. ATN/FP-14161-GY. FCPF.

[657] Benn et al. 2020. The context of REDD+ in Guyana Drivers, agents and institutions. CIFOR.

[658] In December 2019, Guyana officially became an oil-producing country and had its first lift of oil a few months later in February 2020. The uncertainties of the COVID-19 pandemic depressed global energy prices as well as other turbulent domestic matters have resulted in a slowdown or pause in onshore and offshore activity. Guyana completed three lifts of oil in 2019 with a fourth expected in November 2020. https://www.pwc.com/gy/en/assets/home/pdf/guyana-2020-21-budget.pdf

rise over the next 30 years, the country faces significant decisions on the protection or possible decampment of the capital city, Georgetown. 39% of Guyana's population and 43% of GDP are in regions exposed to significant flooding risk, and extreme weather events are increasing in frequency - in 2005 floods caused losses equivalent to 60% of Guyana's GDP. Although the discovery of oil presents a shift in resource revenues, Guyana remains unique in terms of its pristine forest cover, which had been a key source of revenue under REDD+. Detailed financial plans will be needed, by sector, to understand the costs of adaptation and mitigation requirements, and the extent to which they can be offset by carbon credits or extractive industry rents, as determined by the national planning process. Guyana approved a Low-Carbon Development Strategy (LCDS) in 2010. The implementation of the LCDS lasted through 2015, under which Norway committed to paying Guyana annual installments based on performance criteria linked to preserving its rainforests. The initial package was worth US$250 million for five years from 2009, paid out of a World Bank-administered Guyana REDD+ Investment Fund (GRIF).[659]

Climate profile

Data and knowledge gaps

This report provides information at the national level, and where possible tries to focus on the Amazon region – the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[660] Much of the accessible climatological data for Guyana is compiled by the Hydrometeorological Service under the Ministry of Agriculture, supplemented by data from weather and hydrometeorological stations, as well as from private entities such as the Guyana Sugar Corporation and the Dadanawa Ranch. Detailed information on climate variables, trends and projections is available through the SNC (latest version from 2012). Other information is available through the country's first NDC (2016) and background documents for the National Adaptation Plan (ongoing since 2018).

Nonetheless, it is important to note information on climate risk and vulnerability varies per region in Guyana, and remains an area where substantial additional research is needed. The available climate and hydrology data sets have significant gaps in historical records, problems in data quality, and gaps in the spatial data coverage. There remain substantial records that have potential high value that have not yet been processed into digital form.[661] In particular, climate risk and vulnerability studies are limited in Guyana´s Amazon region, where most studies focus on the national level, or in more densely populated regions in the country. Ninety per cent of the population live on the coastal plain, where several rainfall gauges and weather stations are located, but there are gaps especially in the interior. This is an issue of uneven population distribution, but also of inaccessibility around the denser Amazon region. In comparison with the central Amazon rainforest, the climate, hydrology and other bio-physical characteristics of the northern Amazonia rainforests of the Guiana Shield region (Guyana, Suriname, French Guiana, and parts of southern Venezuela and northern Brazil) are even less well

659 http://www.guyanareddfund.org/

660 see list of references

661 Bovolo et al. 2009; Bovolo et al. 2011

known. In addition, the majority of climate-related studies in the Amazon focus primarily on deforestation, forest degradation and REDD+, rather than on climate trends, risks and vulnerabilities. As such, it is important that the following report builds on existing information, and should be interpreted with caution given the aforementioned data and knowledge gaps. It is recommended the program not only promotes activities with adaptation benefits, but also explores synergies to strengthen adaptation monitoring and reporting in the Amazon.

Overall climatology

Generally, much of the Amazon Basin and coastal areas of Guyana are classified as having a tropical-wet climate. Guyana lies within the Equatorial Trough (ET) Zone. At the macro-level, this is further categorized into very dry, very wet, and tropical wet-dry areas (the Amazon region in Guyana falls under the third category). The overall climate and weather are determined and impacted by the seasonal shifts of the ET, and associated Zone of Rainbands, known as the Inter-Tropical Convergence Zone (ITCZ). The north/south movement of these patterns is responsible for Guyana's high rainfall variability, and produces two wet seasons and two dry seasons per year.

Guyana experiences uniformly high average monthly temperatures and heavy annual precipitation distributed throughout the year. El Niño Southern Oscillation (ENSO) episodes lead to dry conditions throughout the year, and bring warmer temperatures between June and August. While the country experiences warm temperatures and abundant rainfall, extremes of hot and cold days and night are not generally reported.[662] Guyana's Amazon region generally receives a smaller total precipitation volume than the Tropical Wet climate zone of the lower Amazon basin, and its annual rainfall is less well distributed throughout the year.[663]

Temperature

Annual temperatures in Guyana tend to be high, ranging between a minimum of 16°C to a maximum of 34 °C, with small annual temperature variations between 1 and 2.5°C. The mean temperature in Guyana is 25 to 27.5°C throughout the year in most regions, except the upland regions in the west, where mean temperatures range from 20 to 23°C. Temperature maxima occurs in April and October in almost all regions, including in the Savannah region and in mountainous areas over 1000 meters. Generally speaking, forested areas are marked by hotter days and cooler nights.[664]

In Potaro-Siparuni and Upper Takutu/Upper Essequibo, the Amazon regions of Guyana, average temperatures range from a maximum of 36°C in March and October, and a minimum of 33°C in July during daytime, and a maximum of 24°C in November and minimum of 22°C in July during nighttime. The average monthly values correspond to an average of over 20 years.[665]

Precipitation

Precipitation in Guyana is highly variable both spatially and temporally. Most parts of the country receive 250-450 mm of rainfall per month between May and July in the first wet season. The second wet season affects mainly the northern coastal regions, which receive around 150-300 mm

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[662] Ministry of Agriculture, 2012

[663] Bovolo et al. 2009

[664] Bovolo et al. 2009

[665] World Data Web n.d.

precipitation per month from November to January. Major rainfall peaks are reported in June and December, and relatively dry periods in March and September. The two-peak rainfall pattern is observed mainly over the coastal regions.[666]
In the Amazon region of Guyana, monthly rainfall totals over forest areas generally demonstrate a strong primary wet season from May to August, and a primary dry season beginning at the end of September. Although a secondary wet season in November is common in coastal regions, over Amazonian rainforests, only small increases in rainfall are observed during this period, with heavy rains recorded rather in March. A short secondary dry season is observed in some years in April, before the start of the primary wet season.[667] Overall, the wet season in Guyana's Amazon region is shorter and the dry season is longer (with more severe droughts) compared to the lower Amazon basin.[668]

Climate-related natural hazards
The major climate-related natural hazards in Guyana are summarized in the table below. Climate-related factors, paired with the country's low-lying coastline (2 meters below sea level in many areas) make river flooding a 'high' risk across the entire country. Focusing on the Amazon region (Potaro/Siparuni and Upper Takutu/Upper Essequibo), the main climate-related hazards are river floods, and wildfires (both considered high risk), and extreme heat (medium risk). Across the Amazonian region, severe floods and droughts were recorded in 2009 and 2010 respectively.

Table A27: Climate-related natural hazards across Guyana, per region

	River flood	Landslide	Extreme heat	Wildfire	Water scarcity	Cyclone
National						
Guyana	High	Low	Medium	High	Very low	Low
Amazon region						
Potaro/Siparuni	High	Low	Medium	High	Very low	Very low
Upper Takutu/upper Essequibo (Amazon region)	High	Low	Medium	High	Very low	Very low

Source: GFDRRR No Date. https://thinkhazard.org

Observed trends of climatic variables

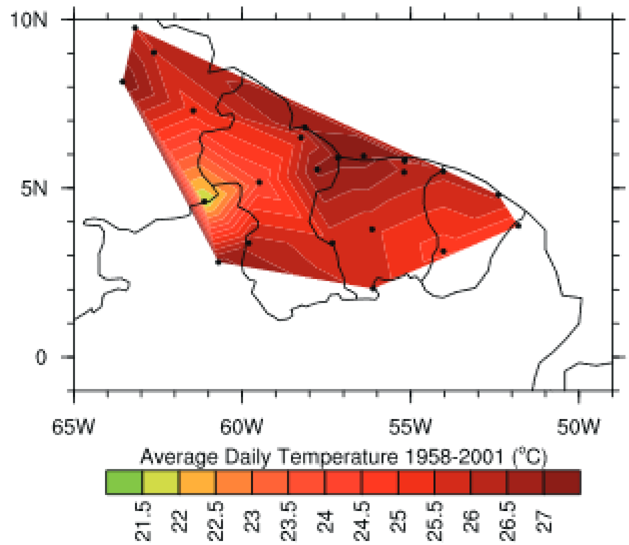
Temperature
The figure below visualizes temperature distribution (average daily temperatures in Guyana) for the period 1958-2001. Bearing in mind that the Amazon region lies along the west/south-west border, it can be inferred that this region has historically been a 'high temperature zone'.

Figure A104: Observed trends in temperature distribution across Guyana

666 J-CCCP 2018, and Bovolo et al., 2009

667 Pereira et al., 2014

668 Bovolo et al. 2009



Source: Pereira et al., 2014

Since 1960, mean annual temperatures in Guyana have increased by 0.3°C, amounting to an average rate of 0.07°C per decade. This rate of warming is considered to be less rapid than the global average. The average number of 'hot' days per year has increased by 93 (an additional 25% of days) between 1960 and 2003. The rate of increase is seen most strongly in summer months, when the average reported number of hot summer days increases by 9 days per month (an additional 30% of summer days). Over this same period, the average number of 'hot' nights per year increased by 87 days, i.e. an additional 24% of nights.[669]

The Amazon region of Guyana is particularly recording variability (and sometimes increases) in temperature compared to historical averages and the rest of the country. For example, Upper Takutu has recorded mean maximum and minimum temperatures slightly above its long term averages over multiple years; as well as the highest mean maximum temperature, and the highest one day maximum temperature in the country over many months.[670]

Precipitation

Mean annual rainfall over Guyana has increased at an average rate of 4.8 mm per month (2.7%) per decade since 1960. Observed trends in seasonal rainfall are however not statistically significant; wherever data is available, there is no evidence of any significant trends in maximum 1- or 5-day rainfalls.[671] Some years record a shortage in rain during the wet seasons. Given the high variability, annual rainfall totals may range anywhere from 2100 to over 3400 mm. This precipitation pattern is in contrast to the intense, longer than normal rainy season recorded in the northern and north-western Amazon basin.[672]

The figure below presents a detailed comparison of the wet season rainfall in Guyana in 2017 against the historical average, for selected stations. Arrows indicate the closest two stations measuring rainfall

669 World Bank CC Portal, n.d.

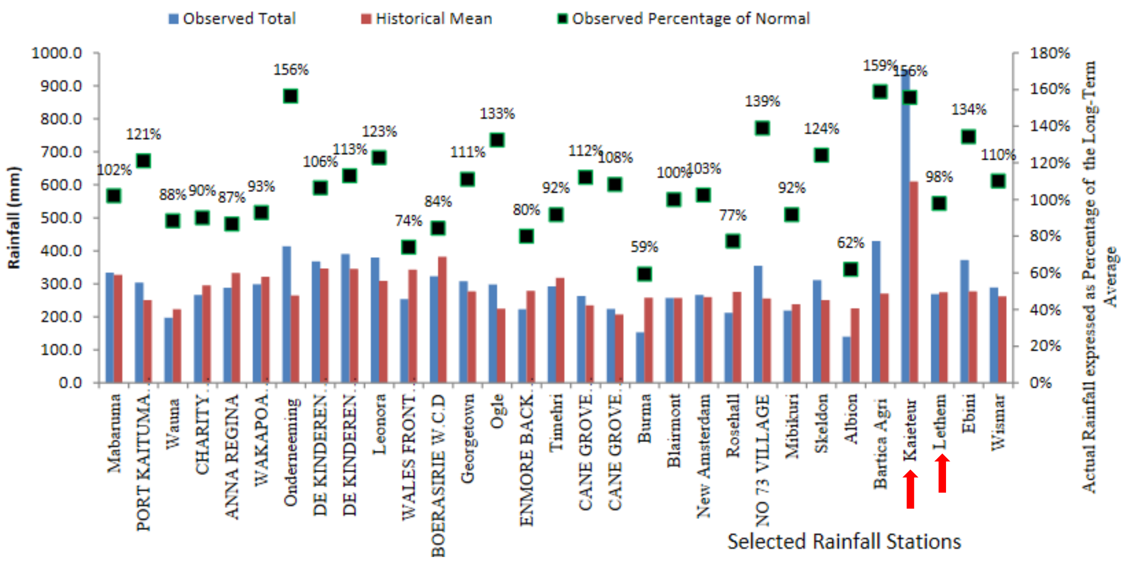
670 Hydromet, 2017

671 World Bank CC Portal, n.d.

672 Pereira et al., 2014

in the Amazon region. According to Hydromet records, most locations across Guyana recorded rainfall amounts consistent with their historical averages, with a notable exception being Kaieteur, in Potaro/Siparuni. This region also recorded the highest accumulated rainfall for May 2017 – an observed rainfall 56% in excess of the historical average. Additionally, this location has recorded the highest one-day rainfall amounts in the country over several months.[673] This points to an increase in rainfall variability and erratic trends over one of the Amazon regions in the country.

Figure A105: Comparison of the accumulated observed rainfall for the 2017 wet season, expressed as a percentage of the historical mean



Source: Hydromet, 2017

Climate-related natural hazards

Guyana has been experiencing loss and damage across key sectors due to climate-related natural hazards. An overview of losses and impact on people is presented below.

Table A28: UNDRR Preliminary analysis of climate-related natural hazards in Guyana and in the Amazon region (cumulative 1972-2003)

Hazard	Persons directly or indirectly affected		Houses destroyed or damaged	
	All regions	Amazon region / Upper Takutu	All regions	Amazon region / Upper Takutu
Flood	86%	89%	98%	93%
Drought	11%	4%	No data	No data
Storm	No data	5%	No data	2%

Source: UNDRR, n.d.

Both in terms of the number of people directly or indirectly affected, and houses destroyed or damaged, floods are attributed as the main cause among all natural hazards across Guyana, and in the Amazon region in particular. The spatial distribution of these hazards shows that the main areas

[673] Hydromet, 2017

affected fall across the north of the country, however, this may rather be due to the limited quality or availability of data.
The Amazon regions of Upper Takutu and Potaro/Sipuruni experience climate-related natural hazards in the form of extreme rainfall and landslides. In the past, severe infrastructure damage has resulted from these events, including at the MocoMoco hydropower plant.[674] Bush fire episodes have been recorded in these areas particularly during drought years, with severe consequences for human health and disruptions to agricultural production.[675]

Climate change projections

The climate change projection data shown below uses the CMIP5 ensemble models from the World Bank Climate Change Knowledge Portal,[676] and the Special Report on Emissions Scenarios (SRES) A1B, A2, and B1[677]. According to the IPCC SRES report[678], the scenarios describe the following conditions:

- *"A1B: convergent world; rapid economic growth; a global population that peaks at mid-century and declines thereafter; introduction, and evenly distribution among all energy sectors, of new and more efficient technologies; convergence among regions, capacity building, and increased cultural and social interactions; and substantial reduction in regional differences in per capita income.*
- *A2: heterogeneous world; self-reliant nations and preservation of local identities; fertility patterns across regions converge very slow, which result in continuously increasing global population; economic development is regionally oriented and per capita economic growth and technological change are more fragmented and slower.*
- *B1: convergent world; global population peaks in mid-century and declines thereafter; rapid changes in economic structures towards a service and information economy, with reductions of material intensity; introduction of clean and resource-efficient technologies; emphasis on global solutions economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives".*

Temperature

Based on the SRES climate model used in Guyana's 2nd National Communication, the mean annual temperature is projected to change in the following ranges, compared with the period 1960-2006:

Table A29: Projected air temperature changes (°C) for the 2030s, 2060s, and 2090s

SRES Scenario	2030s			2060s			2090s		
	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
A1B	0.6	1.5	2.0	1.3	2.6	3.2	2.0	3.3	4.6
A2	0.8	1.3	1.8	1.7	2.5	3.3	2.9	4.0	5.0
B1	0.4	1.1	1.4	0.9	1.7	2.3	1.4	2.2	3.0

Source: McSweeney et al. 2008, in Pitamber et al. 2012, p. 185

[674] Ministry of Agriculture, 2012

[675] J-CCCP, 2018

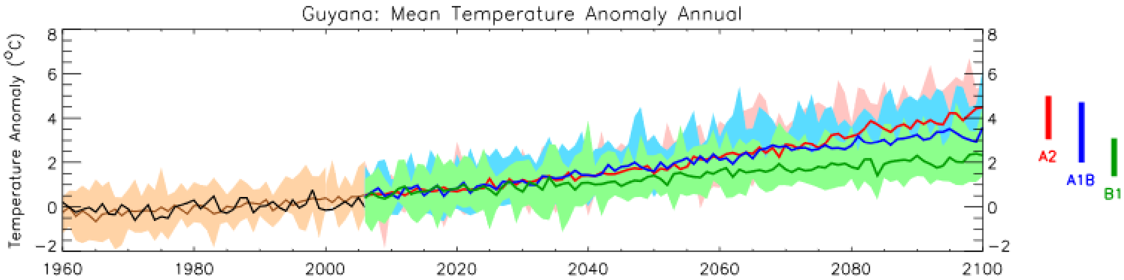
[676] World Bank, n.d.

[677] Pitamber et al. 2012, p. 177

[678] IPCC 2000, p. 4-5

Additionally, under the projection scenarios A2, A1B and B1, the mean annual temperature anomalies display a steady increase until the end of the 2100 (see Figure below).

Figure A106: Annual mean temperature anomalies in Guyana for A2, A1B and B1 emission scenarios from 1960-2100

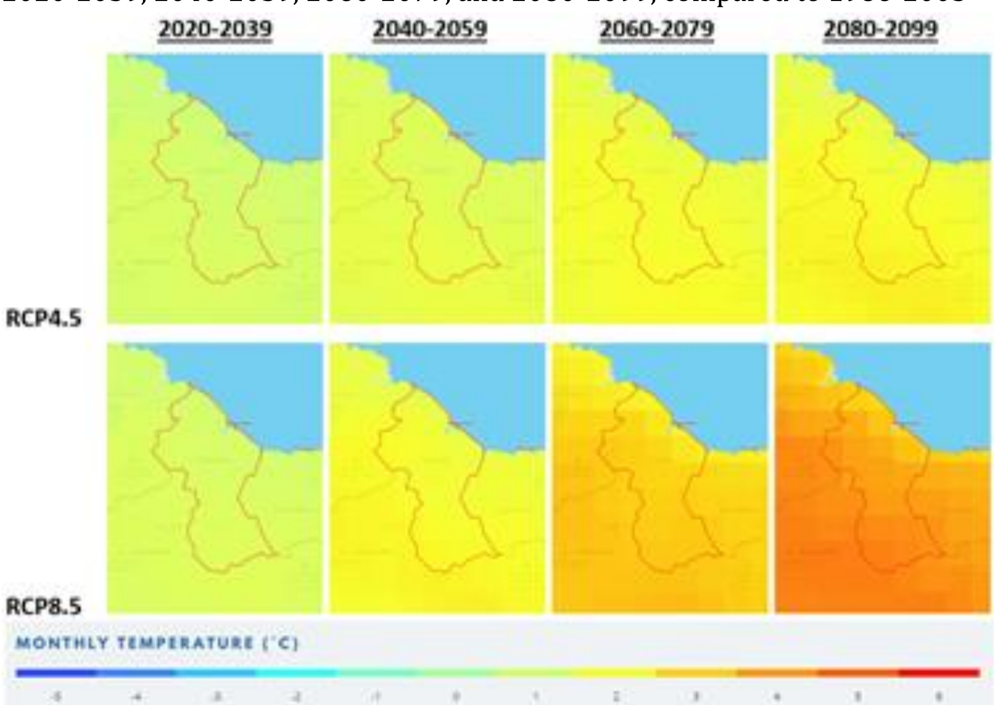


Source: McSweeney at al. 2008, in Pitamber et al. 2012, p. 179

According with CMIP5 ensemble models, temperature in Guyana is likely to increase compared to the baseline period 1986-2005; particularly in the south and south-west regions of the country, including the Amazon. RCP4.5 projections indicate that the mean annual temperature will increase by 0.96°C in 2020-2039, 1.36°C in 2040-2059, 1.82°C in 2060-2079, and 1.92°C for the period 2080-2099 (see Figure below). Moreover, it is projected that the highest monthly temperature variations will occur between July and November.

Under RCP8.5, the mean annual temperature will increase by 1.88°C (average 0.9°C to 3.3°C) between 2040 and 2059; by the 2090s, this increase could be between 1.4 to 5°C.

Figure A107: Change in monthly temperature of Guyana based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005



Source: World Bank Climate Change Portal n.d.

All projections further indicate substantial increases in the frequency of days and nights that are considered 'hot' in the current climate. At the same time, all projections indicate decreases in the frequency of days and nights that are considered 'cold' in the current climate. These 'cold' day events are expected to become increasingly rare; by 2090, they may occur on a maximum of 4% of days per year, or potentially, not at all.[679]
The following table contains a summary of projected changes of temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.[680]

Table A30: Projected changes of temperature-related climate variables in Guyana (at the national level), compared to 1986-2005

Variable	RCP 2.6				RCP 4.5				RCP 8.5			
	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99
Maximum daily temperature (°C)	1.06	1.42	1.39	1.30	1.13	1.73	2.33	2.42	1.43	2.41	3.73	4.88
Minimum daily temperature (°C)	0.91	1.19	1.21	1.17	1.00	1.45	1.86	2.00	1.10	1.94	2.97	4.00
Hot days (above 35°C)	16.15	20.98	21.59	21.63	18.19	32.82	49.20	51.64	23.23	52.10	96.84	161.59
Hot days (above 40°C)	0.00	0.01	0.02	0.01	0.01	0.11	0.40	0.55	0.04	0.77	5.59	16.80

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

According with SRES models, the mean annual precipitation is projected to change in the following ranges, compared with the period 1960-2006:

Table A31: Projected air precipitation changes (mm per month) for the 2030s, 2060s, and 2090s

SRES Scenario	2030s			2060s			2090s		
	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
A1B	-11	-2	10	-23	-5	4	-33	-4	17
A2	-12	-2	8	-25	-5	3	-39	-5	6
B1	-7	0	5	-14	-4	4	-21	-4	16

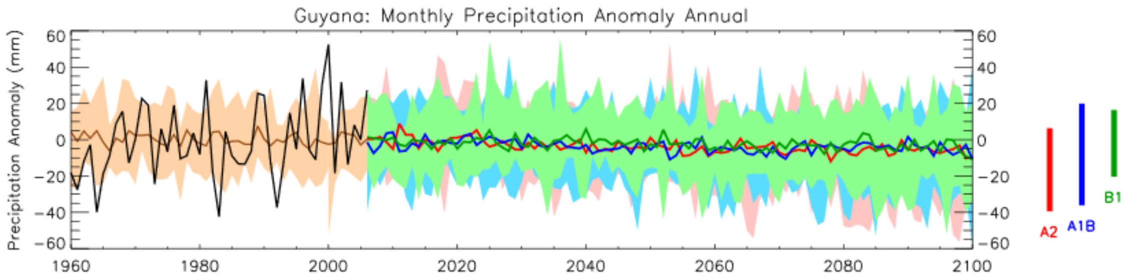
Source: McSweeney et al. 2008, in Pitamber et al. 2012, p. 185

[679] World Bank CC Portal, n.d.

[680] World Bank CC Portal, n.d.

Additionally, under the projection scenarios A2, A1B and B1, the mean annual precipitation anomalies display a steady decrease until the end of the century (see Figure A108).

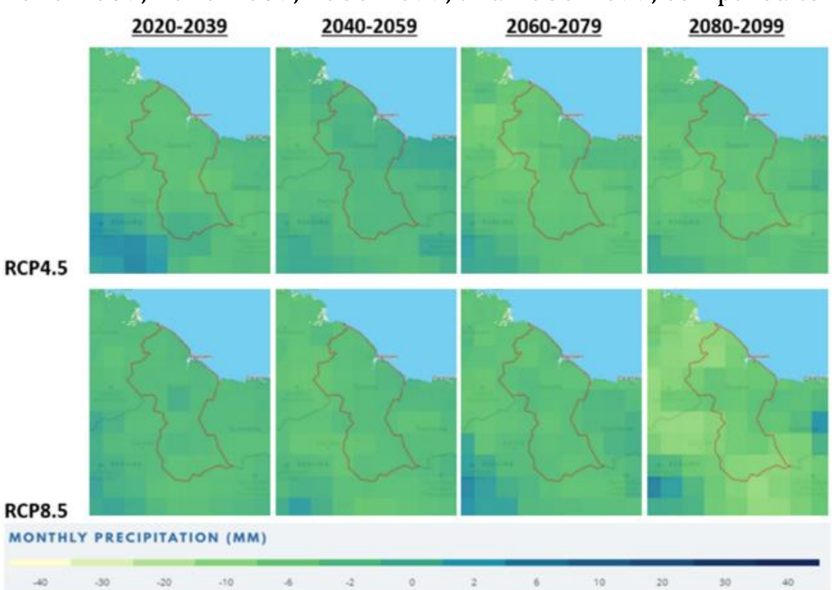
Figure A108: Annual mean precipitation anomalies in Guyana for A2, A1B and B1 emission scenarios from 1960-2100



Source: McSweeney at al. 2008, in Pitamber et al. 2012, p. 182

Projections of mean annual rainfall from different RCP models project a wide range of changes in precipitation for Guyana. Projections of mean annual rainfall based on RCP4.5 show a negative change of (-)2.60mm for the period 2020-2039 (see Figure below). A decreasing trend of projected change in monthly precipitation is expected for the periods 2040-2059, 2060-2079, and 2080-2099 with values of -2.05mm, -3.78mm, and -4.41mm, respectively.

Figure A109: Change in monthly precipitation of Guyana based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005



Source: World Bank Climate Change Portal n.d.

As per the RCP 8.5 ensemble model, annual precipitation is expected to decrease (including in the Amazon region) by 36.8 mm. This corresponds to an average decrease of 330.11mm to 362.05mm in

2040-2059. Ensemble median values of precipitation change by the 2060s are consistently negative for all seasons and all emission scenarios. The maximum 1- and 5-day rainfall events show little consistent change. However, across the southern parts of the country, these tend towards positive changes.[681]

An overview of mean annual temperature and precipitation change and percentage of rainfall falling as 'heavy' precipitation events is presented in the table below. While temperatures will continue to rise (particularly around the Amazon region), total precipitation will decrease, and rainfall intensity will increase.

Table A32: Overview of climate trends and projections until 2100

Climate variable	2030s	2040-2070s	2070s-2100
Mean Annual temperature change	+0.4 °C-2.0 °C	+0.9 °C-3.3 °C	+1.4 °C to 5.0 °C
Mean Annual Precipitation change	Median: 0 to -4% Min.-Max.: -29% to +14%	Median: -4% to -5% Min-Max: -41% t +13%	Median: -4% to -5% Min-Max: -63% to +20%
% of rainfall that falls as heavy precipitation events	No Data	Median: +1 to +2% Min-Max: -3% to +10%	Median:+2-3% Min-Max:-8% to +12%

Source: J-CCCP, 2018

The following table contains a summary of projected changes of precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A33: Projected changes of precipitation-related climate variables in Guyana (at the national level), compared to 1986-2005

Variable	*RCP 2.6*				*RCP 4.5*				*RCP 8.5*			
	2020-39	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*
Days with rainfall >20mm	-0.75	-0.50	-0.40	-0.42	-0.78	-0.47	-0.18	-0.28	0.01	0.47	0.54	0.58
Rainfall of very wet days (%)	- 22.58	- 18.35	- 17.71	- 17.79	-13.25	- 14.14	- 12.63	- 14.07	-5.29	-8.89	-8.51	- 23.97
Maximum daily rainfall (10 year RL) (mm)	-1.61	-1.26	1.18	-0.13	-1.84	1.45	1.13	1.54	3.58	6.45	4.82	5.89
Maximum daily rainfall (25 year RL) (mm)	1.03	1.05	3.43	2.75	1.52	4.16	3.47	4.44	5.27	9.43	8.60	11.95

[681] World Bank CC Portal, n.d.

Projected change in annual rainfall (mm)	-42.17	-82.66	-34.66	-28.20	-129.36	-58.22	-57.37	-81.38	14.88	-16.54	-6.76	-76.43
Severe drought likelihood	0.14	0.17	0.18	0.21	0.16	0.23	0.35	0.36	0.20	0.35	0.51	0.72
Probability of heat wave	0.09	0.13	0.13	0.13	0.11	0.20	0.32	0.35	0.13	0.30	0.57	0.78

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal (World Bank, n.d.)

Climate-related natural hazards

Guyana is generally particularly vulnerable to climate change impacts because of its extensive low-lying coastal zone, which hosts over 90% of the population. In addition to communities, their livelihoods, economic activities and infrastructure are vulnerable to climate-related natural hazards. This zone will be increasingly threatened by sea-level rise, saltwater inundation, increase in storm surges and changes in rainfall patterns. All impacts on this coastal zone inevitably has consequences for the country's overall economy (mainly agriculture, forestry and fishing).[682]

Guyana, including its Amazon region, will be further impacted by increasingly intense and frequent ENSO events causing changes in rainfall and precipitation events, resulting in more frequent and damaging floods and droughts. The latter is expected to directly cause an increase in frequency of forest fires.[683]

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:

In terms of sensitivity, there are various biophysical considerations:

- **Flooding:** The susceptibility of slopes against flooding ranges from low to high, soils range from high to very high susceptibility to flooding (see following two figures).[684] In terms of hydrological endowment, the region is not considered particularly susceptible (ranks low;)[685]
- **Droughts:** Guyana's Amazon region is also susceptible to droughts, with moderate to very high susceptibility when considering hydrological endowment.[686]

In terms of dependence on agricultural activities, Guyana's Amazon region ranks from low to moderate susceptibility (Figure A112).[687] This is largely due to the concentration of agricultural activities in the coastal plains.

[682] ; Ministry of Agriculture, 2012

[683] Ministry of Agriculture, 2012

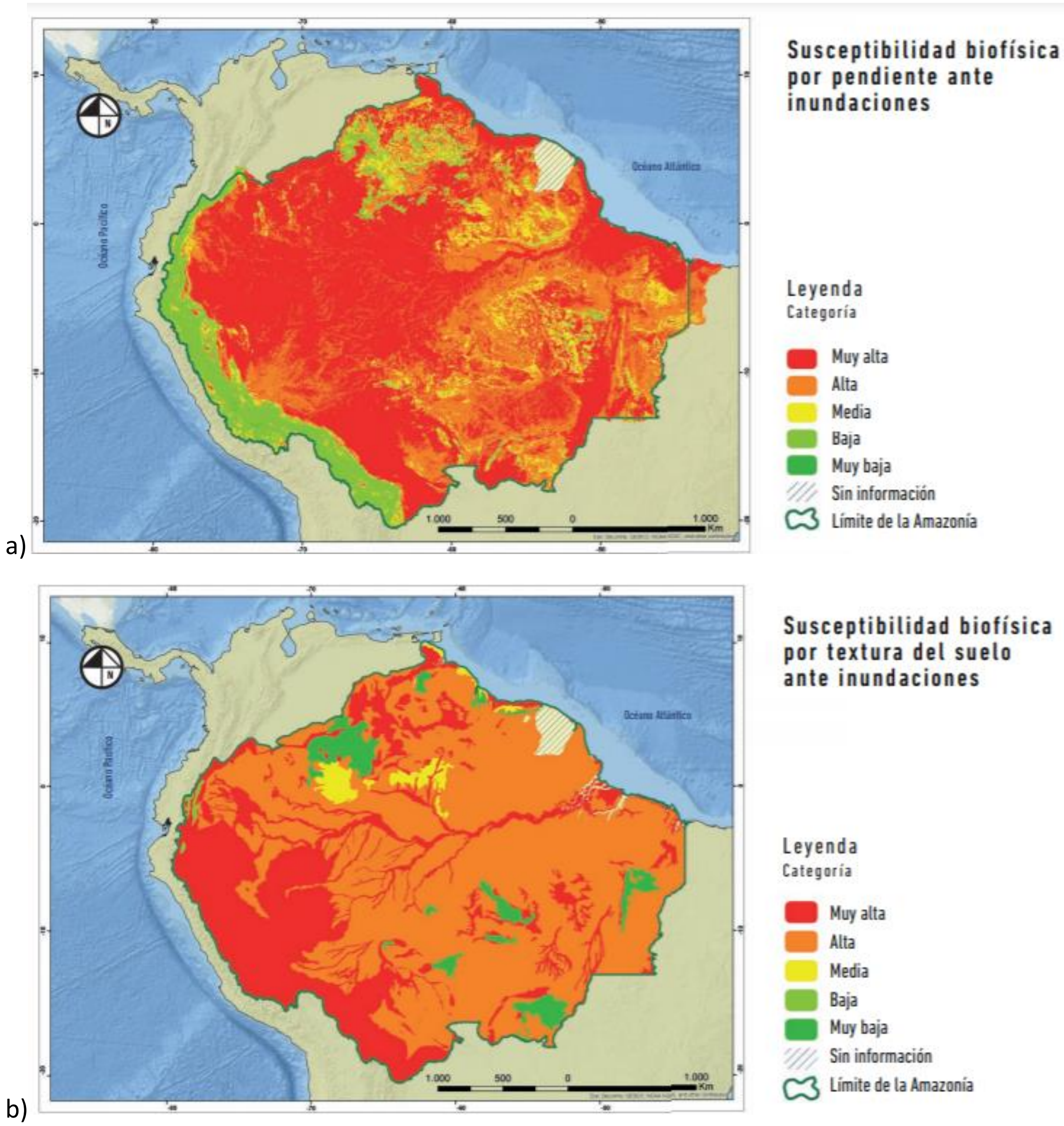
[684] Pabón-Caicedo et al. 2018

[685] Pabón-Caicedo et al. 2018

[686] Pabón-Caicedo et al. 2018

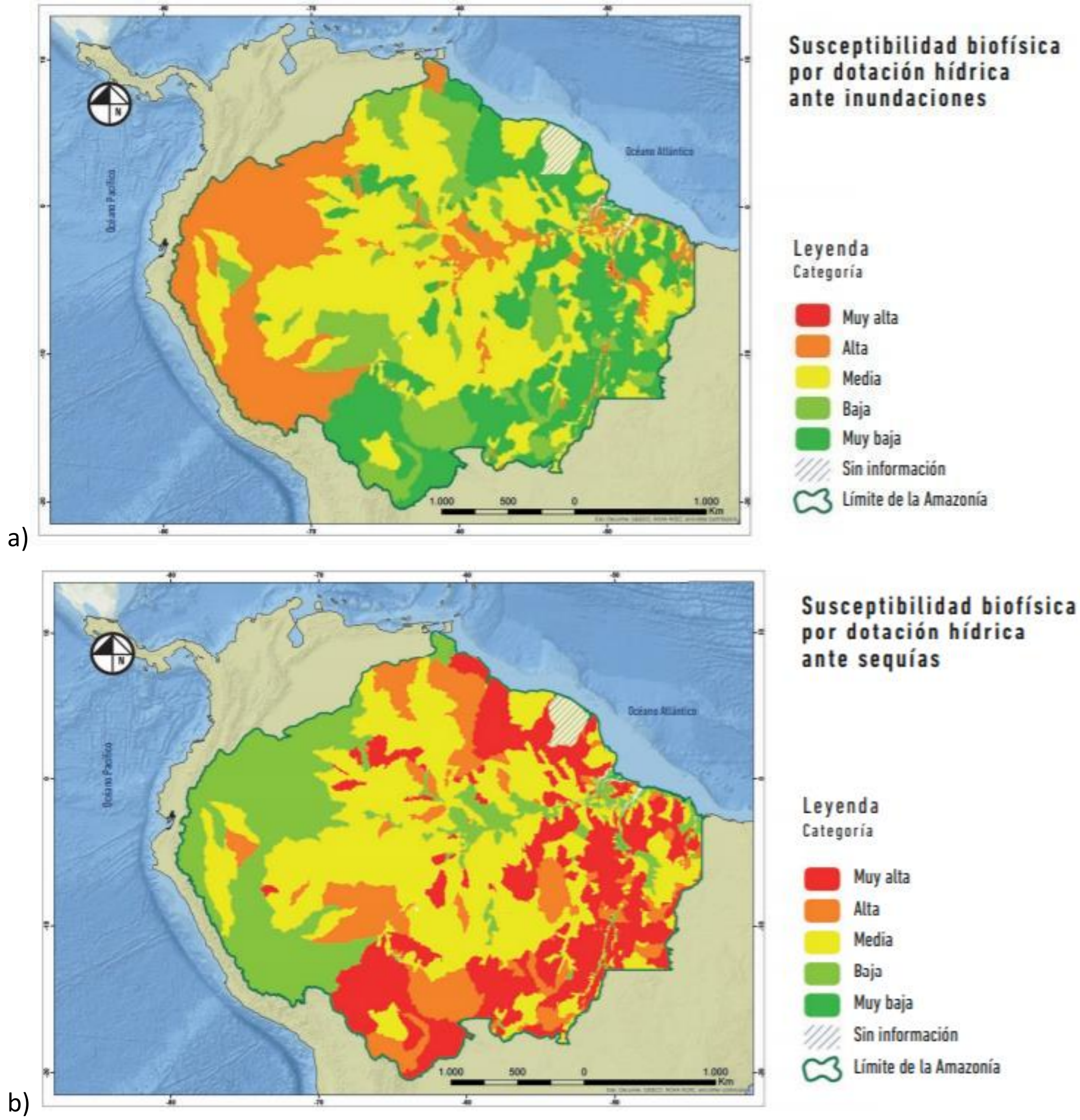
[687] Pabón-Caicedo et al. 2018

Figure A110: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin



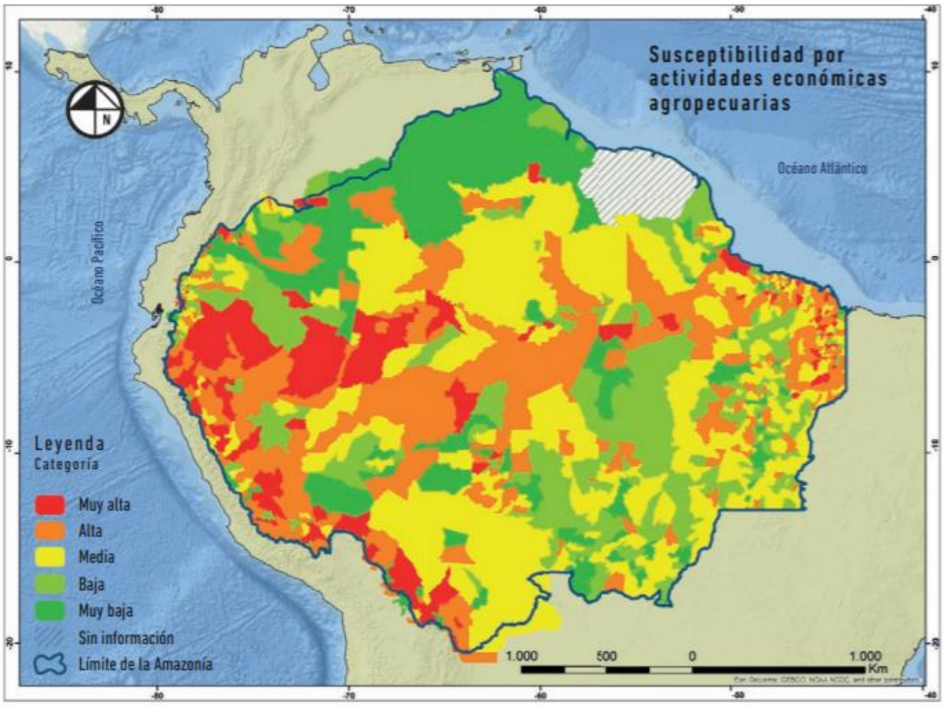
Source: Pabón-Caicedo et al. 2018, p. 42

Figure A111: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin



Source: Pabón-Caicedo et al. 2018, p. 42

Figure A112: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector



Source: Pabón-Caicedo et al. 2018, p. 41

At the national level the following challenges have been identified that limit the strengthening of adaptive capacities at the national level:[688]

- Inadequate human resources and technical capacities
- Inadequate access to finance.
- Inadequate mainstreaming of climate change in national and sectoral policies, programmes and projects
- Limited awareness and appreciation of Guyana's vision for a green and climate-resilient economy
- Lack of a national M&E framework for tracking adaptation actions and assessing adaptation achievements

In terms of capacity, there is limited information on the specific adaptive capacities and coping capacities in Guyana's Amazon region. The National Climate Change Policy and Action Plan note the relevance of strengthening adaptive capacity, however there is no regional focus. The NAP Inception Report highlights projects implemented to strengthen capacities on resilient agriculture, however they have concentrated on the coastal region.[689]

Climate risks and impacts on the bioeconomy and local livelihoods

Climate Risk Guyana

[688] J-CCCP 2018

[689] J-CCCP 2018

Overall, Guyana is considered to face a low level of climate risk compared to countries in the wider Amazon/Caribbean area.[690] On the GermanWatch Climate Risk Index for 2021, Guyana is ranked 130th in the world, and in terms of fatalities, it ranks 106th. The scoring takes into account the extent to which Guyana is affected by climate related extreme weather events and its impacts. In 2020, Guyana suffered losses amounting to $130 million (increase from the average of $122 million over 2000-2019. From the available data, it can be inferred that droughts cause up to USD 14 million in losses across the country, including crop damage across over 87,000 ha, and affecting over a million people directly or indirectly. Flooding results in losses and damages of up to USD $538 million nationally (~USD $2.5 million in Upper Tukutu), causing crop damage across 26,040 ha, resulting in over 300,000 lost livestock, and affecting over 750,000 people either directly or indirectly. Fires have additionally caused over $500 million in losses and damages across Guyana (figures specifically on the Amazon region are not available). These figures correspond to an average over the period of 1972 - 2013.[691]

Although Guyana is not a Small Island Developing State (SIDS), it is often categorized as one due to similar economic characteristics and risks associated with anticipated or current climate change impacts in the country. The IDB Disaster Exposure Index (DEI) identifies Guyana as the fourth most exposed country in the Latin American and Caribbean region to natural disasters. This is primarily the result of the country's high exposure to and experience of flooding as well as drought. Guyana's DEI score, 0.60 on a scale of 1, is particularly high given that the country is not significantly exposed to tropical storms, is not on the Caribbean hurricane belt, and also has no significant earthquake or volcano risk[692]. Guyana's priority climate adaptation measures are[693]:

- Upgrading infrastructure and assets to protect against flooding through urgent, near-term measures (US$225 million)
- Hinterland Adaptation Measures (US$10 million)
- Addressing systematic and behavioral concerns (US$33 million)
- Developing innovative financial risk management and insurance measures to resiliency (US$10 million)
- Switching to flood-resistant crops (US$10 million).
- Upgrading the Conservancy to recognized engineered standards (US$410 million)

Mangroves are also part of the adaptation agenda, specifically protect and/or restore mangrove areas. This will be achieved through spatial planning of coastal defenses, carefully weighing benefits and costs of protection provided by the existing mangrove ecosystem and their contributions to the country's biodiversity. To that end, any expansion of re-planting programs or implementation of conservation measures will be coordinated among the responsible agencies. This may require review and/or harmonization of associated legislation and policies. Both mangroves and hard sea defenses are becoming increasingly dilapidated. Mangroves along the coast are relatively thin due to clearance for fuel wood, localized damage from fishing, dumping and the grazing of livestock in mudflats[694].

690 Bovolo et al. 2009

691 UNDRR, n.d

692 Government of Guyana. 2016. Climate Resilience Strategy and Action Plan. Ministry of the President.

693 Government of Guyana. 2016. Guyana Second National Determined Contributions to UNFCCC.

694 Government of Guyana. 2019. Guyana Green State Development Strategy – Vision 2040.

Guyana's agriculture suffers from the negative impacts of climate change. Extreme flooding and droughts – triggered by El Niño and rising sea levels – affect the coastal areas of Guyana and cause severe income loss among farmers[695]. In 1998, Guyana experienced a major drought, triggering a state of emergency because of widespread devastation to agriculture and mining. The coastal region can further be regarded as the economic and administrative hub of the Country (represents about 5% of the total area of the country but is also where approximately 90% of the country's population resides). Finance Division suggests that approximately 75% of economic activities are located along Guyana's coastal zone. At high tide, Guyana's coastline experiences a median depth of 2.5 meters below median sea level. Sea level rise in Guyana for the period 1951-1979 was 10.2mm, just over five times the global average for the same period[696]. The Agriculture sector contributes 35% of Guyana's GDP; 40% of export earnings; 30% of the country's workforce and is important not only in terms of export earnings, but as a local food source for the population. Sugar and rice are the most important crops, accounting for some 74% of agriculture's GDP, as well as 65% of Guyana's total agriculture exports, including shrimp and timber. Thus, any external shock to this sector can significantly reduce these percentages, with cascading socio-economic consequences. Since 2005 there have been seven extreme rainfall events which resulted in floods in 2006, 2008, 2010, 2011, 2013, 2014 and 2015. The UNISDR estimates that the floods of 2006 and 2008 affected approximately 135,000 people and those of 2006 and 2010 resulted in cumulative economic damage of US$183,700,000[697].

One of the most significant flood events occurring in recent history was in early 2005. This event is reported to have affected close to 275,000 people (37% of the population) and caused economic damage estimated at US$465,000,000 (60% of GDP). It was caused by a combination of a wetter than average in December 2004, which left the ground saturated, followed in January 2005 by some of the heaviest rainfall the country has experienced since records began (1888). Some areas reported as much as 120-150cm of standing water, which remained for several days. The heavy rainfall also caused an increase in the water levels of the East Demerara Water Conservancy Dam (EDWC), which came close to a critical breaching level (59ft) and could have resulted in the failure of the dam wall. A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts to the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica and Mahaica/West Berbice. Region 4 was most severely affected, experiencing close to 55% of the total damage, followed by Regions 2 (23%) and 5 (19%). Considerable losses were recorded in the sugar, rice, livestock and other crop (fruits, vegetables, roots and tubers, and herbs and spices) subsectors[698].

On the other extreme, in 2014-2015, some hinterland areas experienced a prolonged period of drought, which caused significant problems for local communities highly dependent on subsidence agriculture and reliable groundwater supplies. Climate change will alter the characteristics of hazards Guyana is exposed to (e.g. average annual rainfall) and the nature of variability (e.g. more intense

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[695] FAO. 2020. Perspectives on diversification prospects for the agrifood industry in Guyana.

[696] ILO. 2018. Skills for Green Jobs in Guyana.

[697] Government of Guyana. 2015. Climate Resilience Strategy and Action Plan for Guyana. Ministry of the Presidency.

[698] Idem

storms, irregular seasonal rainfall), which will cause associated knock-on consequences for Guyana's socio-economic development objectives. It is estimated that by 2030 Guyana could be exposed to cumulative annual flood-related losses totaling US$150 million and that an extreme event similar to the serious flooding in 2005, which resulted in losses equivalent to 60% of GDP, could result in some US$0.8 billion in losses and harm to more than 320,000 people[699].

Following an extended period of dry weather in late 2014 and early 2015, the hinterland was facing drought conditions by April 2015. Region 9 (Upper Takutu-Upper Essequibo) and parts of Region 1 (Barima-Waini) were particularly affected, resulting in reduction in the agricultural output in the Region, reduction in available water supply and increased dust pollution among other issues. The lack of rainfall caused decreased water levels in the wells, lakes, ponds, rivers, creeks and other water sources, and frequent bush fires, which destroyed several farms at Aranaputa. Local communities experienced limited access to potable water for domestic and agriculture use. Residents were forced to go to local rivers, including the Rupununi River, for untreated water for domestic use, which at the time were flowing at low levels and with higher concentrations of particles. There were reports of an increase in the number of people suffering from vomiting and diarrhea. The drought conditions were also linked to a resurgence of pests, including acushi ants and caterpillars, which attacked the few remaining crops. Dasheens, cassavas, eddoes and cash crops were observed to be particularly severely impacted by the drought[700].

Climate Impacts and Risk for the Amazon

Several adverse effects on the health and livelihoods of the population as well as vital ecosystems in the Amazon region can be inferred from the possible effects of climate change:

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. While there are limited studies available on the Amazon region in Guyana, potential impacts could include: changes in productivity, crop failure, increased or changing need for production inputs, losses and damages due to hazards (floods, droughts, fires), shifting production zones, pest and disease outbreaks, among others. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.).
- Climate change and climate-related hazards (such as extreme drought and flood events) may **limit access to food and foraging** in the Amazon region. Extreme rainfall events in the Amazon region in 2020 and past years were reported to have affected the food security of indigenous peoples in inland Guyana, where agricultural production failed (e.g. due to crop rot), increasing the overall vulnerability level of communities. A related decline in traditional hunting and fishing opportunities in future years is expected to increase reliance on store bought food, which will have cascading socio-

699 Guyana Lands and Surveys Commission. 2020. Guyana's National Drought Mitigation and Adaptation Plan
United Nations Convention to Combat Desertification (UNCCD). Drought Initiative.

700 Idem.

economic and health implications.[701] Given the Covid-19 pandemic, this additionally puts indigenous communities and their elders at higher risk of contracting and spreading Covid-19.

- Decreasing rainfall amounts further threatens water supply around the Amazon region, as aquifer and surface water recharge potential is reduced.[702]

Risk of injury, illness, death and adverse health impacts

- Climate change may result an increase in climate-related injuries, illness or even deaths. Direct causes could be injury or loss of life due to climate hazards (e.g. flooding), and the same events could also limit available health services if hospitals or other medical facilities are damaged. In addition, other health impacts from climate change include:[703] heat stroke& stress, illnesses and diseases attributed to temperature effects on food and water-borne diseases, changes in air pollution and related respiratory illnesses, among others.
- Climate change has the potential to increase air and soil temperatures that could create the necessary conditions for a **wider distribution of disease transmitters** such as mosquitoes, ticks and rodents. Consequently, conditions for the spread of diseases (e.g. dengue fever, malaria and leishmaniasis) and epidemics would be more likely to occur.[704]

Risk of damages and losses to infrastructure and homes

- Climate-related hazards (e.g. flooding, fires) could result in **increasing losses and damages** to communities in the Amazon, as well as infrastructure (e.g. housing, small-scale farms and tourism infrastructure).[705]

Risk of ecosystem transformation and loss of ecosystem services

- Climate change is expected to impact the health of ecosystems, and could cause degradation (e.g. climate change affects plant growth, changes in groundwater systems, soil erosion, damage due to flooding, landslides, etc.). This may not only lead to biodiversity loss and affect the provision of ecosystem services, but could also lead to increased conflict over resources.[706]
- D**eforestation and forest degradation** in the Amazon exacerbate the impact of climate change on ecosystems and local communities. Deforestation leads to increasing erosion and sedimentation, which can in turn increase flood risks, and result in riverbed rise and riverbank cutting. The conversion of forests and savannah into grasslands potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness.[707] Forest degradation may also contribute to pest and disease outbreaks, and reduced provision of other key ecosystem services. Studies on the Guianas Shield show a negative correlation between growth rates of trees and increases in annual average temperature, annual maximum temperature and intensity of the dry season. This will result in stress and reduced net primary production and, causing impacts on ecosystem structure, and fragmenting forest margins. These

[701] J-CCCP 2018

[702] J-CCCP 2018

[703] ELAC 2011a in the Climate Resilience Strategy and Action Plan for Guyana 2015

[704] J-CCCP 2018

[705] Ministry of Agriculture, 2014

[706] J-CCCP 2018

[707] Bovolo et al., 2009

areas are then more vulnerable to stresses such as increased wind speed, turbulence, elevated temperatures, reduced humidity, increased sunlight, increased drought and fire risk, etc.[708]

- The effects of **increasing climatic exposure** may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, open roads, and deforestation usually cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change (e.g. erosion and sedimentation could contribute to an increased risk of flooding, exacerbated by projected increases in precipitation).

The following Table provides a summary of potential climate impacts on the main sectors covered by the proposed GCF program:

Table A34. Overview of potential climate change impacts in Guyana's Amazon region

Sector	Potential impacts
Agriculture	▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures ▪ Changes in crop yields and productivity of key crops in inland areas
NTFPs (e.g. wattles, manicole palm)	▪ Decrease in NTFP quality and availability due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks
Aquaculture & Fisheries	▪ Annual recurring drought events threaten water quality and quantity for fisheries sector ▪ Water quality deterioration (changes in pH, oxygen, temperatures)
Tourism	▪ Damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) ▪ Damage to forest resources due to wildfires ▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (malaria, dengue) ▪ Risk of decreased attractiveness of key tourism features (waterfalls) due to precipitation variability
Ecosystem regulation services	▪ Decrease in biodiversity (threatened species) due to changes in habitat and changing climatic conditions ▪ Decrease in opportunities for traditional hunting and consumption practices. ▪ Changes in ecosystem functions, including regulatory and cultural services ▪ Risk of biodiversity loss, endangered flora and fauna ▪ Risk of loss of key ecosystem functions including regulatory, production and cultural services

[708] Bovolo et al. 2011

	▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience)
Forests	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Forest degradation and interruptions to landscape connectivity ▪ Inundation along rivers threaten forest resources ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume ▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities

Source: World Bank CC Portal, n.d.; Ministry of Agriculture, 2012; J-CCCP 2018; Tomby & Zhang, 2019; Hickey and Weis, 2012.

Climate change benefits from bioeconomy investments

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g. country, region, site-conditions, etc.), many of the program's investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g. agroforestry, ecotourism)

The program is further aligned with key climate policy and commitments within Guyana, including the NDC and Guyana's climate change policy.,

National climate change policy: Guyana's climate change policy consists of nineteen Policy Objectives addressing adaptation, mitigation, resilience-building and risk reduction. These objectives are clustered together into nine Policy Directives:

- Establish climate resilient infrastructure and physical development
- Sectoral climate change mainstreaming for a healthy, educated society
- The implementation and use of green and clean technologies
- Build a diversified, climate-ready, low-carbon Guyanese economy
- Responsible management and utilization of natural resources
- Promote equitable participation in national decision-making processes
- Drive climate change decision making that is based on leading-edge scientific evidence
- Develop and access finances and resources to achieve national climate change goals
- Encourage and promote cooperation on climate action between the public and private sectors

International Conventions and Commitments: Guyana has ratified numerous international agreements, such as the UN Convention on Biological Diversity, UN Framework Convention on Climate Change, UN Convention to Combat Desertification, Convention on the International Trade in Endangered Species of Wild Fauna and Flora, and the Rio Declaration on Environment and Development. Guyana also participates in the United Nations Forum for Forests, and has made numerous international agreements. After signing the Paris Agreement, the Government of Guyana also promised to add 2 million ha to its national Protected Areas system.

iNDC (2012) and revised NDC (2016):[709] Guyana's NDCs comprise conditional and unconditional policies, measures and actions to reduce the normative business-as-usual growth in emissions. The forestry and energy sectors are where the majority of current and historic emissions are produced. While it is true that agriculture is a main source of carbon emissions and a considerable source of other greenhouse gas (methane and nitrous oxide), agriculture in Guyana is under threat from the adverse effects of climate change, including floods and droughts. Given its small scale and concentrated as it is along the narrow coastal strip where Guyana's most productive soils are found, its agriculture is particularly vulnerable to sea level rise and other adverse effects of climate change. Therefore, its contributions are focused entirely on CO_2 emissions and Guyana's agriculture is treated purely as an adaptation issue in the nation's NDC.

Unconditional policies:

- *Forestry:* Improve sustainable forest management and legal compliance; increase monitoring; finalize and implement EU FLEGT VPA; add value to timber; strengthen the MRVS (and CMRV); and implement the opt-in mechanism.
- *Energy:* Renewable energy (solar, wind, water and biomass for national grid and hinterland communities).

Conditional contributions:

- Contribute to avoided deforestation and achieve an effective REDD+ program.
- Avoid a cumulative 48.7 Mt CO_2 eq emissions through an emissions reduction program in mining and logging.
- Eliminate near-complete dependence on fossil fuels and develop 100% renewable energy supply by 2025.

In order to implement its conditional adaptation actions, including infrastructural development works, Guyana will require an estimated US$1.6 billions in the period to 2025.

Guyana and REDD+ Policy: Guyana's participation in the REDD+ program was driven by the desire for a strategy that will allow for forest protection while simultaneously enhancing the contributions of forestry to national development. Under the Agreement, the Government of the Kingdom of Norway committed to provide Guyana with US$250 million in support of its avoided deforestation efforts over a five-year period commencing in 2009 if annual deforestation is maintained at a rate lower than 0.056%. The Agreement stipulates, among others, for protected areas to be created and established in close collaboration with indigenous communities. It expanded the mandate and technical capacity of

[709] Government of Guyana. 2016. Guyana Second National Determined Contributions to UNFCCC.

the Guyana Forestry Commission (GFC), which became the focal point for REDD+ implementation. It also created a new Ministry of Natural Resources and an Office of Climate Change, also revised a number of legal and policy frameworks to support REDD+ efforts, notably the Forest Regulations, the National Forest Plan and the Code of Practice for Timber Harvesting. The REDD+ Secretariat was created as an operational unit of the GFC to oversee the implementation of the technical aspects of REDD+ and more specifically, the development and operation of the Monitoring Reporting and Verification System (MRVS). To this end the Guyana REDD+ Investment Fund (GRIF) was established and managed by the Project Management Office within the Ministry of the Presidency. The GRIF is temporary and is channeling REDD+ payments from Norway and other potential contributors. Work is being undertaken to allow for a more flexible, fit-for-purpose financial mechanism that would ensure the application of internationally recognized safeguards while allowing for stronger Guyanese ownership[710].

Bioeconomy sectors and actors

Agriculture

Guyana is one of the leading agricultural producers in the Caribbean and is among the largest agricultural economies, with sugar, rice, and livestock as the most important subsectors. Diversification in Guyana's agriculture sector is promoted through the Agriculture Export Diversification Program (AEDP), which was designed to endorse exports, particularly of the 4Ps (peppers, plantains, pineapples, and pumpkin) and the 4Cs (coconut, citrus, cassava, carrots). The government of Guyana recently began a process to divest and privatize the Guyana Sugar Corporation's (GuySuCo) assets. Sustainable private investments will be triggered by a diversification strategy on focused value chains, such as roots and tubers, herbs and spices, small ruminants, and fisheries, based on the CARICOM priority commodities.

At the end of 2020, the agricultural sector accounted for 27.1% of Guyana's non-oil GDP and 21.3% of its non-oil exports. The Government has crafted a holistic plan for agriculture aimed at realizing Guyana's potential of becoming the "breadbasket of the Caribbean". In 2021, expenditure in the ag sector is expected to increase to US$105 millions from US$85 millions the previous year[711].

It is estimated that 1,740,000 ha of land are being used for agricultural purposes, although only approximately 200,000 ha are used effectively, with relatively adequate drainage and irrigation systems. Agriculture is primarily undertaken by smallholder farmers on less than 5 ha of land. A recent study on agriculture in hinterland Region 9 shows that the region has traditionally been linked to smallholder agriculture, animal husbandry and gathering activities, hunting and fishing, mainly for subsistence. Indigenous peoples, in accordance with their traditional culture, follow a rotational system of slash and burn or shifting agriculture, with most families cultivating cassava. Livestock breeding prevails in the savannah. The main commodity in Guyana's agricultural export basket is rice, which contributed 45%, or roughly US$200 million, to Guyana's agricultural exports. The main

[710] Ministry of Finance. 2019. Guyana First Voluntary National Review of the Sustainable Development Goals.

[711] Ministry of Finance Guyana. 2020. Budget 2021: A Path to Recovery, Economic Dynamism and Resilience.

exported subproducts include other white rice, other rice in the husk (paddy or rough), and semi-milled white rice. Crustaceans contribute 12% to the export basket, with frozen shrimps and prawns being the main contributors. Eleven percent of agricultural exports come from the sugar industry, with the most important subproduct being cane sugar. Ethyl alcohol (< 80%) also contributes 10% to the agricultural export basket; the main exported subproduct of ethyl alcohol is rum[712].

Guyana's agricultural policy is characterized by two approaches. On the one hand, the country wishes to pursue an ambitious diversification strategy that reduces its dependence on traditional exports, creates more added value, and reduces the sector's vulnerability to price or climate shocks. It seeks to promote agro-processing and boost the livestock sector through investments in beef and dairy value chains. On the other hand, the government has chosen to spend most of its agricultural budget on the sugar sector to prevent the collapse of GuySuCo. Draining the agricultural budget to support the sugar sector is jeopardizing the goal of a more diversified agricultural sector. It also increases the government of Guyana's dependence on funding from international donors to finance capital investments in agriculture because its agricultural budget is primarily used to cover recurrent costs and sugar sector contributions.[713]

The identified commodities that might provide a basis for greater product diversification include oil seeds (including sunflower), bovine meat, fish flours, palm oil, cocoa products, and aquaculture products (including fresh fish and fish meat). We believe that these commodity sectors can make use of existing export capacity and value-chain infrastructure, both physical and institutional[714].

The Ministry of Agriculture of Guyana is the primary institution tasked with ensuring the formulation and implementation of policies and programs that facilitate the development of agriculture and fisheries in Guyana. Much of the technical work supporting the agricultural sector is carried out by semi-autonomous agencies, for which the Ministry of Agriculture has reporting obligations to Parliament. The directors of the boards of these agencies answer to the Minister of Agriculture. However, the agencies have their own budget and are semi-autonomously managed by Chief Executive Officers. Among others, these agencies include the Guyana Rice Development Board, the Guyana Sugar Company and the New Guyana Marketing Corporation.

Forestry

Forest covers approximately 87% (18,483,000 ha) of Guyana's total surface area. Of the forestland, 12,249,000 hectares have been designated as state forests and placed under the management of the Guyana Forestry Commission (GFC); 4,792,420 hectares (37.25%) of this land have been allocated to the forest industry for timber extraction (e.g., State Forest Authorizations Timber Sales Agreements, SFA-TSA, with large companies, and SFA-Community Forestry Management Agreements, SFA-CFMA, for small producers). Another 751,217 hectares have been designated as protected and research areas (e.g., forest reserves, Kaieteur, Iwokrama, Kanuku Mountains, and Shell Beach). Another 96 (mostly

[712] IFAD. 2016. Cooperative Republic of Guyana - Country strategy note.

[713] Derlagen et al. 2017. Analysis of agricultural policies in Guyana. IDB.

[714] FAO. 2020. Perspectives on diversification prospects for the agri-food industry in Guyana.

forested) areas, consisting of 3,077,000 hectares, have been conveyed as Amerindian titled lands, the largest private landownership in Guyana[715].

This forest resource is part of the Guiana shield, as well as an integral component of the Amazon basin and contains in excess of 1000 tree species most of which have physical and mechanical properties that make them suitable for commercial utilization. These resources provide direct employment for approximately 26,000 persons and contribute about 4% to the nation's GDP as a primary product. The growth of the forestry industry has stimulated the development of other manufacturing and service industries. Its products supply many other sectors of the economy, such as residential construction, furniture-making, printing and publishing. On the other hand, the forestry industry is also a major consumer of energy, chemicals, transportation services, machinery and processing and control systems[716].

The GFC administers and manages the state forest through two types of forest concessions for harvesting under Guyana's regulations. In addition to these harvesting permits, there is the option of a State Forest Exploratory Permit (SFEP) that is valid for three years, during which the environmental permitting process and other requirements must be completed. If all of the requirements, including the conduct and approval of an environmental and social impact assessment, and the submission of a business plan, are successfully completed at the end of the three-year period, the SFEP can be upgraded to a SFA-TSA, formerly called a Timber Sales Agreement (TSA) or Wood Cutting Lease (WCL) as applicable. In 2017, six of these permits (SFEPs) were given, covering 7.3% of state forest. Based on MRVS results, forestry concessions do not lead to deforestation and the impact and scale of timber harvesting is low. The commission's enforcement of sustainable forest management practices, including reduced impact logging, is considered contributory to this position. However, forest degradation impacts are detected and reported by the GFC as a REDD+ interim indicator with emission impacts[717].

Table A35: Types of forest concessions in Guyana

[715] Benn et al. 2020. The context of REDD+ in Guyana Drivers, agents and institutions. CIFOR.

[716] Idem.

[717] Idem.

Concessions types	Target groups	Number of groups
State Forest Authorizations (Small Concessions) are granted on a bi-annual basis (with possibility of renewal) for small areas of state forest less than 8,097 ha. Community Forest Management Agreements are issued under this category.	Small operators, communities and cooperatives operating, primarily chainsaw logging	410 SFPs covering 13.5% of state forest
State Forest Authorizations (Large Concessions) are granted for between 25 and 40 years for areas greater than 24,291 ha. For first time issuance of large concessions, a precursor state is the State Forest Exploratory Permit.	Large commercial interests, both Guyanese (e.g. Toolsie Persaud Ltd) and foreign owned (e.g. Vaitarna Holdings Private Inc (VHPI)) *This category has seen a reduction of 2 million ha over the last 3 years resulting from non-renewals and revocations for non-compliance.*	TSAs cover the majority of state forest exploratory permits granted for production, with 15 concessions covering almost 8% of the total State Forest Estate area

Source: Benn et al (2020)

Micro, Small and Medium Enterprises (MSMEs) make up approximately 80-90% of the forestry sector in Guyana. Many MSMEs in Guyana involved in timber production operate through the Community Forest Organization/Associations. However, they have challenges meeting the social, environmental and fiscal requirements of the European Union Forest Law Enforcement Governance and Trade Voluntary Partnership Agreement (EU FLEGT-VPA). These challenges are further compounded by limited knowledge of administrative and business standards and procedures. In various areas of the country, small loggers have organized into 69 Community Forestry Associations (CFAs), mainly with the assistance of the GFC's Community Forestry program, to better equip them to deal with forest management and conflict issues in their areas. These CFAs currently manage over 500,000 ha of state forest lands and employ over 2,000 persons[718].

The GFC is responsible for advising the subject minister on issues relating to forest policy, forestry laws, and regulations. The GFC is also responsible for the administration and management of all state forest land. The work of the GFC is guided by a National Forest Plan that has been developed to address the forest policy. The GFC develops and monitors standards for forest sector operations, develops and implements forest protection and conservation strategies, oversees forest research, and provides support and guidance to forest education and training. The GFC is governed by a board of directors appointed by the President. The board is responsible for the performance of the functions conferred on the Commission by the Act.

Case Study: Iwokrama International Center for Rainforest Conservation and Development[719]

Context

718 https://forestry.gov.gy/2020/12/19/msmes-in-forestry-sector-get-support-to-operate-sustainably/.

719 https://iwokrama.org/

In 1989, the Government of Guyana offered approximately one million acres of pristine tropical rain forest to the International Community at the Commonwealth Heads of Government meeting in Malaysia. The Iwokrama International Center for Rainforest Conservation and Development (IIC) was established by an Act of Parliament, passed and assented to by the President of Guyana in 1996 and the Centre was given the sole authority to sustainably manage the Iwokrama Program Site. In keeping with its commitment to address best practices, IIC will ensure that all operations continue to comply with the stipulations of national regulatory agencies, and all national laws and intends to once again achieve international accreditation of its forest management practices and operations by the Forest Stewardship Council (FSC). An extensive zoning processes resulted in approximately 50% of the 371,000 ha Iwokrama Forest being designated a Wilderness Preserve (WP), which is IIC's biodiversity reserve and 'control' area. The remainder, called the Sustainable Use Area (SUA) was demarcated for development work where the Centre's timber model and all of its other business development activities, including tourism and training services, are undertaken.

The SUA includes a Net Operable Area (NOA) for sustainable timber harvesting which is approximately 108,000 ha and constitutes only 29% of the total forest area. Using the Guyana Forestry Commission's recommended Annual Allowable Cut (AAC) of 20 m3/ha for a 60-year cycle, the maximum annual harvesting area would be 1,800 ha (0.5% of the total forest area) and the allowable cut would be 36,000 m3/ year.

Management and partnerships
The Centre is replicating its overarching management and sustainability protocols in the timber operations by building local and regional capacity in sustainable forest management including but not limited to models of benefit sharing amongst multiple stakeholders, Reduced Impact Logging (RIL), and the use of non-traditional species. Techniques for improving logging and processing efficiencies and the production of value-added products will be the main tools of this second phase of operations. IIC's partnership with neighboring local communities provides an innovative model for sharing benefits, as it is based on ownership (communities have moved from stakeholders to shareholders) and formalizes the arrangement of co-management of forest resources between the Centre and the communities).

Harvest Planning and Operations
Selective harvesting is planned and executed according to strict Reduced Impact Logging (RIL) guidelines whereby all commercial species to be harvested are identified, measured, marked and mapped. These tree-location block maps are then used to layout roads, bridges, log-markets and skid trails in an efficient manner, avoiding any unnecessary road construction and reducing the number of watercourse crossings. Directional felling techniques are used to minimize gap sizes and to reduce logging debris in the creeks and streams. On average, no more than 5 trees per ha are felled. In this manner, the overall impact of harvesting is minimal, and operational cost is carefully managed.

Processing High Quality Products
IIC plans to consistently produce the highest quality rough sawn lumber in terms of grade and dimensional accuracy and at the highest possible recovery rates from log volume. It expect to install value added equipment to produce products such as kiln dried flooring and decking that match the properties of our species to niche, high-end markets. Production focus is on sawing for grade rather than sawing for dimension against specific orders, concentrating on the recovery of value through proper planning, efficient operations and appropriate value-added production. This focus will permit Iwokrama to offer high quality products to their clients and ensure delivery in a timely manner. The Iwokrama International Centre continues to employ protocols and practices that demonstrate how a tropical forest can be conserved and used sustainably for ecological, social and economic benefits to local, national and international communities. All of Iwokrama's models are designed to follow international best practices and employ innovative governance systems involving various stakeholders.

Tourism

Guyana is positioned as the next must-see destination for travelers. With daily non-stop flights already available from New York, Miami and Toronto; and direct routes available from Europe through sister Caribbean countries. Being the only English-speaking country in South America, travelers can experience vibrant indigenous culture, rich history, and hospitable and friendly people in the language both know best. Guyana has also recently become the first country to adopt the Adventure Travel Trade Association's International Adventure Travel Guide Qualification and Performance Standards.

Therefore, Guyana has natural comparative advantages in nature-based and adventure tourism relative to its neighbors in the Caribbean and South America. The comparative advantage for Destination Guyana is its nature, adventure, and culture-based tourism products. This type of tourism is on the rise, since a larger percentage of people travel for some sort of experience-based activity. Guyana's sustainable and green pathway differentiates it from the mass tourism destinations and allows to carve out a niche that is high value, low volume.

Compared with the island states of the Caribbean, Guyana has much larger extensions of forest, many more waterways and waterfalls (32 major rivers and 70 waterfalls), and more diverse flora and fauna. Since nature-based tourism attracts an older, highly educated, more affluent, environmentally conscious segment of the travel market, many of the potential travelers to Guyana are likely to hail from high-income. However, it should be noted that ecotourism is a specialty market with limited demand and the standards required for international certification and branding are quite high.

Guyana's tourism product is nature and adventure-based owing to its abundant natural and cultural diversity. The country's location in the South American Amazonian region exercises exceptional influence on its natural resources. The savannah, rainforest regions, and, to some extent, the coastlands, offer scope for engagement in a number of activities. The most common activities are birding, wildlife spotting, trekking, mountain climbing, safaris, and rivers tours. Other types of tourism offered are ecotourism, multi-destination tourism, and heritage and cultural tourism.

The main ecotourism/nature-based tourism attractions in Guyana are:

- **Kaieteur and Orinduik Falls:** Kaieteur is the highest single drop waterfall in the world (266 meters). The conditions created by the falls support a unique microenvironment allowing endemism to exist. Orinduik, near the Brazilian border, is a set of staircase falls with jasper beds Both falls are very unique, and they are well maintained.
- **Rupununi:** It is a vast area of numerous water bodies, savannahs, shrubs and various types of forests. Divided into the North and South Rupununi by the Kanuku mountains. There are scattered Amerindian villages, a few cattle ranches, and several community-run eco-lodges in this area. The combination of savannahs, abundant fish in navigable rivers, and a wide variety of wildlife that can be viewed, indigenous peoples and cultures makes the Rupununi the premier place for ecotourism.
- **Kanuku Mountains:** Notable for its diverse bird and mammal species, approximately 80% of the known species of mammals in Guyana are found here. The Kanuku is bisected by the Rapununi river, one of the primary tributaries of the Essequibo. The mountain boasts many trails and are very appealing to naturalist and hikers.
- **Iwokrama rainforest:** located in central Guyana, between Essequibo, Siparuni and Takutu rivers, and just north of the Rapanuni savannah. Approximately 360 thousand hectares of pristine rainforest have been set aside in a national park. The park has a suspended walkway through the rainforest canopy that covers close to half mile in length, 90 feet of the ground.

- **Bartica and Marshall Falls:** Bartica is located at the confluence of the Essequibo Mazaruni and Cayuni rivers and has great potential for the development of a yachting tourism product as well as ethno-historical tourism. Not far from Bartica past the ruins of the ancient Dutch Fort KYK-Over-Al. Up the Cayuni river are the Marshall Falls.
- **Mainstay lake:** a large recreational lake with resorts. Very popular for domestic tourists.
- **Mt. Roraima:** The mountain is the highest peak of Guyana at 2,180 meters and straddle the border with Venezuela. It is a spectacular tabletop mountain with a unique microclimate. It appeals to the mountain climbers.

Guyana is an expensive destination to travel to and within. This is why the Guyana Tourism Authority's strategy is to promote what uniquely differentiates Guyana from competing destinations. This means targeting travelers interested in five brand pillars: (1) Nature/Wildlife, (2) Culture/Heritage, (3) Active/Exploration, (4) Birding, and (5) Scientific/Academic/ Educational travel and tourism[720]. In other words, the Guyana Tourism Authority is pursuing a strategy centered on "sustainable tourism" that is built upon the country's product strengths: natural and forest resources, indigenous community and cultural heritage. The country is therefore prioritizing tourism development that is community-led, nature- and adventure-based (bird watching, wildlife observation and adventure experiences). Guyana is also connecting to heritage and traveler networks that embody these core values, for instance, trough the "SAVE" travel network (i.e. travelers with particular interests in scientific, academic, volunteer and education.

The Tourism and Hospitality Association has 47 members represented including hotels, tour operators, resorts, airline services, among others. There are approximately 13 tour operators providing transportation services to tourists, 4 travel agencies, and 24 eco-lodges active in Guyana.

Restoration and ecosystem services

In the ten years since the beginning of its REDD+ process, Guyana is just now formulating its national REDD+ strategy, assigning carbon rights and designing a long-term benefit sharing scheme to incentivize keeping its extensive forests standing. During the implementation of the Norway–Guyana REDD+ program (2010 to 2015), annual tree cover loss did not increase above the 0.1% threshold at which REDD+ payments would have ceased. There were 3 years where deforestation was higher than the 0.056% baseline deforestation rate, against which payment deductions occurred. In the 2 years after the Norway–Guyana REDD+ program ended (2016 to 2017), tree cover loss more than doubled to 0.122%/y (22,985 ha/y)[721].

Guyana is under an ongoing process financed by the Forest Carbon Partnership Facility (FCPF) to design a benefit sharing mechanism (BSM) for REDD+. Additionally, there is the newly establishing Natural Resource Fund, which puts the oil money on the table as a credible source of finance for a national payment for environmental services (PES) program, among the other REDD+ strategic

[720] https://www.stabroeknews.com/2019/06/14/guyana-review/sustainable-tourism-development-in-guyana-2019-2025/.

[721] Roopsind et al. Evidence that a national REDD+ program reduces tree cover loss and carbon emissions in a high forest cover, low deforestation country. PNAS: vol. 116, No. 49, 24492–24499

options. Continued finance for an Amerindian Land Titling (ALT) project that produces land titling results would be a tangible benefit, as would financial, technical, logistical and communications support for community forest monitoring, and better coordination with law enforcement. A national PES scheme would provide a substantial payment to communities with extensive forests, even at a moderate $5/ton, but requires legislation and set up, so could be years away. Payments to miners to stop mining, and support alternative livelihoods could also benefit indigenous communities involved in or directly affected by mining, and those living around mining areas affected by downstream water contamination. There could be risks of perverse incentives though, especially if the REDD+ strategy ends up including the mapping of mineral deposits to better target mining, rather than eliminating unsustainable small and medium gold and diamond mining operations altogether. The same is true for participation of logging concessionaires as beneficiaries of PES payments for undertaking activities such as reduced impact logging (RIL) and sustainable forest management (SFM) certified operations, which are already established by law as good practice, so there is little additionality to these activities and the carbon benefit of such strategies is dubious anyway. Supporting indigenous peoples to conserve their forests through land titling, forest monitoring and sustainable livelihoods, represent perhaps the best strategic options for keeping forest standing through the REDD+ strategy.[722]

As part of its global effort to establish a REDD+ regime and to commence its partnership with Norway, the Government of Guyana (GoG) established a four-phase structure in its LCDS back in 2009 which accounts for the "interim reference level" that reflects Norway's support for the Economic Value to the Nation (EVN) of Guyana's forests. The GoG in its phased approach recognizes that long-term funding beyond Norway's initial payment structure for its LCDS and subsequent REDD+ activities could possibly be sourced from four main categories: Carbon markets (pending the inclusion of REDD+ in carbon markets), market-linked mechanism, voluntary funding mechanisms, and the pending UNFCCC-mandated global model for REDD+. The GoG also has recognized that the estimated costs for REDD+ global efforts are such that the additional private capital must also be leveraged. To accommodate the sources of funding the GoG anticipates from additional donors and under a future REDD+ global regime, it has set forth a "phased approach" to REDD+[723]:

Table A36: Guyana's phased approach for REDD+ under the GRIF

PHASE	REDD+ PAYMENTS AVAILABLE TO GUYANA	DESCRIPTION
Phase 1 (2009)		Interim payments to launch the LCDS incl. funding for an MRV system in Guyana
Phase 2 (2010 – 2015)	Starts at: ~ US$60 million Ramps up to US$230- US$350 million (40%-60% of EVN)	Transitional funding that will be used for: – Capacity building – Investment required to build a low-carbon economy – Human capital
Phase 3 (2013 – 2020)	Starts at: ~ US$230- US$350 million (40%-60% of EVN) Ramps up to US$580 million	Continued payments to avoid deforestation. Payments will be used for further: – Investments in low-carbon economy

722 Rainforest Foundation. 2019. REDD+ in Guyana: Progress and challenges. US.

723 Frankfurt School - UNEP Collaborating Centre for Climate and Sustainable Energy Finance. 2012. Case Study: The Guyana REDD-plus Investment Fund (GRIF).

	(EVN)	– Capacity building – Climate change adaptation
Phase 4 (2020 onwards)	At or above EVN (> US$580 million)	"At-scale" REDD+ mechanism should: – Provide incentives at or above EVN – Account for increasing value of the forests (e.g., reset EVN periodically)

Source: Frankfurt School - UNEP (2012)

- Establishment of the GRIF fund-based mechanism for REDD+ in 2010 with financial payments from Norway for avoided deforestation and low-carbon development,
- Gradually merging REDD+ into carbon markets for supplementary funding. This assumes that forestry emissions quotas or carbon credits (REDD+ Credits) will be assigned to countries with HFLD as offsets to trade within the carbon markets. This depends upon further international negotiations regarding the role of REDD+ in carbon markets, the outcome of which still remains uncertain.

Financial system and financing for bio-businesses

Banking system

Guyana's financial sector is small and underdeveloped. There are six commercial banks operating in Guyana, of which three are owned by a foreign parent: Bank of Baroda (India); Scotiabank (Canada); Republic Bank (Trinidad and Tobago); Citizens Bank; Demerara Bank; and Guyana Bank for Trade and Industry (GBTI). Republic Bank is the largest, accounting for 40% of commercial bank assets, followed by GBTI with a 20% market share. Guyana's commercial banks are well-capitalized, holding reserves equal to over 160% of required reserves at the end of November 2016. The Central Bank of Guyana supervises commercial banks, non- bank financial institutions, insurance companies, finance companies, pension plans, money transfer services, and currency exchange houses[724].

Many of the large conglomerates possess majority ownership positions in the country's banks. Amongst the largest conglomerates are: Edward B Beharry & Company Ltd which owns companies in the food and beverage industry, in addition to having a large ownership stake in the GBTI. The Yesu Persuad Group is a shareholder of the Demerara Distillers Ltd and the Demerara Bank. The Banks DIH Limited group which controls companies in the beverage and bottling sector has a controlling stake in Citizens Bank. The results of these crossholdings are that the largest and most sophisticated companies in the country are well-banked, while the smaller ones are not.

Commercial banks are not allocating resources according to their significance in the Guyanese economy. The composition of the loan portfolio in the commercial banking sector is concentrated on the service sector (43%) of which more than half represents wholesale and retail distribution, followed by manufacturing (23%) where construction is the largest subsector. It is worth noting that the agriculture sector, which represent almost a fifth of the country's GDP, only receive about 13% of commercial financing. In relative terms, agriculture alone received 10% less funding in 2016 compared to 2010. The reasoning behind this is twofold. First, the financial structure of commercial

[724] IDB. 2016. Guyana country development challenges.

banks, combined with simple credit evaluation technologies and products, as well as a very low risk appetite, does not produce an incentive to expand lending in these sectors. Second, the agriculture sector has inherently carried a much higher and more unpredictable risk profile that banks have not been able to manage efficiently. Agricultural risks, (which cannot be mitigated because of a lack of insurance products) such as climate, informality, farming technology, and commodity price fluctuations are too complex for the banking sector to evaluate and price correctly, therefore the strategy is to limit exposure[725].

According to Central Bank statistics, in 2016 the average concentration of the top 20 borrowers in the system is 100% of the total capital base. On an individual basis, Demerara Bank and GBTI reported concentration levels of 298% and 235%, respectively; the latter being the second largest bank in Guyana with a 20% market share. These high levels of portfolio concentration make the banking sector vulnerable and crowds-out resources that could be targeted to smaller borrowers.

There are six non-bank financial institutions, of which two are deposit-taking institutions providing savings and mortgage services, among others. Non-bank financial institutions include both deposit and non-deposit taking institutions. This group is composed of six entities: two trust companies, one finance company, one merchant bank, one housing lender and an investment firm. These entities represent 19% of the financial system's assets. The housing lender, New Building Society (NBS), is the largest player in this group, with total assets representing 9% of the financial system. NBS is a deposit taking institution that focuses primarily on mortgage loans. There are 17 registered insurance companies in the country; eleven of them cover general casualty risk, and six are long term insurance companies. The insurance sector is responsible for 7.4% of the financial system's assets. Information from the Central bank of Guyana suggests that insurance companies invest in long term assets, both domestically (68%) and abroad (32%)[726].

Commercial banks account for almost 70% of the financial system's total assets, concentrating the great majority of lending and investment capacity in the country. In 2018, commercial banks accounted for 65% of the sector's total assets, while non-bank financial institutions (including deposit and non-deposit taking) represented 17% of total assets. Insurance companies represented a further 9.5% of assets, while pension plans accounted for another 8.5%. Indicators of physical access to the retail banking system in Guyana have improved over the past decade. The number of commercial banks has remained unchanged, but commercial bank presence in terms of branches nearly doubled, from 23 in 2005 to 40 in 2018. However, the coverage of the financial sector is still poor. Port Kaituma and Lethem are the only hinterland communities with bank branches; as a result, many hinterland residents must make costly overnight trips to access financial services[727].

Guyana's financial sector contributed 4.2% to GDP in 2019 and is well positioned for growth. The drivers include oil and gas development, real estate, agriculture and services. The current financial sector leaves much fertile ground for wealth management and financial technology. A digital

725 Idem.

726 Gauto and Mooney. 2020. Review of financial development and inclusion for Guyana: Assessment and options for reform. IDB.

727 Government of Guyana. 2017. Framework of the Guyana Green State Development Strategy and Financing Mechanisms.

transformation is ongoing as banks continue to restructure. COVID-19 has further accelerated change. Guyanese society is heavily cash based, making it likely for the country to adopt digital wallets and other "safe" financial products during the pandemic. On the other hand, Guyana has a large population of youth that can serve as a catalyst to adopt of financial technology and will fuel demand for wealth management as national income grows[728].

Capital markets

Guyana has an incipient capital market, comprised of a stock exchange and a handful of brokerage firms with very low trading volumes and lack of debt instruments. The Guyana Association of Securities Companies and Intermediaries[729] (GASCI) is the home of Guyana's Stock Exchange. GASCI is registered with the Guyana Securities Council to carry out business as both a stock exchange and an association of securities companies and intermediaries. There are four entities that are registered as brokers in the exchange, buying and selling securities on behalf of their clients. There are seventeen companies currently listed under two types of listings: the Official List and the Secondary List. Trading in the market is incipient. Only 12 of the companies listed are traded on a regular basis, and 9 of them have a majority ownership which means that the actual float is low. No IPOs have ever been issued in the Stock Exchange. Trading sessions are held once a week and the average monthly trading since 2013 has been just above US$170 thousand. Total market capitalization is US$704 million. GASCI has not developed a debt capital market. No corporate bonds, commercial paper, bank time-deposits or government securities are currently listed or traded in the Exchange. The government issues Treasury Bills, but they are placed through the Central Bank. The capital market's industry regulator is the Guyana Securities Council. The Council is a statutory body created by the Securities Industry Act 1998. The Council was created in 2001 and its main responsibilities are to regulate the securities market and ensure orderly, fair and equitable dealings in securities. The Securities Council is a dependent agency of the Ministry of Finance[730].

Finance

Guyana faces high cost of domestic finance and does not have access to international capital markets. Domestic cost of financing is high, and penetration is low and there is a high portfolio concentration reflecting crossholdings between banks and large conglomerates. There is zero credit registry coverage and low credit bureau coverage. Underlying these features is an inadequate financial regulation and supervision. The country does not have a sovereign credit rating and no access to private international capital markets to smooth external shocks effects[731]. Most sources of international finance are multilateral and bilateral development agencies.

The 2020 Doing Business Report ranks Guyana 94th out of 189 countries for getting credit. This challenge particularly affects SMEs that do not comply with stringent and conservative credit policies.

[728] https://www.trade.gov/country-commercial-guides/guyana-financial-sector

[729] http://www.gasci.com/

[730] IDB. 2016. Guyana country development challenges.

[731] Idem.

The challenge banks face in their effort to expand their lending activities is finding creditworthy clients with proven cash flows and sound business plans. Commercial banks claim that a lack of credit information systems, clients with audited financial statements, bankable business plans, and problems with collateral collection are the main obstacles that prevent a more aggressive credit expansion into the SME segment.

Microfinancing in Guyana is underdeveloped particularly affecting agriculture. There are only two microfinance entities (MFIs), legally constituted as NGOs, which are not supervised by the Central Bank. These NGOs offer financing for MSME with loans as low as US$200. Their portfolio is concentrated in agriculture and commercial retail. Though both NGOs have been in the market for several years, their combined portfolio is still low (approximately US$17 million)—less than 1% of commercial banks' total assets. They currently serve over 5,000 clients combined and the average loan is approximately US$3,300 per client. These numbers denote low microfinance penetration, as the estimated number of informal businesses and self-employed individuals who are eligible and would be interested in a micro loan is approximately 29 thousand clients (15-20% penetration)[732].

Guyana has developed a segment of credit unions that are very large in terms of coverage and number of affiliates, but not very representative in terms of intermediation volumes. Structured as co-operatives, these credit unions are non-for-profit depository institutions created to serve their members with depository and loan services throughout the country. There are 24 active credit unions with more than 27 thousand members, but only US$25 million in assets (approximately 1% of total commercial bank assets). The three largest unions serve nearly one-third of the total membership. Three entities lend at the legally established rate of 1% per month, regardless of amount requested and current market interest rates. Unlike the rest of the financial intermediaries, credit unions are supervised by the Ministry of Labor, consequently they are not subject to the same regulatory compliance imposed by the Central Bank upon other regulated financial intermediaries. As the size and relevance of the credit unions in Guyana continue to grow, with many of these entities managing substantial amounts of deposits from the public, it has been recommended that they should be placed under the surveillance of the Central Bank to ensure the integrity of the financial system as a whole[733].

The major limiting factor for the future of Official Development Assistance (ODA) financing is Guyana's reclassification as an upper middle-income country in July 2016. Guyana's ODA has mostly been granted on highly concessional terms through grants and low-interest loans; finance must have a grant component of at least 25% to be classified as ODA. With its reclassification, Guyana will no longer be eligible for concessional financing from many creditors. Traditional aid flows are unlikely to provide a significant share of new, additional funding to deliver the Green State Development Strategy: Vision 2040. Although donors are shifting aid to include More Advanced Developing Countries (MADCs) which offer significant trade benefits, these flows do not generally increase as countries move from LDC to Middle Income Country status.

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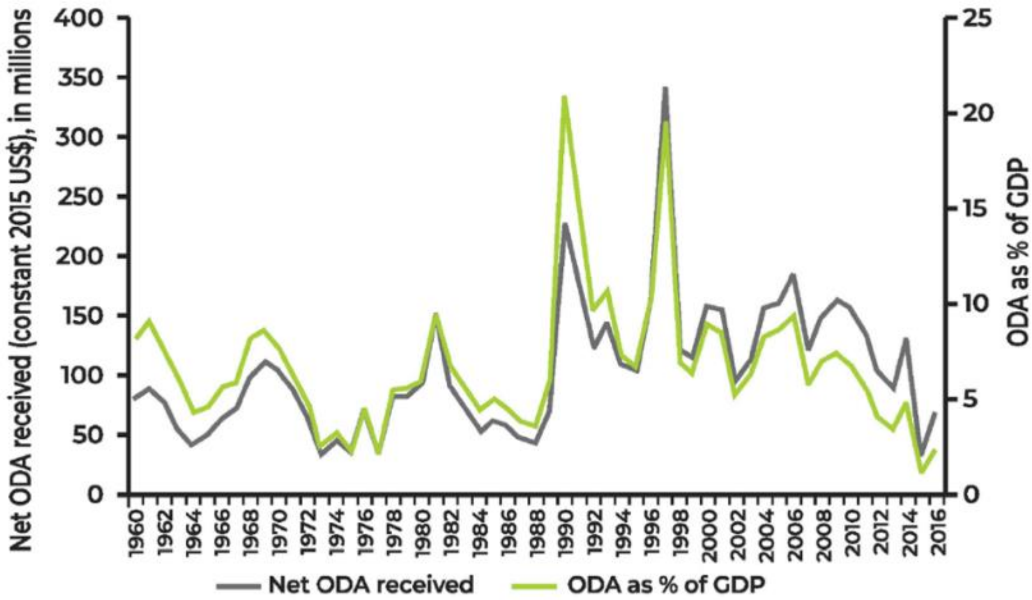
[732] Gauto and Mooney. 2020. Review of financial development and inclusion for Guyana: Assessment and options for reform. IDB.

[733] https://caribccu.coop/cccu-affiliates/guyana/.

Figure A113: Official Development Assistance (ODA) has been declining in significance for Guyana



Source: Government of Guyana (2019)

The GoG established in January 2019 a sovereign wealth fund known as the Natural Resource Fund (NRF). As of August 2020, contributions to the NRF stood at over US$150 million from Guyana's initial 3 lifts. In fact, Foreign Direct Investment in Guyana is largely driven by the oil and gas sector and exponentially increased by US$463.6 million in 2019, when compared with 2018, and therefore reaching US$1.7 billion overall[734].

Development finance

Inter-American Development Bank (IDB): The IDB is the most active development bank in Guyana and has an active national loan portfolio of US$244 million, the majority of which addresses transport and energy needs. IDB's Country Strategy program for Guyana for 2017-2021 has the explicit aim to "respond to developing Government priorities in the new Green State Development Strategy." This represents one of the most promising pools of finance for the Strategy and the GoG should work closely with the IDB to identify what activities could be delivered or supported.

Caribbean Development Bank (CDB): The CDB Country Strategy Paper covers the 2017-2021 period and features a program of assistance that is designed to help achieve the following development outcomes: increased competitiveness and productivity; improved quality of, and access to, education and training; strengthened social protection; reduced vulnerability to natural disasters; and improved governance and development planning. CDB has identified an indicative resource envelope of US$194 million to support this program.

734 PwC. 2020. Guyana: 2020/21 budget.

World Bank (WB): Guyana's Country Engagement Note covered the period 2016- 2018 and continued the strategic objectives set out in the previous Country Assistance Strategy of enhancing resilience of selected infrastructure and building Disaster Risk Management (DRM) capacities; setting up the foundations for high quality education; and laying the ground for private sector development. The WB's financing to Guyana is channeled through interest-free loans and grants from the International Development Association (IDA). In 2018, the WB approved a US$35 million Development Policy Credit to support Guyana's efforts to strengthen financial sector development and fiscal management to better prepare the country to benefit from its newly discovered oil and gas reserves and transform its oil wealth into human capital. This credit is expected to be the first of a series of two, both focused on financial and fiscal development, providing an important potential financing line for the Green State Development Strategy.

Climate finance

The GRIF was set up in October 2010 with partner entities the World Bank, IDB and the UNDP to implement the financing aspects of REDD+ in Guyana. This multi-contributor trust fund was established to: (1) manage payments provided by Contributors to the GRIF for forest climate services provided by Guyana; and (2) transfer these payments and any investment income earned on these payments, net of any administrative costs of the Secretariat and the Trustee, to Partner Entities for Projects and activities that support the implementation of Guyana's LCDS. The GRIF represents an effort to create an innovative climate finance mechanism which balances national sovereignty over investment priorities while ensuring that REDD+ funds adhere to the highest internationally recognized standards for financial, environmental and social safeguards. This is a temporary mechanism, pending the creation of an international REDD+ scheme. The GRIF structure includes Contributors, a Steering Committee, a Secretariat, Trustee, Partner Entities, and various Implementing Entities[735].

In November 2009, representatives of Guyana and Norway signed a *Memorandum of Understanding* with result-based payments for forest climate services of up to US$250 million by 2015, alongside co-operation between the two countries in the fight against climate change, the protection of biodiversity and the enhancement of sustainable development. Despite initial teething problems in establishing the mechanism to intermediate funds between Norway and Guyana, to date Guyana has earned US$115 million in payments for forest climate services through this partnership –making it the second largest Interim REDD+ arrangement in the world (Brazil's is larger at a total of just over US$1 billion in payment commitments from Norway and Germany, but Guyana's is by far the world's largest per capita). Alongside Guyana's own financial investments and policy initiatives, these payments have started to enable Guyana's forests to be worth more alive than dead, by creating an Economic Value to the Nation (EVN) derived from Interim REDD+. In turn, this is generating the capital needed to invest in the new economy[736].

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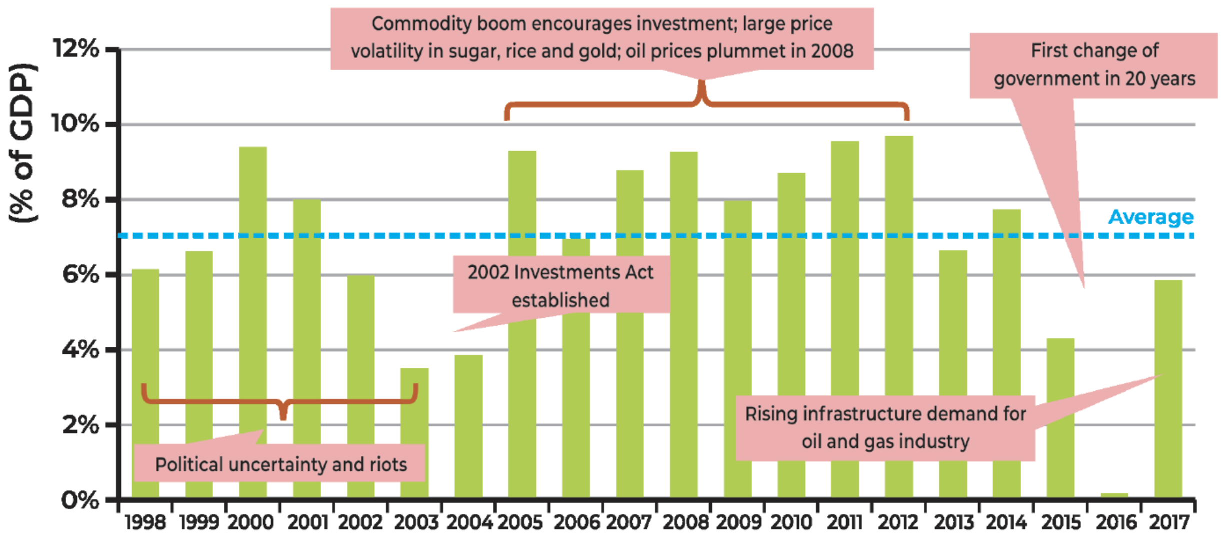
[735] Benn et al. 2020. The context of REDD+ in Guyana Drivers, agents and institutions. CIFOR.

[736] Government of Guyana. 2013. Low Carbon Development Strategy Update: transforming Guyana's economy while combating climate change. Office of the President.

Figure A114: Foreign direct investment (FDI) has been highly volatile over the past 20 years



Source: Government of Guyana (2019)

Another example would be the Leveraging Capital in Guyana's Rupununi Project. It's a multi-sector partnership between Conservation International (CI) and IADB's Multi-Lateral Investment Fund, who collectively financed US$1.2 million towards the project. Moreover, the GoG waived taxes on income from a seed investment of US$300,000 by the Guyana Bank for Trade and Industry (GBTI) in the Rupununi Innovation Fund. This Fund provides access to low-cost start-up financing for indigenous communities to develop climate resilient and environmentally sustainable enterprises in agriculture, eco and nature tourism, and fishing in particular. Additionally, beneficiaries receive entrepreneurial training, access to market support, awareness and capacity-building for ecological systems maintenance and are involved in forest conservation mandates undertaken by CI. CI notes that twenty-three indigenous community- based enterprises, impacting 42% of the population of Region 9 in Guyana will be directly impacted. Another inclusion strategy to support participation of indigenous groups in a sustainable green economy is the "Opt-In" in GRIF facility. Communities that Opt-In receive a share of total REDD+ payments received by Guyana. In exchange, these communities receive training to monitor, verify and report on agreed forest conservation targets. Communities through their respective governance structures collaborate to apply finances received for community development actions, including green enterprises. This could be a scalable mechanism since Indigenous communities have titles to upwards of 14% of land in Guyana[737].

The Fund aims to strengthen green enterprise and investment capacities of indigenous communities in Guyana's Rupununi district; agriculture, agro-processing, nature-tourism and eco-tourism are priority enterprise development opportunities. The GBTI holds and disburses low-interest financing for entrepreneurs through the Rupununi Innovation Fund. To facilitate lower interest rates, the Government issued an income tax exemption for revenue earned by the bank from the fund. In addition to this, the GBTI has established a Green Loans program that provides investments for: (1) solar energy products, (2) water treatment recycling – water filters, (3) energy-saving appliances,

[737] ILO.2018. Skills for green jobs in Guyana.

(4) air filters, (5) wind power projects, (6) hand powered projects, (7) and low carbon economic investments including high-end fruits, vegetables, aquaculture and other low-carbon enterprises. Some of the benefits of the green loan program are 25% discount on lending services, no late payment fees and zero prepayment penalties.

Similarly, the Amerindian Development Fund (ADP), financed through the GRIF facility was established to provide access to financing for economic, social and environmental development activities in indigenous communities. Approximately 180 communities located in Guyana's rural interior are eligible to access the fund to finance activities included in their respective community development plans. In addition to community and enterprise development financing, the ADP facilitates training in business development, climate resilient agriculture, apiculture, forestry, low carbon livestock farming and other skills. Once Community Development Plans are approved via majority or consensus vote during an official community general meeting, the Government and communities enter into a Micro Capital Grant Agreement. The fund aims that at least 180 Micro Capital Grant Agreements will be signed.

Development, research and technical programs

Table A37: List of programs and projects, closed and ongoing, based on its relevance to bioeconomy.

	Period	Funding	US$
Agricultural Export Diversification Program[738] The specific interventions were: (1) drafting guidelines for the diversification strategy for Guyana; (2) analyzing bottlenecks that constrain exports in these sectors; (3) preparing a sequenced and prioritized plan to address these bottlenecks and to improve the enabling environment for agribusiness, which will include clear roles for public and private sectors, and investment estimates for each intervention; and (4) conducting pre-feasibility studies for establishing facilities that will assist the country to meet international standards in its exports of fruits and vegetables, and meat products.	2007-2014	IDB, GoG	21,919,000
Sustainable Development Program[739] Increase productivity of the agricultural sector while maintaining a sustainable and climate resilient use of natural resources in Guyana. The specific objectives were: (1) produce high quality data for the agricultural sector; (2) increase productivity, especially for medium and small farmers; and (3) increase sanitary and phytosanitary (SPS) standards and access to meat processing facilities. Higher productivity will also contribute to reduce pressure on forest and fragile ecosystems, and at the same time, increase income for small and medium-sized farmers.	2016-2020	IDB, ASDU	15,000,000

738 https://www.iadb.org/en/project/GY-L1007.

739 https://www.iadb.org/en/news/news-releases/2016-11-16/guyana-invests-in-sustainable-agricultural-sector,11642.html; http://agriculture.gov.gy/2017/03/29/us-15-m-sustainable-agri-development-programme-launched-over-29000-households-set-to-benefit/

Promoting a Cluster Approach for Agricultural Diversification in Guyana[740] The purpose of the project was to facilitate the integration of contract farms into the cluster for non-traditional crops through the development and delivery of key agri-business support services and access to investment capital. The objective at the impact level is to sustainably increase the crop incomes of contract farms and to provide year-round employment in the cluster for non-traditional agricultural crop. The project improved the competitiveness of Guyana's small-scale farmers and promote their access to high value export markets. The project financed the implementation of a cluster farming model which will help small scale farmers to achieve scale and also provide key marketing and agronomic services.	2016-2020	IDB, ASDU	1,732,544
Forest Carbon Partnership Facility Project in Guyana[741] Undertake key activities identified in the Readiness Preparation Proposal (R-PP) that lays out a roadmap of preparation activities needed to be undertaken for Guyana to become REDD+ ready	2013 - 2020	IDB	3,800,000
Developing a Sustainable Tourism Circuit in South Rupununi Guyana[742] The objective of this Technical Cooperation is to formalize the South Rupununi Tourism circuit through technical assistance to develop and package market-ready products that meet the needs for cultural and environmental sustainability. The project involves local capacity building and marketing. The purpose is to foster inclusive and sustainable economic development in the region.	2020	IDB, Guyana Tourism Authority	333,244
Implementation of a Secured Transaction Regime and Green Business Framework in Guyana[743] The general objective is to improve access to credit and the enabling environment for green business development, trade and integration.	2017	IDB, Ministry of Business and Ministry of Legal Affairs (Commercial Registry)	500,000
Enhancing the National Quality Infrastructure for Economic Diversification and Trade Promotion[744] The program's objective is to support economic diversification and exports through the enhancement of the National Quality Infrastructure (NQI) and through a National Export and Investment Promotion Strategy. Specific objectives were: (1) to enhance the capacity of the NQI; (2) to improve facilities for the NQI; and (3) to enhance the capability of the Guyana Office for Investment for export and investment promotion.	2016	IDB	9,000,000

740 https://www.iadb.org/en/projects-search?country=GY&sector=AG&status=Implementation&query=

741 https://www.iadb.org/en/project/GY-T1097

742 https://www.iadb.org/en/project/GY-T1171; https://www.guyanastandard.com/2020/10/16/idb-grants-guyana-52-7m-to-develop-sustainable-tourism-circuit-in-south-rupununi/

743 https://www.iadb.org/en/project/GY-T1141

744 https://www.iadb.org/en/project/GY-L1059

Safe Lodges, Safe Guests, Safe Communities[745] To implement Health and Safety Protocols, Processes and Information Systems to facilitate re-opening of the ecotourism sector in Northern Rupununi	2020	IDB	521,050
Guyana Petroleum Resources Governance and Management Project[746] It supports the enhancement of legal and institutional frameworks and the strengthening of the capacity of key institutions to manage the oil and gas sector in Guyana. Its first component being enhancement of legal framework and stakeholder engagement. This component aims to support the update of Guyana's legal and regulatory frameworks for the governance and oversight of the O&G sector as well as support stakeholder engagement and transparency. The second component is the capacity building of key institutions. The third component is the enhancement of fiscal management. Finally, the fourth component is the project management.	2019-2024	WB (IDA), Department of Energy	20,000,000
Flood Risk Management[747] The objective is to reduce the risk of flooding in the low-lying areas of the East Demarara. (1) Priority works for flood risk reduction component includes: upgrading critical sections of the East Demerara Water Conservancy, or EDWC dams selected pursuant to the criteria set forth in the construction supervision and quality assurance plan; carrying out priority flood risk reduction investments in the East Coast Demerara drainage system selected pursuant to the criteria set forth in the construction supervision and quality assurance plan. (2) Institutional strengthening for flood risk reduction component will support flood modeling through the following activities: (i) hydraulic and hydrological modeling; (ii) specialized training in hydraulic and hydrological modelling, use of remote sensing tools, and data management; and (iii) information technology support for management of data. (3) Project management and implementation component will support reporting and auditing activities.	2014-2024	WB (IDA), ASDU	37,890,000
Cooperative Republic of Guyana: Setting the Foundation for Strategic Climate Change Interventions for the Agriculture Sector[748] - Generate an enabling environment for projects or programs that are calibrated to climate change, including through multi-stakeholder consultation and engagement process at national and subnational levels, improving knowledge on climate vulnerability of the agriculture sector, including livestock, agroforestry and aquaculture and promoting adaptation of good practices and innovative solutions - Develop a pipeline of costed evidence based feasible and fundable projects based on country priorities and agriculture sectoral climate risk assessments including coastal regions and savannah lands	2018-2020	GCF, FAO	697,183

745 https://www.iadb.org/en/project/GY-T1172

746 https://projects.worldbank.org/en/projects-operations/project-detail/P166730

747 https://projects.worldbank.org/en/projects-operations/project-detail/P147250; https://projects.worldbank.org/en/projects-operations/project-detail/P170025

748 https://climatechange.gov.gy/en/index.php/resources/documents/gcf-readiness-agriculture-sector/83-gcf-readiness-agriculture-summary/file

- Enable private sector engagement through public-private partnerships for responsible investments in climate resilient agriculture - Progress towards Guyana´s direct access accreditation aspiration for national agriculture agencies to become accredited and act as implementing/executing entities with the Green Climate Fund			
Climate Change Adaptation Program[749] The goal of the Program is to reduce risks to human and natural assets resulting from climate change vulnerability. The activity aims to strengthen an integrated system for the implementation and financing of sustainable adaptation approaches in the Eastern and Southern Caribbean region. There are three technical components of the CCAP: - Component 1: Promotes the use of climate data and information or use in decision-making - Component 2: Supports innovative adaption approaches which demonstrates proof of concept necessary to secure additional financing - Component 3: Fosters climate financing to support scale up and replication of sustainable adaptation initiatives	2016-2020	USAID, Caribbean Community Climate Change Centre	25,600,000

Enablers and barriers for bioeconomy development

- Guyana's agriculture suffers from the negative impacts of climate change. Extreme flooding and droughts – triggered by El Niño and rising sea levels – affect the coastal areas of Guyana and cause severe income loss among farmers[750]
- The projected strong growth of Guyana's GDP per capita is due to the emerging oil productive capacity, which may lead to an unbalanced economic transformation and the potential for unsustainable development. The soaring growth should be carefully governed in order to ensure adequate resources for sustainable medium and long-term development.[751]
- The coastal region can further be regarded as the economic and administrative hub of the Country (represents about 5% of the total area of the country but is also where approximately 90% of the country's population resides). It is where the main urban centers are located and where most of the economic activity takes place. The Agriculture sector for instance contributes 35% of Guyana's GDP; 40% of export earnings; 30% of the country's workforce and is important not only in terms of export earnings, but as a local food source for the population. Sugar and rice are the most important crops, accounting for some 74% of agriculture's GDP, as well as 65% of Guyana's total agriculture exports, including shrimp and timber. Thus, any external shock to this sector can significantly reduce these percentages, with cascading socioeconomic consequences.
- While Guyana has maintained relatively low rates of deforestation for more than two decades, growing economic pressures in logging, agriculture, and mining are creating concern for the country's continued trajectory toward sustainable development. Much of Guyana's forests are suitable for timber extraction, and the existence of large underground mineral deposits are increasingly attractive to the developing mining sector. Rising agricultural commodity prices are

749 https://climatechange.gov.gy/en/index.php/resources/documents/5-climate-change-adaptation-program-ccap-program-brief/file

750 FAO. 2020. Perspectives on diversification prospects for the agrifood industry in Guyana.

751 Idem.

also driving land use change that could lead to increased deforestation[752]. The average annual tree cover loss in Guyana during the Norway–Guyana REDD+ pre-implementation period (2001-2009) was 0.036%/y (6,787 ha/y) and increased to 0.056%/y (10,652 ha/y) during the program (2010-2015)[753].

- It has been identified several constraints for the forestry sector including deteriorating infrastructure, lack of business reinvestments, evolving unfavorable market conditions, and little apparent interest in generating value-added jobs in timber processing. These constraints are seen as having contributed to the diminishing importance of traditional forestry products over the past two decades.

Social, political, economic and environmental risks for and arising from the bioeconomy

From an investment point of view risks in Guyana can be summarized as follows[754]:

Macroeconomic risks: Guyana faces the challenge of maintaining adequate levels of public capital investment to promote growth while managing its debt. The largest potential source of risk is Guyana's vulnerability to commodity price shocks in the absence of fiscal buffers. In the advent of such a shock, the country could experience widening fiscal and external imbalances, which could potentially destabilize the macroeconomic framework over the medium term. Furthermore, as Guyana continues to grow richer, the amount of concessional resources at its disposal will decrease. De-risking also remains a major source of concern for the country's banks. Macroeconomic risks will be mitigated and monitored by close supervision of economic performance and policies to support corrective measures, as well as by assisting the Government in the strategic area of strengthening public sector institutions and governance.

Environmental risks: Guyana remains vulnerable to a wide range of natural hazards and is particularly vulnerable to the effects of climate change. According to sea-level rise estimates, Guyana is one of the most affected countries in the LAC region, with some scenarios anticipating as much as 60 miles of coastal loss by 2050, as a majority of its coastal plain is 2.5 meters below mean high tide sea level. So far, coastal protection along 200 kilometers where critical and residential infrastructure there located has relied mainly on engineered sea-defense, including sea walls, drainage and irrigation canals. However, most of this infrastructure is currently considered to be ill-equipped and no longer adequate to withstand current and future climate related impacts[755]. Such a result would threaten much of the country's present-day arable land. The agriculture sector, which generates one-fifth of Guyana's GDP and employs one-third of the country's economically activity population, is likely to be negatively affected through decreasing yields caused by greater drought-like conditions[756].

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752 https://www.climateinvestmentfunds.org/country/guyana.

753 Roopsind et al. Evidence that a national REDD+ program reduces tree cover loss and carbon emissions in a high forest cover, low deforestation country. PNAS: vol. 116, No. 49, 24492–24499.

754 IDB. 2017. IDB Group country strategy with the Cooperative Republic of Guyana 2017–2021.

755 Government of Guyana. 2017. Framework of the Guyana Green State Development Strategy and Financing Mechanisms.

756 IDB. 2017. IDB Group country strategy with the Cooperative Republic of Guyana 2017–2021.

Political risks: The Government has set forth for itself an ambitious program of improving the capacity of the State to deliver better public services and critical infrastructure. Such change management processes are difficult due to institutional inertia, vested interests, and insufficient human capital—given Guyana's extraordinarily high emigration rate of tertiary-educated nationals. Mitigating associated political and implementation risks will require extensive and widespread consultation with stakeholders, creating attractive jobs for young people as a part of this process, rapid deployment of legislative and regulatory reforms, utilization of technology to increase transparency, and commitment from the highest levels of government.

Portfolio execution risks: The lack of project management capacity, frequent changes to the structure of government agencies, and reassignment of key decision makers engaged in program execution may continue to delay implementation and undermine efforts to coordinate agencies and deliver timely results. Moreover, given the demand-based nature of the private sector opportunities that are influenced by market fluctuations, and the country's current productive capabilities, implementation of private sector operations may face several obstacles that could hinder external support to private sector development.

Appendix 8 – Peru Bioeconomy Context

Overview of policy, regulations and norms

Peru is committed to sustainable development and the conservation of its forests and biodiversity at the highest political level. However, as we will see in this section, the country has a complex policy and governance context, a challenge for the development of the bioeconomy.

The Political Constitution of Peru, in its Article 66, establishes that both renewable natural resources (forests, fisheries, etc.) and non-renewable resources (minerals, hydrocarbons, etc.) are patrimony of the Nation and that the State administers their use by individuals, communities and companies, through specific laws on the subject.[757] Article 67 confirms that the State determines national environmental policy and promotes the sustainable use of its natural resources, while Article 68 ratifies the obligation of States to promote the conservation of biological diversity and protected natural areas. Article 69 mentions that the State promotes sustainable development of the Peruvian Amazon through appropriate legislation.

In Article 88, the State confirms preferential support for agricultural development and guarantees the right to land ownership, whether private, communal or in any other form of association. In accordance with the legal provision, abandoned lands become the property of the State, to be placed on the market.

The key implication of the Constitution for the bioeconomy is that land and soil are preferentially destined for agricultural development through private ownership, and the crops and plantations that are planted on these lands are privately owned and subject to regulation by the Ministry of Agriculture and Irrigation. However, the forests and natural ecosystems that can be found on this same land, and the minerals and hydrocarbons that can be found in the subsoil, remain the property of the State and are subject to regulation and oversight by other sectors. Thus, an inevitable public-private and public-public tension and overlap arises in the management of Amazonian land and natural resources.

The Ministry of Agriculture and Irrigation

The Ministry of Agriculture (MINAG) was created in 1943 and is responsible for coordinating and implementing national agricultural policy. The Ministry was renamed the Ministry of Agriculture and Irrigation (MINAGRI) in 2013 to better reflect the growing importance of technified irrigation in the Peruvian agricultural sector. Law 26505 passed in 1995, often referred to as the Land Law, [758]and Law 27360 passed in 2000, often referred to as the Agricultural Promotion Law, [759]reiterate the Constitution's commitment to economic pluralism and the right of all persons to acquire and own land, including men and women, communities and legal persons, both national and foreign. Law 26505 has

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[757] The specific laws are framed by Law No. 26821 - Organic Law for the Sustainable Use of Natural Resources.

[758] Law 26505 - Law on private investment in the development of economic activities in the lands of the national territory and of the peasant and native communities.

[759] Law 27360 - Law that approves the Rules for the Promotion of the Agricultural Sector.

several articles in support of agribusiness.[760] These laws establish norms for the use and allocation of land located in the Amazon regions, and are implemented by MINAGRI. Through its various directorates, MINAGRI is also responsible for the competitiveness of the agricultural sector and implements various programs, such as AGROIDEAS and AGRORURAL, to support the value chains of key smallholder crops throughout the country, such as coffee and cocoa. At the same time, there are specific agricultural promotion policies for the growth of oil palm, coffee, cocoa and timber plantations. It is beyond the scope of this study to describe these specific policies in detail, but to summarize, we can state that the regulatory framework applicable to agricultural and forestry production does not explicitly prevent the development of new plantations in primary forest areas of the Amazon.

Natural and plantation forestry, as well as wildlife use, is regulated by the Forestry and Wildlife Law (Law 29763), passed in 2011, and its Regulations, approved in 2015. The Law establishes that public lands with forestry potential must be conserved in their natural state, as Permanent Production Forests. Conversion of these lands to agriculture is prohibited and states that such lands must be reforested if they have been previously deforested. The Law also states that ecologically or edaphically fragile lands that are not suitable for timber exploitation, with or without forest cover, must be classified as Permanent Protected Forests, and that these forests cannot be classified for uses that may lead to their conversion or alteration or the elimination of their soils. Law 29763 emphasizes the allocation of forest rights, provides clearer guidelines for forest management and develops an institutional framework for the sector that, if properly implemented, will allow for better control and administration of Peru's forest resources. [761]

The Ministry of Environment

The Ministry of Environment (MINAM) was created in 2008 as the administrative entity in charge of implementing the 2005 General Environmental Law.[762] The Vice-Ministry of Strategic Development of Natural Resources has a diverse mandate covering issues related to development planning, climate change, forests, desertification, natural capital and ecosystem services, and includes the National Forest Conservation Program for Climate Change Mitigation (Programa Nacional de Conservación de Bosques para la Mitigación del Cambio Climático, PNCB).

In 2014, Law 30215 (Law on Mechanisms of Remuneration for Ecosystem Services) was approved and, in 2016, its Regulations. This Law promotes, regulates and supervises incentive mechanisms for voluntary agreements that establish the conservation, recovery and sustainable use of ecosystems and associated services. Mechanisms for water regulation services by public entities and voluntary

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[760] For example, Title I, Article 2 specifically establishes that the legal security of rural properties is guaranteed and will be governed according to the norms and standards of the Civil Code, whether for national or foreign owners.

[761] Law 27653 establishes the National Forest System (SINAFOR) with the National Forestry and Wildlife Service (SERFOR) at the head, the National Forestry Council (CONAFOR) as the technical advisory body and the Forest and Wildlife Resources Oversight Agency (OSINFOR) as the supervisory body.

[762] Law No. 28611 - General Environmental Law in Peru.

mechanisms for forest climate regulation services linked to REDD+[763] so far are the most important examples of actions under these new policies.

In July 2016, the National Strategy on Forests and Climate Change (NBSCC) was approved. Its first objective is to reduce deforestation and forest degradation, while improving the resilience of forest landscapes and the people who depend on these ecosystems. Its strategy to reduce pressure on forests includes promoting competitive, climate-smart, deforestation-free agriculture; reducing illegal/informal activities; and combating the negative impacts of infrastructure expansion and extractive industries. The National Biodiversity Strategies and Action Plans (NBSAP), adopted by decree in 2014, seek to promote actions at different levels of the public sector to conserve forests and promote green growth in Peru's forest regions.

Attached to MINAM is SERNANP (Servicio Nacional de Áreas Naturales Protegidas por el Estado) which is responsible for administering the Sistema Nacional de Áreas Protegidas por el Estado (SINANPE), which includes more than 16 million hectares of forested land in the Amazon. Also attached to MINAM are the Environmental Evaluation and Supervision Agency (OEFA), the National Environmental Certification Service for Sustainable Investments (SENACE) and the National Meteorology and Hydrology Service of Peru (SENAMHI), semi-independent public organizations that play an important role in measuring, monitoring, inspecting and controlling environmental conditions and the use of natural resources.

It is important to note that the concept of bioeconomy still maintains various definitions, and in the case of Peru, this concept is not incorporated into the Peruvian institutional framework. However, the Peruvian regulations (Ministerial Resolution 046-2020-MINAM) use the denomination bionegocios as a recognized definition in our Peruvian institutional framework, which will contribute to the identification of the enterprises and companies that will be beneficiaries of the program. According to MINAM, the direct contribution of the business sector to the bioeconomy is through bio-businesses, which are based on the sustainable use of biodiversity, incorporating the three sustainability criteria: economic, social and environmental into their business model. Bio-businesses contribute to transform and add value to the production of economies rich in natural resources.

Ministry of Production and Ministry of Foreign Trade and Tourism

In the last decade, both the Ministry of Production (PRODUCE) and the Ministry of Foreign Trade and Tourism (MINCETUR) have become more active in promoting the competitiveness of the agricultural, aquaculture, forestry, and tourism value chains in the Amazon and in accessing foreign markets for Amazonian products. Specifically, Law 29337 (Law for the Promotion of Productive Competitiveness) focuses on the development, adaptation and improvement or transfer of technology (also considering

[763] REDD+: In Peru, Reducing Emissions from Deforestation and Degradation (REDD) is the set of actions, policies and interventions at the national and sub-national levels, established taking into consideration the vision of the different levels of government and actors of civil society and indigenous peoples, which facilitate the implementation, by both public and private actors, of the five eligible actions considered in the UNFCCC, to reduce Greenhouse Gases in the Land Use, Land Use Change and Forestry (LULUCF) sector. The effective implementation of the actions would allow access to financing mechanisms linked to payment by results.

the transfer of equipment, machinery, infrastructure, inputs and materials) to organized producers in rural areas, including the Amazon, where private investment is insufficient. At the same time, Law 28846 (Law for the Strengthening of Productive Chains and Clusters) has established programs focused on agricultural, aquaculture and forestry value chains that promise to be competitive in local and foreign markets, integrating the development of financing from the Development Finance Corporation (COFIDE)[764] and loans from Agrobanco to finance the development and implementation of business plans, as well as technical assistance for promising economic activities.

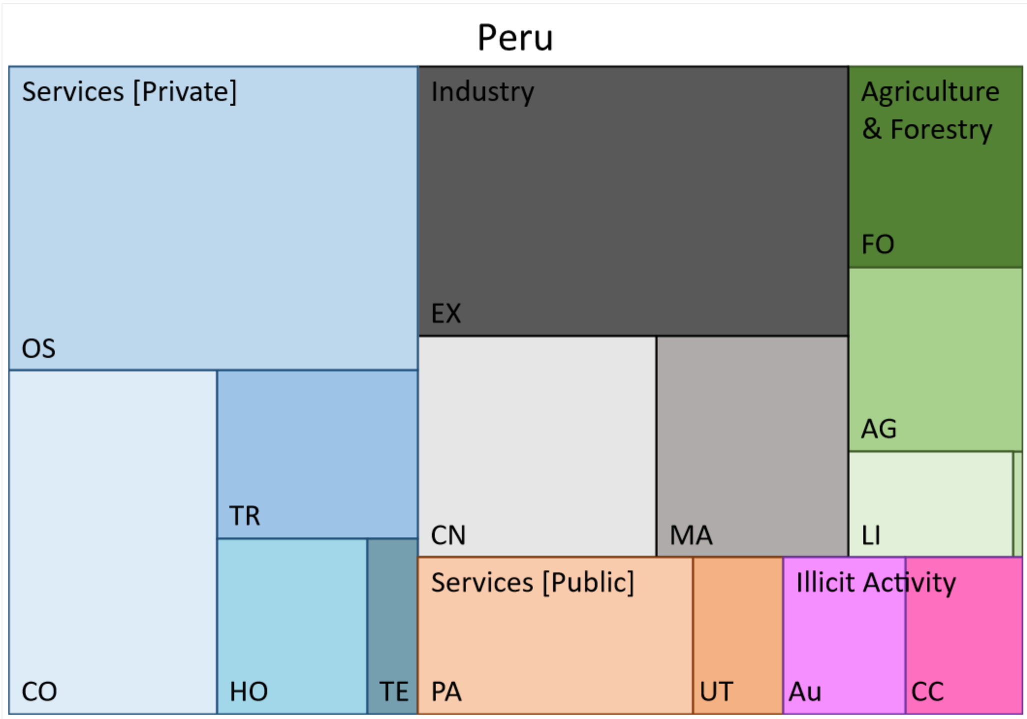
GDP, income and productivity

Between 2000 and 2014, the average GDP growth rate was 6.1%. However, in the last five years the growth rate has slowed down, partly due to a less favorable international context for the main commodities that Peru produces, and a reduction in the level of investments in the country. In 2019, the Peruvian GDP grew 2.2%, a rate well below the 4.0% of 2018, partly due to the contraction of the primary sectors, influenced by supply shocks to fishing and mining. Likewise, non-primary activities were affected by the lower dynamism of domestic demand, both from the private sector and the public sector. The impact of lower terms of trade on income and the moderation of formal employment growth had a negative impact on private consumption and investment. Public investment contracted in a context of a change in subnational government authorities. Relative contribution of sectors and subsectors to GDP from the Amazon jurisdiction is shown in Figure A115.

This economic performance was partly driven by a slowdown in global GDP growth, high uncertainty in international financial markets and a decline in the terms of trade. The trade war between the United States and China affected the evolution of global trade, agents' confidence and growth prospects. As a result, the expansion of the world economy at 2.9% was the lowest in 10 years. The lower international prices of base metals affected our terms of trade, which accumulated two years of reduction. In this context, the central banks of the main developed economies and several emerging economies maintained an expansive monetary policy, which was reflected in low international interest rates.

[764] COFIDE has received institutional capacity support from the GCF preparedness resources and the IDB, to i) assess the fiduciary standards required to channel resources from multilateral banks, development banks and climate funds such as Clean Technology Fund (CTF) and the Green Climate Fund (GCF), ii) evaluation of COFIDE´s institutional capacities of compliance with the GCF environmental and social safeguards, and gender and diversity requirements. COFIDE currently is addressing the findings through an external consultancy through the GCF Readiness resources. Since 2020, IDB has been providing technical assistance in the framework of project PE-T1430 to strengthen the internal process and the area of environmental and social risk analysis which enhances the process of preparing credit operations. Furthermore, COFIDE has been supported by the IDB in the design and implementation of a technological tool for the registration, selection, verification, monitoring and reporting of operations with international sources, which allows monitoring the impact of the programs in terms of climatic and social impacts.

Figure A115: The relative contribution of sectors and subsectors to the GDP of the Amazonian jurisdictions of Peru



Note: Agriculture and Forestry: Agriculture (AG), Fisheries and Aquaculture (FI), Forestry (FO), Livestock (LI); Industry: Extractives (EX), Manufacturing (MA), Construction (CN); Services (Private Sector): Real Estate (RE), Commerce (CO), Transportation (TR), Hospitality (HO), Telecommunications (TE), Finance (FI), Professional Services (PS), Other services (OS); Services (Public sector): Public Administration (PA), Utilities (UT); Illicit Activities: Coca/Cocaine (CC), Artisanal Gold (Au).
Source: Instituto Nacional de Estadística e Informática –INEI, https://www.inei.gob.pe/estadisticas/indice-tematico/producto-bruto-interno-por-departamentos-9089

It is important to note that since the beginning of 2020, markets and global activity have been severely affected by the effects of COVID-19. In Peru, the national emergency measures to face it have had a significant negative impact on economic activity, mainly due to the mandatory social immobilization, which implies the suspension or reduction of work in most economic sectors. In this context, the Central Reserve Bank of Perú (BCRP for its acronym in Spanish) has taken measures to reduce the cost of financing and avoid the suspension of the chain of payments, such as the reduction of the reference interest rate by 200 basis points to 0.25%, a historical minimum level[765]; the provision of liquidity to the financial system through the extension of the term of reporting operations and the relaxation of reserve requirements. In addition, a loan program of up to Soles (S/.) 30 billion with government guarantees to support the financing of working capital. To this end, the BCRP will provide liquidity for these operations through portfolio repo auctions.

[765] In 2019, the BCRP had already reduced the benchmark interest rate by 25 basis points on two occasions, in August and November, from 2.75 to 2.25%, thus maintaining an expansionary stance. This position was reflected in the evolution of the real reference interest rate, which was below the estimated neutral real interest rate of 1.50% throughout the year.

Savings and credit levels

In 2019, the fiscal deficit decreased for the second consecutive year from 2.3% of GDP in 2018 to 1.6%. The lower deficit mainly reflected the increase in general government current revenues by 0.5% of GDP. Public debt at the end of 2019 represented 26.8% of GDP, higher by 1 percentage point than at the end of 2018, due to higher long-term domestic debt resulting from the debt management operations carried out in June and November 2019. Inflation and its expectations remained within the target range of 1 to 3% throughout 2019, in a context in which economic activity continued to be located below its potential level, as well as high uncertainty in international financial markets due to the intensification of the trade war between the United States and China.

The moderation of domestic demand and the evolution of the international context contributed to the credit growth rate falling from 8.7% in 2018 to 6.9% in 2019, mainly due to the development of the segment aimed at companies, particularly corporate and large companies. Credit to households also showed a slowdown explained by the reduction in consumption. Averaged across segments, credit destined to companies moderated its growth from 7.0% in 2018 to 4.2% in 2019. This was a product of lower credit expansion in the corporate and large company segment, where the deceleration was from 9.1% in 2018 to 4.4% in 2019. There was also a deceleration in credit destined to medium-sized companies from 3.8% in 2018 to 0.5% in 2019. On the other hand, credit destined to small and micro companies accelerated its growth from 5.9% in 2018 to 7.7% in 2019.

Furthermore, financial services in the Amazon region in Peru illustrate an increase in the operations of regulated banking and non-banking entities, savings and credit cooperatives and social financial entities in recent years. However, the credit granted by the Commercial Bank (Banca Múltiple), the Rural Savings and Loans, the Municipal Savings and Loans, and the Finance Banks in these five departments only represents 2.22% of the national total, as of December 2020 (Source: Superintendencia de Banca, Seguros - SBS). In particular, rural Savings Banks and Municipal Savings Banks only represent 33% of the total in the Amazon region, with Commercial Banks being the one with the highest participation with 62%. Regarding the size of the beneficiary companies, although the credit in force as of December 2020 in the Amazon region of Peru is concentrated in micro, small and medium-sized companies, which is due to the composition of the business fabric in the region, the products Existing financial institutions are not aimed at undertakings or projects and investments in early development phases, by practically none of the segments of financial entities present in the region, among other reasons, due to the lack of credit history of the businesses in the initial phase and due to the absence of guarantees or collaterals to back up the credits. Additionally, the financial products offered by these entities do not always address the particularities of investments, especially those related to agribusiness, in terms of terms and amortization of capital, since they do not take into account the seasonality of productive activities.
The program will support financial entities not only in the identification of new financing opportunities in the value chains associated with bio-businesses, but also in the incorporation of new financial products with added value to their portfolio, such as associative credit or reverse factoring. Additionally, to increase access to credit and make financial conditions more flexible, the program will also allow financial institutions to access risk coverage and transfer mechanisms so that they can increase the penetration of credit in the region, particularly in activities related to bioeconomy.

It is important to mention that micro and small companies suffer from low professionalization and financial education with the consequent weak structuring and justification of their loan applications, which makes it difficult for the financial sector to approve more loans. A program to attend this sector, shall also seek to support bio-entrepreneurs in project formulation (Source: SBS, December 2020, own construction).

Interest rates

In line with the reduction of the BCRP reference rate of 50 basis points during 2019, the interbank interest rate presented a decrease from 2.79% in December 2018 to 2.25% in December 2019. In the case of interest rates by credit segment, all of them present lower levels compared to 2018, and even three sectors were at their historical minimum levels since September 2010, among which mortgage credit stands out. It is important to highlight that the average interest rate for loans to large companies stood at 6.0%, for medium-sized companies at 9.3%, for small companies at 18.0% and for micro-enterprises at 31.3%.

In 2019, before the COVID-19 shock, the financial sector's high-risk portfolio increased from 4.4% to 4.5% of the total portfolio. The higher delinquency recorded in 2019 came mainly from medium-sized companies (the overdue portfolio ratio of these companies increased from 7.4% to 8.0%). The deterioration observed in the medium-sized companies segment was due to arrears from companies operating in the construction and real estate sectors, as well as in the transportation and agriculture sectors. The level of arrears was also high for small businesses at 8.2%, but this was down from 8.8% in 2018. With respect to non-banks, the increase in the overdue portfolio in municipal and rural savings banks (6.9% and 7.8% respectively) was concentrated in a group of entities that operated with a poor credit model in previous years, but are currently implementing corrective measures in their credit policies.

Special Amazon tax regime

The Law for the Promotion of Investment in Amazonia 27037 establishes a special tax regime for the five Amazonian departments and for 48 additional districts of neighboring departments. The benefits in such law include: i) exemption from the General Sales Tax (IGV), ii) exemption from IGV on imports destined to the Amazon, iii) reduced Income Tax (IR) rates fluctuating between 0% and 10% depending on the type of legal entity, iv) exemption from the Selective Consumption Tax (ISC), and v) special tax credit. The Finance and Economy Ministry (MEF for its acronym in Spanish) estimates that for 2019 the tax benefits for the Amazon will amount to S/. 3,121 million. The government is currently implementing a program of gradual substitution of tax benefits in the Amazon. This is based on an evaluation by the MEF of the Amazon Law and the special tax regime[766]. This analysis determined that there is no evidence that these tax benefits have been either effective or efficient for the development of the Amazon. The tax benefits promote a mercantile extractive development model that undermines local production and transformation initiatives by subsidizing product imports and limiting employment to routine activities. In addition, evaluations indicate that the prices of products with benefits are equal or higher compared to the rest of the country. The exoneration of IGV on imports

[766] MEF, 2019. Substitution of tax benefits in the Amazon. April 2019, Lima, Peru.

creates a differentiated treatment for Peruvian products with respect to foreign products, generating smuggling and favoring the development of illegal activities. A highly complex system has been created, which increases compliance costs for taxpayers and makes it more difficult for the tax administration to administer and control the benefits. In 2005, the San Martin region waived the tax benefits of special tax credit and tax reimbursement and created a trust fund in COFIDE in its favor, to which it transfers approximately S/. 50 million per year for investments. From 2006 to date, approximately S/. 700 million have been financed with these funds for some 100 public works.

Social and environmental context

The Amazon region in Peru has an area of approximately 770,000 km^2 covering nearly 62% of Peru or 11.3% of the Amazon Biome. Peru´s Amazon region is located within the following departments: Loreto, Amazonas, Ucayali, San Martin, Huánuco, Pasco, Junin and Cusco. The ecosystems found in this region are divided in two main groups: lowland jungle (selva baja) and highland jungle (selva alta) (Figure A116).

Between 2001 and 2018, gross anthropogenic deforestation in the Peruvian Amazon caused a total forest loss of 2,318,318 hectares (128,795 hectares/year), resulting in approximately 1,038 million tons of Greenhouse Gas emissions. In the absence of more effective policies to halt the current trend, approximately 3 million additional hectares of deforestation are predicted by 2030[767].

In Peru, deforestation and forest degradation are responsible for the loss of natural capital and the goods and services it provides to society, causing more than 50% of national greenhouse gas emissions, which contributes significantly to climate change. As of 2018, over 8.4 million hectares of the Peruvian Amazon had been deforested by human activity, as can be seen in Figure A117. This could be an underestimate, as current remote sensing technologies used by the Peruvian government to measure deforestation do not distinguish well between secondary forests on deforested land and primary forests.

Figure A116: Land cover in the Peruvian Amazon

[767] MINAM, 2016. Reference Level of Forest Emissions (NREF) to reduce emissions from deforestation in the Peruvian Amazon.

Figure A117: Deforestation in the Peruvian Amazon

Deforestation Patterns in the Peruvian Amazon

Land cover classes

- Forest
- Floodplain forest and wetlands
- Non forest vegetation and savanna
- No vegetation
- Lakes and rivers
- Glacier
- Amazon Study Area

Deforestation periods

- Deforestation before 2000
- 2001 - 2010
- 2011 - 2020

Deforestation period	Total year	Deforestation period	Total year
2001	129,571	2010	128,353
2002	127,479	2011	117,179
2003	137,048	2012	137,453
2004	117,122	2013	139,116
2005	146,173	2014	118,693
2006	119,951	2015	118,582
2007	133,564	2016	119,773
2008	118,750	2017	138,442
2009	137,755	2018	133,314
	Total	2,318,318	

Sources:
Land cover classes: RAISG, 2020
Deforestation: RAISG, 2020
Amazon Study Area: RAISG, 2020

Geographic Projection
Datum: WGS84 Scale: 1:5,800,000

0 50 100 200 300 Km

Land tenure

Tenure transparency and recognition of formal and customary forest rights are a key precondition for reducing deforestation and biodiversity loss. Uncertainty in land tenure is still widespread in the Peruvian Amazon. According to data from the National Agricultural Census (CENAGRO, 2012), in the Amazon region 28% of farmers have land titles duly registered with the National Superintendence of Public Registries (SUNARP). Of the remaining 72% of farmers, 5% have a title deed, but it is not registered in the public registry; 11% have no title deed, but have a pending registration process at SUNARP; and more than half (57%) have no title deed or registration process. The agricultural, forestry and environmental regulatory framework, and even the new forestry law, cannot address the problem of deforestation in its real dimension, since the possession of a title or other real right over the land is a precondition for several of the processes.

The NBSAP and Peru's Forest Investment Program present a comprehensive analysis of deforestation across the Amazon according to land-use category and tenure. To facilitate decision-making, land has been grouped into four categories, in line with Peru's agricultural, forestry and environmental laws and policies:

Individual and communal lands: this category includes lands granted to individuals, native and riparian communities, and peasant communities. It includes land under agricultural title and, in the case of communities, also land under cession in use. Custody of the resources is divided between the landowners and the regional authorities, MINAGRI and SERFOR.

State forest production lands: includes Permanent Production Forests in which timber, NTFP, tourism, conservation and reforestation concessions, or cessions of use (CU) are granted to individuals, companies or communities. Ownership of the land and forests remains with the State, and custody of the resources remains with the regional authorities, SERFOR and the concessionaire or user.

State Protected Lands: includes national and regional Natural Protected Areas declared by the State (with SERNANP as the national authority and the regional governments as the regional authority), Territorial Reserves and Indigenous Reserves under the custody of the Ministry of Culture (MINCUL) and Protected Forests (under the custody of SERFOR). The ownership of the land and forests remains with the State, as well as the responsibility for their custody.

4. Land to be categorized by the State: includes from remote forest lands planned for protection, to heavily settled agricultural mosaic lands, which have not yet been formalized or titled. Often, the overlapping of several land use claims or land uses that contradict the land use capability classification (CT-CUM) prevents clarifying and granting rights over these lands. Responsibility for their custody rests with the Regional Governments and SERFOR.

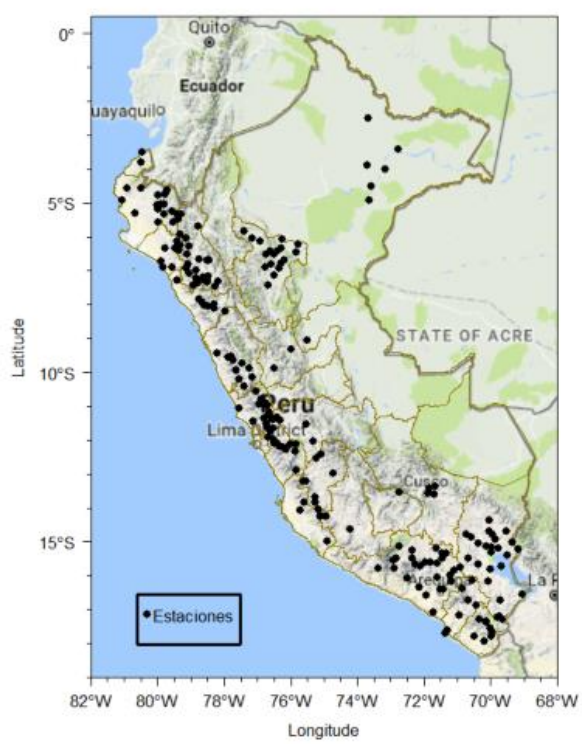
Climate profile

Data limitations

The report provides information at the national level, and where possible tries to focus on the Amazon region – the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[768] Nonetheless, it is important to note information on climate risk and vulnerability varies per region in Peru, and remains an area where substantial additional research is needed. In particular, climate risk and vulnerability studies are limited in Peru´s Amazon region, where most studies focus on the national level, or in more densely populated regions in the country (along the coast). Majority of climate-related studies in the Amazon focus primarily on deforestation, forest degradation and REDD+.
There are various barriers associated with climate monitoring in Peru:[769]

- The National Service for Meteorology and Hydrology (SENAMHI) manages 781 stations, and 388 others are independently managed, which limits data accessibility and the use of climate information.
- The geographic distribution of stations is concentrated towards the coast and the highlands, whereas the Amazon region has low coverage (see figure below). This limits the measurement of conditions and trends, and makes predictions and projections more difficult for the Amazon region. In addition, majority of stations often only measure rainfall and do not consider other variables.

Figure A118: Distribution of stations with data for the period 1981-2010.



768 see list of references

769 UNDP 2013

Source: SENAMHI-data base, n.d.

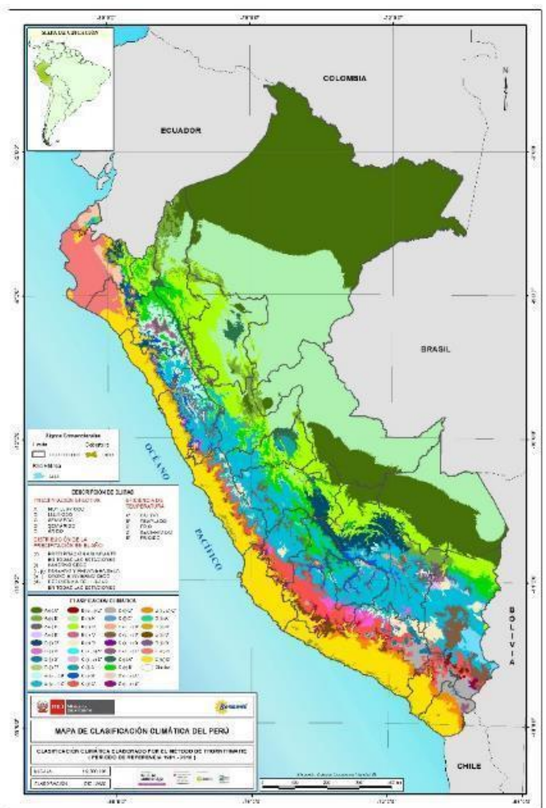
Overall climatology

Peru possesses a complex geography, the elevations of the Andes Mountains and the currents of the Pacific determine the conformation of diverse climates and landscapes that are reflected along the desert coast, the highlands or the tropical jungle of the Amazon basin.[770] According to Thornthwaite's classification, Peru has 27 of the 32 types of climate existing on the planet.[771]

Peru is located between the equator and the Tropic of Capricorn and should therefore have a tropical climate; however, several factors, such as the Peruvian or Humboldt Current, the Andes mountain range, and the inter-annual dynamics of ENSO (El Niño-Southern Oscillation) generate a heterogeneous climate.[772]

In the amazon region, climates vary from rainy temperate climate in the eastern slopes of the Andes, to warm climate with abundant precipitation in the northern and southern parts, and warm with abundant precipitation in the central part of the region (see Figure below).[773]

Figure A119: Climate Classification Map of Peru (2020)



Source: SENAMHI 2020, p. 3

770 SENAMHI 2009

771 SENAMHI 2009

772 MINAM 2016

773 SENAMHI 2020

El Niño is an unpredictably cyclical (three to eight years) climatic phenomenon consisting of a change in the patterns of movement of ocean currents in the intertropical zone, resulting in a superimposition of warm waters from the northern hemisphere immediately north of the equator on the very cold upwelling waters that characterize the Humboldt Current.[774] This situation causes damage on a zonal scale due to intense rainfall in the coast, mainly affecting South America. The magnitude of this warming ranges from approximately 2.0°C to 12°C above normal sea surface temperature. In this period the Andean and Amazon regions present, on the contrary, colder and drier weather.

La Niña events, on the other hand, occur between El Niño events. La Niña phases often lead to the opposite conditions, especially in terms of temperatures cold deviations and droughts in the coast, whereas the Andes and Amazon region present increased rainfall and warmer weather. Droughts can also be brought about by anti-cyclonic movements over the western Pacific and by abnormally warm temperatures in the Atlantic Ocean in the case of the Amazon basin.[775]

Temperature

The coast is dominated by a Semi-Warm Very Dry climate (desert-arid-subtropical) with an average annual temperature of 18° to 19 °C (see Figure below). The central and southern coast has a climate strongly influenced by the Humboldt Current with an average annual temperature of 18.2 °C, with summer highs of 26 °C and winter lows of 13 °C and little rainfall. However, the north coast differs in that it has a semi-tropical climate with an average annual temperature of 24 °C.[776]

The highlands have a varied climate, determined by the altitudinal changes introduced by the Andean mountain range. In the intermediate levels of the mountain range, where the main inter-Andean valleys are located (between 2 500 and 3 500 m.a.s.l.), the average annual temperature varies between 11 °C and 16 °C .[777] The transition zone between the Andes and the Amazon has average annual temperatures between 22 °C and 26 °C. The lowland jungle has an average annual temperature of 31 °C with few thermal variations during the year, whereas the highland jungle area concentrates high humidity with rainfall, with an average temperature of 25 °C.[778]

[774] SENAMHI 2009

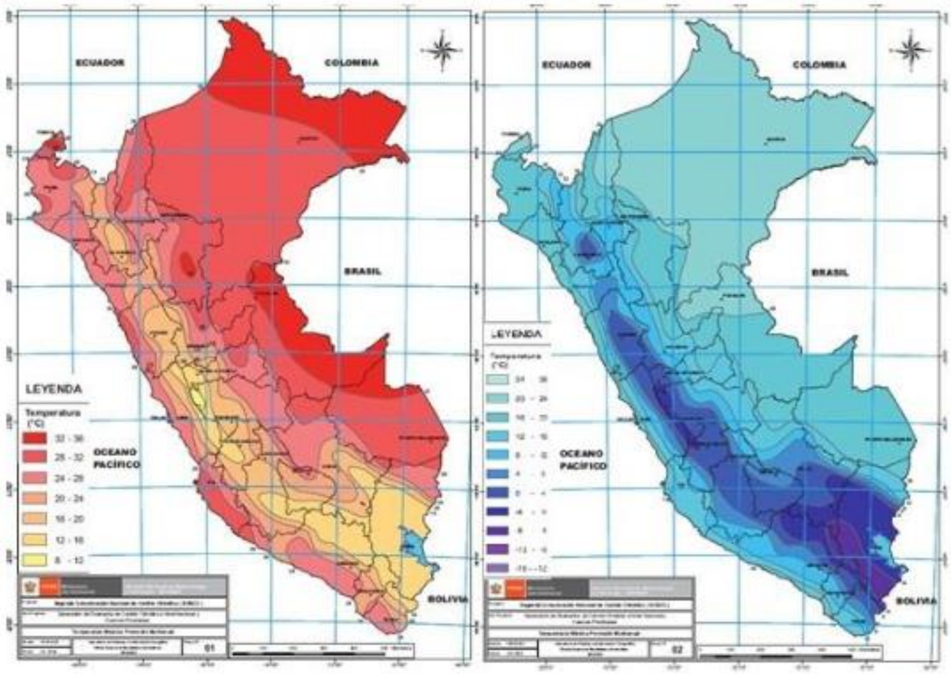
[775] UNDP 2013; Foley et. al 2002

[776] SENAMHI 2009; MINIAM 2016

[777] SENAMHI 2009, MINIAM 2016

[778] SENAMHI 2009; MINIAM 2016

Figure A120: Annual average maximum and minimum temperatures



Source: SENAMHI 2009, p. 18-19

Precipitation

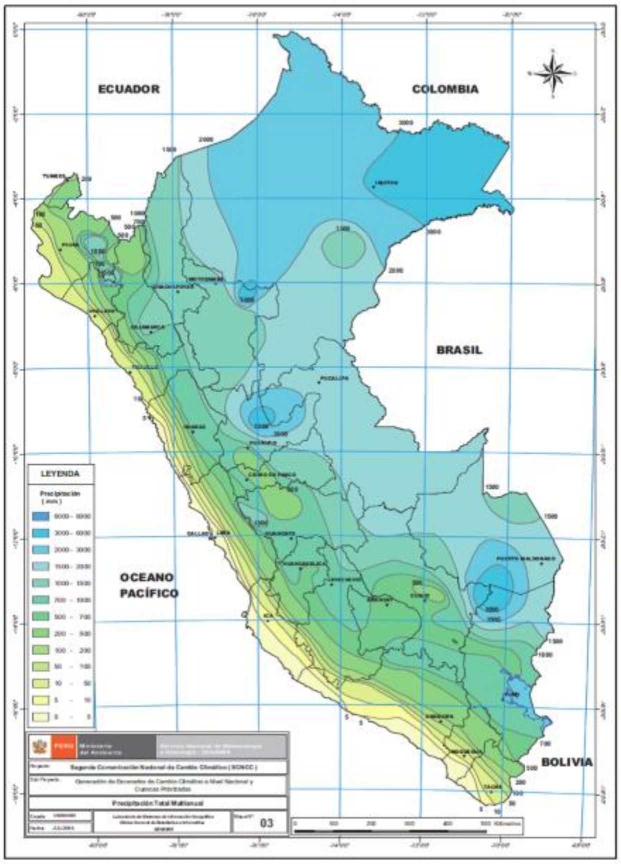
As far as rainfall is concerned (see Figure below), there is limited rainfall on the central and southern coast, moderate rainfall in the highlands and very heavy rainfall in the northern and southern Amazon region. Multi-annual average rainfall varies between 1 to 50 mm on the coast, with the exception of the northern region, which has between 50 to 200 mm. In the Andean region annual precipitation is within the range of 50 to 1,000mm. The Amazon region experiences between 1,000 to 3,000 mm of precipitation per year, with the northern Amazon receiving more precipitation than the southern amazon region.[779]

Multiple-quarterly precipitation for the months December-February and March-May are the rainiest periods at national level. The period March-May show accumulated rainfalls that significantly diminish in all the territory in relation to the previous quarter, except for the northern Amazon region, where precipitations do not vary. The driest period corresponds to the June-August quarter, where the accumulated rainfall for the coast is lower than 5 mm; in the mountain region it reaches 100 mm and in the Amazon region 900 mm. Between September and November, rainfall slightly increases in the Andean and Amazon region with respect to the previous quarter.[780]

[779] SENAMHI 2009

[780] SENAMHI 2009

Figure A121: Annual average rainfall



Source: SENAMHI 2009, p. 20

Climate-related natural hazards

The following shows an overview of climate-related natural hazards risk in Peru, where river flood, landslides, wildfires and water scarcity present high risks. In addition, frost is a climate-related natural hazard with great impact in the agricultural sector in the Andean region of Peru, particularly in the southern half of the country, waves of dry and cold polar winds or so called "friaje" blow from west to east during the winter months, particularly in July, causing temperatures to drop to 15°C in the Peruvian Amazon, and cooling the southern mountain slopes. While such cold waves occur every year, high-intensity events only occur every four to six years.[781]

Table A38. Overview of climate-related natural hazards risk in Peru (nation-wide), and within Provinces of the Peruvian Amazon Region

	River flood	Landslide	Extreme heat	Wildfire	Water scarcity	Cyclone
National						
Peru	High	High	Medium	High	High	Very Low
Provincial level (for provinces located in the Amazon region)						
Loreto	High	Low	Medium	High	Very Low	Very Low
Amazonas	High	High	Medium	High	Very Low	n.a
Ucayali	High	Medium	Medium	High	Very Low	n.a

[781] UNDP 2013

San Martín	High	High	Medium	High	Very Low	n.a
Madre de Dios	High	Medium	Medium	High	Very Low	n.a
Huánuco	High	High	Medium	High	Low	n.a
Pasco	Low	High	Medium	High	Low	n.a
Junín	High	High	Medium	High	Low	n.a
Cusco	Medium	High	Medium	High	Very Low	n.a

Source: GFDRR No date, https://thinkhazard.org/

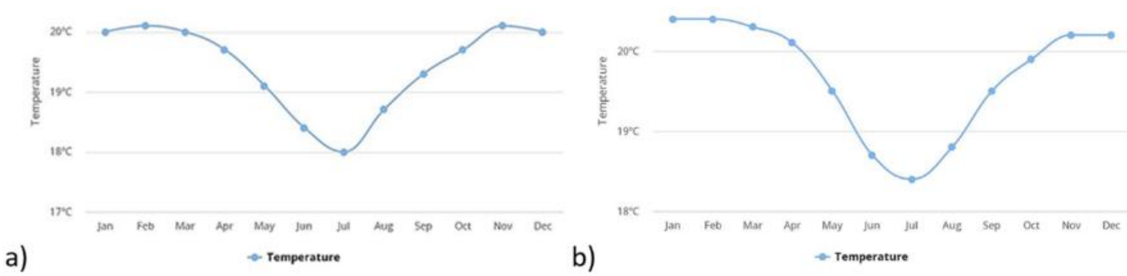
Focusing on the Amazon region of Peru, there is an overall high risk of wildfires, river floods and landslides, medium risk of extreme heat in most departments.

Observed trends of climatic variables

Temperature and precipitation

Climate data shows that the historical annual temperature trend became 0.5°C warmer, when comparing the period 1961-1990 with the period 1991-2020 (see Figure below).

Figure A122: Average monthly temperature (°C) of Peru for the periods a) 1961-1990, and b) 1991-2020



Source: World Bank Climate Portal n.d.

Along the Coast and Northern Andean region there was an observed increase in average temperatures by 1˚C, decreased number of cold days and nights, and increased number of warm days and nights[782, 783]. In the Peruvian Amazon an increase in temperature of 0.09 ˚C per decade has been observed since 1965. There has further been a decrease in precipitation since 1970[784] with a significant increase in the length of the dry season since 1980.[785]

Historically, at the country level, the precipitation trend in Peru hasn't changed. For the periods 1961-1990 and 1991-2020, the months that recorded rainfall above 150mm were December to March; while the months with the lowest recorded precipitation values are June to September (see Figure below).

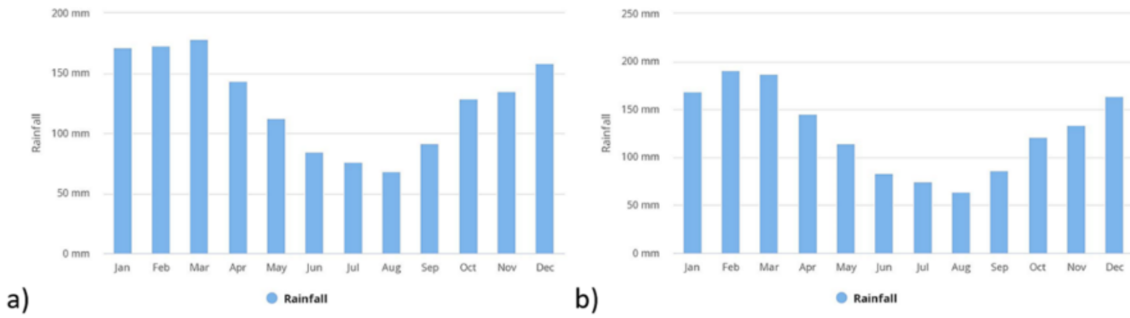
Figure A123: Annual precipitation (mm) of Peru for the periods a) 1961-1990, and b) 1991-2020

[782] Ministerio del Ambiente 2016

[783] USAID 2017

[784] Espinoza et al. 2009

[785] Fu et al. 2013



Source: World Bank Climate Portal n.d.

Precipitation in the Coast and Northern Andean region experienced increased precipitation, coupled with an increased intensity and frequency of rainfall events.[786] Deforestation is linked with increased intensity of the dry season in Peru, referred to as the drought-deforestation feedback loop[787] (see the Amazon profile for a more detailed description).[788]

<u>*Climate-related natural hazards*</u>

The following two figures show time scales of natural hazards. When focusing on the period from 1985-2018, the most recurrent climate-related natural hazards were floods and extreme temperatures. The frequency of dry spells and droughts has increased since the 1960s.[789] Furthermore, intense rainstorms, floods mudflows and forest fires have doubled have increased by 60% since 1970.[790]

In the INDC, the Peruvian Government notes that around 72% which of national emergencies are related climate-related hazards, especially extreme drought and rain, floods, and frost, among others.[791] In Peru, climate-related emergencies due to natural hazards have increased 25% between 2003 and 2014, while non-climate emergencies have registered a stable trend according to the National Institute of Civil Defense.[792]

786 USAID 2017

787 Reduced evapotranspiration, that reduces rainfall recycling, creating a negative feedback loop and a general trend towards increasingly dry conditions during the dry season.

788 Staal et al. 2020

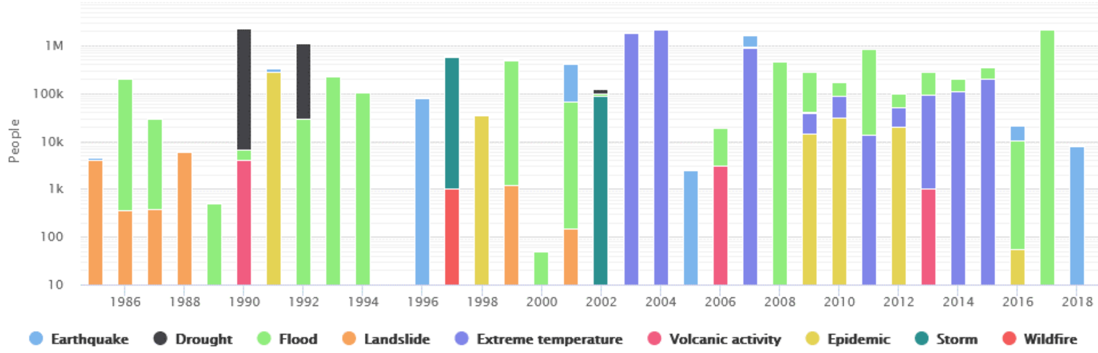
789 USAID 2017

790 USAID 2011; USAID 2017; MINIAM 2016

791 Republic of Peru 2015

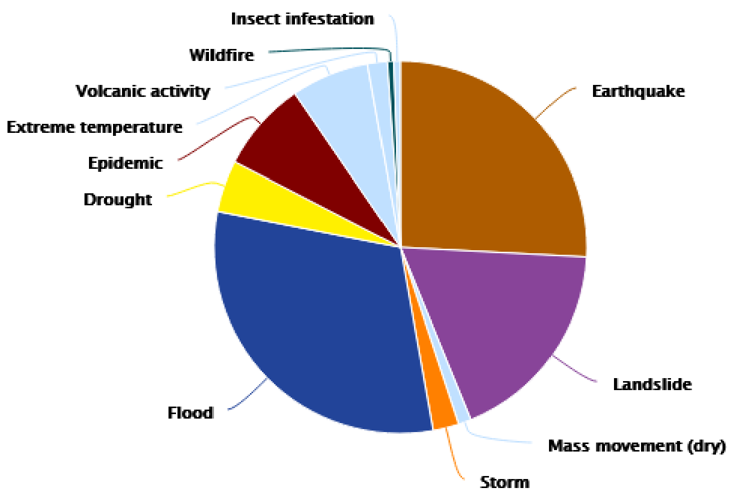
792 MINIAM 2016

Figure A124: Key Natural Hazard Statistics for 1985-2018 by number of people affected.



Source: World Bank, 2021

Figure A125: Average Annual Natural Hazard Occurrence for 1900-2018



Source: World Bank, 2021

Climate change projections

The climate change projection data shown below uses the CMIP5 ensemble models from the World Bank Climate Change Knowledge Portal[793] to display climate change projections under RCP4.5 and RCP8.5. SENAMHI calculated for the third national communication on climate change the RCP 4.5 and RCP 8.5 emission scenarios using different climate models.[794]

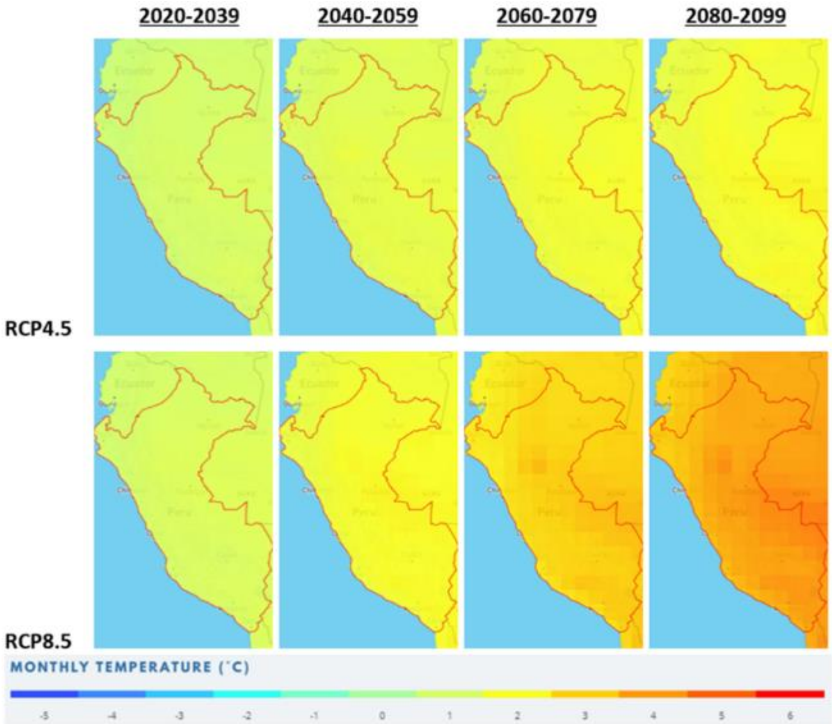
Temperature

According with CMIP5 ensemble models, temperature in Peru is likely to increase compared to the baseline period 1986-2005; particularly in the region near the frontier with Bolivia and Brazil -the Departments of Ucayali, Madre de Dios and Puno (see Figure below).

793 World Bank, n.d.

794 MINIAM 2016

Figure A126: Change in monthly temperature of Peru based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005



Source: World Bank Climate Change Portal n.d.

RCP4.5 projections indicate that the mean annual temperature will increase by 1.01°C in 2020-2039, 1.45°C in 2040-2059, 1.82°C in 2060-2079, and 1.96°C for the period 2080-2099. In comparison, under RCP8.5, the mean annual temperature at country level in Peru will increase by 1.15°C for 2020-2039, 1.88°C for 2040-2059, 2.99°C for 2060-2079, and by 3.98°C for the period 2080-2099.
The following table contains a summary of projected changes of temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A39: Projected changes of temperature-related climate variables in Peru (at the national level), compared to 1986-2005

Variable	***RCP 2.6***				***RCP 4.5***				***RCP 8.5***			
	2020-39	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***
Maximum daily temperature (°C)	1.39	1.73	1.82	1.73	1.16	1.81	2.30	2.51	1.49	2.56	3.87	5.47
Minimum daily temperature (°C)	0.95	1.25	1.22	1.21	1.03	1.73	2.22	2.35	1.32	2.36	3.72	5.09
Hot days (above 35°C)	13.95	19.04	20.17	19.51	11.90	21.16	29.75	33.93	15.70	33.45	60.15	94.38

Hot days (above 40°C)	0.67	0.99	1.31	1.11	0.27	0.97	1.70	2.06	0.73	2.58	6.92	21.29

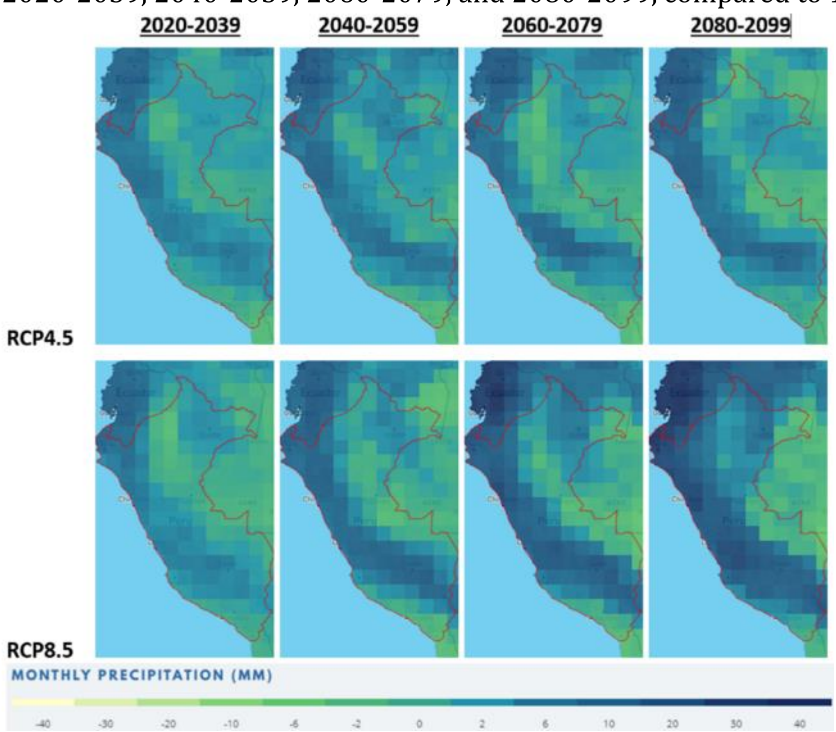
Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

Projections of mean annual rainfall from different RCP models project a wide range of changes in precipitation for Peru. Projections of mean annual rainfall based on RCP4.5 show a positive change of 2.60mm for the period 2020-2039. A positive projected change in monthly precipitation is expected for the periods 2040-2059, 2060-2079, and 2080-2099 with values of 2.87mm, 2.67mm, and 3.43mm, respectively (see Figure below).

According with both climate change scenarios, RCP4.5 and RCP8.5, the regions that will expect the above-mentioned projected changes in precipitation include the Costal, Andean, and the northern part of the Peruvian Amazon -corresponding to the Department of Loreto.

Figure A127: Change in monthly precipitation of Peru based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099, compared to 1986-2005



Source: World Bank Climate Change Portal n.d.

In general, rainfall is expected to increase along the coast. Projected changes in rainfall in the Andean highlands and Amazon vary, with some models suggesting increases and others decreases.[795] According with MINAG (2012), rainfall would increase by 10% in the Amazon region, with the exception of San Martín and Huánuco where rainfall is expected to decrease by 10%.

[795] World Bank 2021

The following table contains a summary of projected changes of precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A40: Projected changes of precipitation-related climate variables in Peru (at the national level), compared to 1986-2005

Variable	*RCP 2.6*				*RCP 4.5*				*RCP 8.5*			
	2020-39	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*	*2020-39*	*2040-59*	*2060-79*	*2080-99*
Days with rainfall >20mm	0.61	0.49	0.63	0.68	1.31	1.64	2.00	2.49	1.21	2.39	3.80	5.29
Rainfall of very wet days (%)	4.17	7.11	3.41	5.48	12.02	15.29	18.78	21.99	14.57	22.33	35.83	50.58
Maximum daily rainfall (10 year RL) (mm)	2.91	3.99	3.91	3.12	2.15	3.67	4.69	5.35	3.07	5.37	9.20	13.50
Maximum daily rainfall (25 year RL) (mm)	3.74	5.09	4.86	4.08	2.55	4.54	5.79	6.65	3.78	6.68	11.53	16.74
Projected change in annual rainfall (mm)	-22.33	-19.14	0.95	-0.35	8.55	-9.63	4.78	-5.29	23.16	78.54	69.06	103.59
Severe drought likelihood	0.07	0.09	0.09	0.08	0.05	0.08	0.10	0.09	0.07	0.11	0.13	0.17
Probability of heat wave	0.08	0.13	0.14	0.14	0.11	0.23	0.35	0.39	0.13	0.35	0.65	0.84

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Climate-related natural hazards

An increase in the frequency and intensity of natural disasters such as floods and droughts is projected.[796] This is partly due to ENSO events which are predicted to become stronger and more frequent in the future.[797] As a result, an increase in the length of dry periods is expected, resulting in increased drought incidences and an increased risk of wildfires.[798]

[796] World Bank 2021

[797] MINIAM 2016

[798] Prüssmann et al. 2016; USAID 2018

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:

In terms of sensitivity, there are various biophysical considerations (see following two Figures):

- **Flooding:** The susceptibility of slopes against flooding is flooding is considered low (in steep areas at the foothills of the Andes) to very high (flatland), whereas the susceptibility of soils to flooding ranks high in the Amazon region of Peru,[799] In terms of hydrological endowment, the region is considered to have moderate to very high susceptibility to floods.[800]
- **Droughts:** Peru's Amazon region is also moderately sensitive to droughts when considering its hydrological endowment, with moderate to low sensitivity.[801]

In terms of dependence on agricultural activities, Peru's Amazon region ranks from moderate to very high susceptibility (Figure A130).[802] The Third National Communication further emphasizes this at the national level, noting that the country´s economy is sensitive to climate change, particularly due to the relevance of the agriculture and fisheries sectors for their role in not only ensuring the country´s food security, but also in supporting over 5.7% of the GDP in 2015.[803] When focusing on the Human development Index in the Amazon region of Peru, the HDI ranges from high to low, with majority of provinces ranking medium to low (Figure A131).[804] When focusing on food insecurity, there were also mixed results in the Amazon region, with Loreto having medium levels, and Puno having high levels of food insecurity, and San Martin and Amazonas very high. Madre de Dios and Ucayali have low levels of food insecurity.[805]

Figure A128: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin

[799] Pabón-Caicedo et al. 2018

[800] Pabón-Caicedo et al. 2018

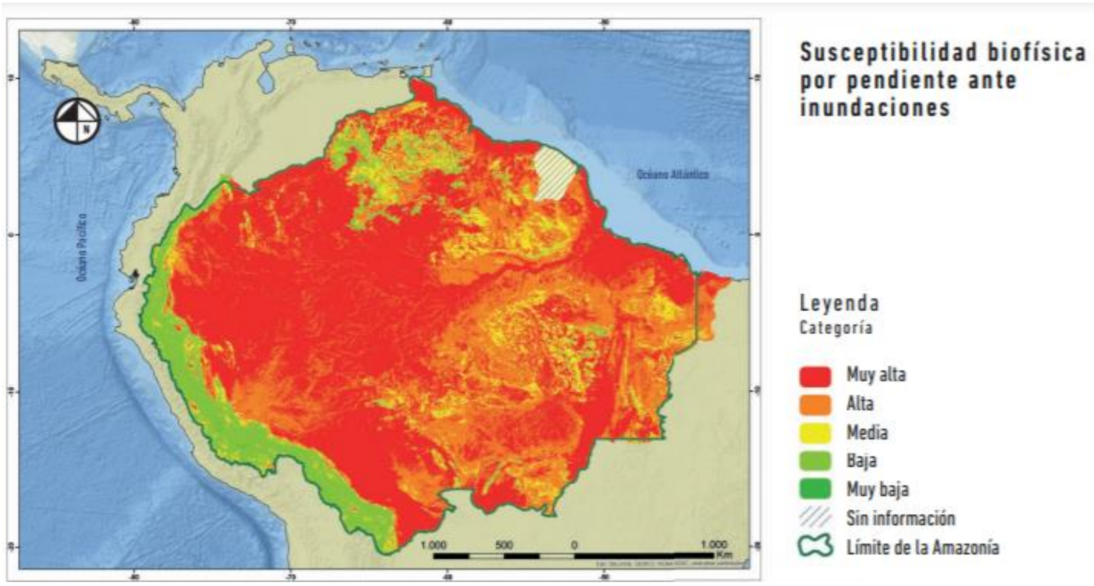
[801] Pabón-Caicedo et al. 2018

[802] Pabón-Caicedo et al. 2018

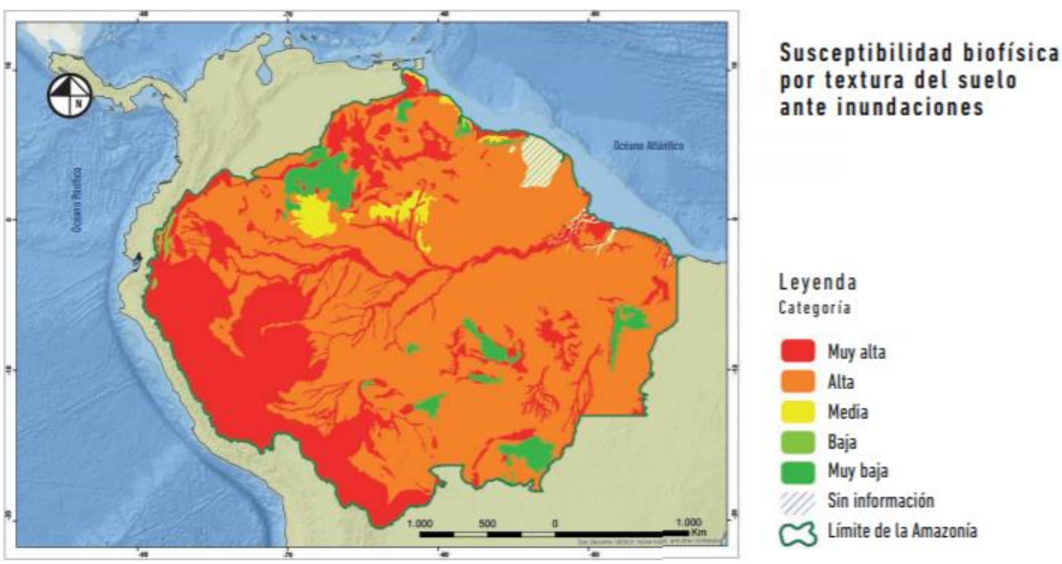
[803] BCRP 2015b in MINAM 2016

[804] MINAM 2016

[805] MINAM 2016



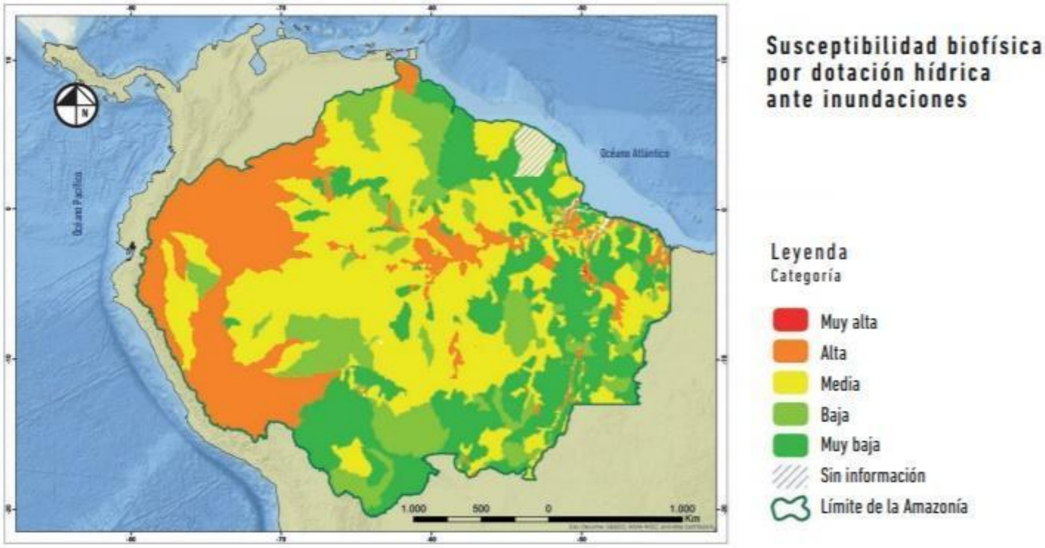
a)



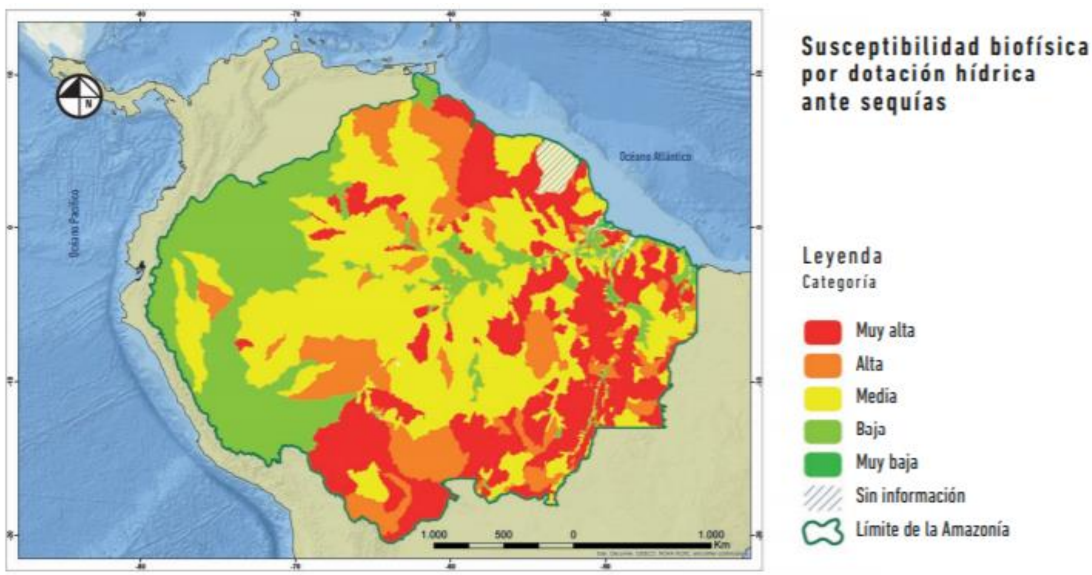
b)

Source: Pabón-Caicedo et al. 2018, p. 42

Figure A129: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin



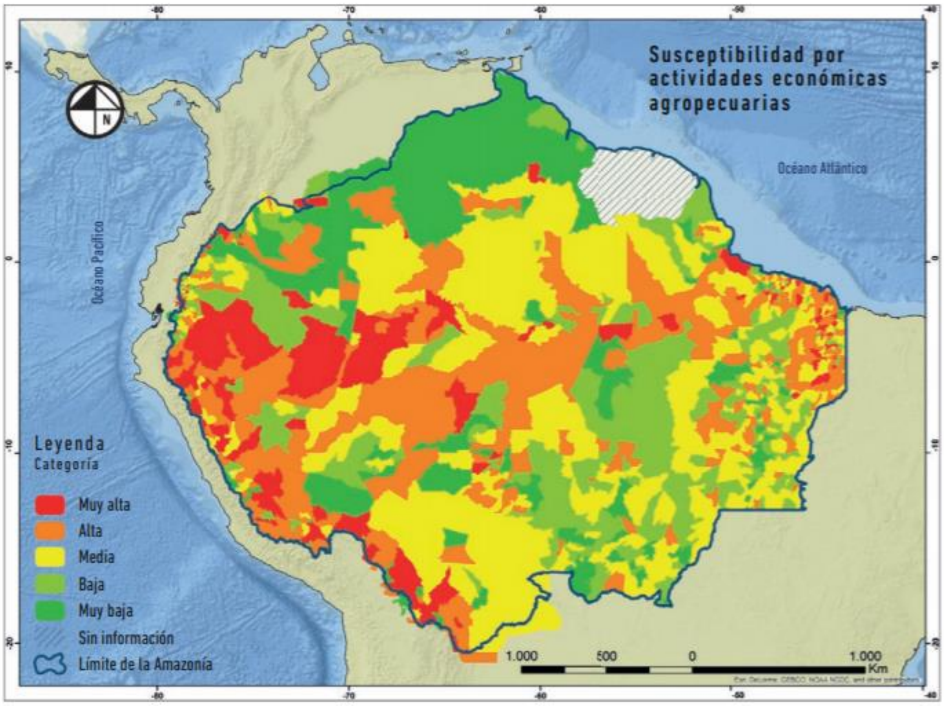
a)



b)

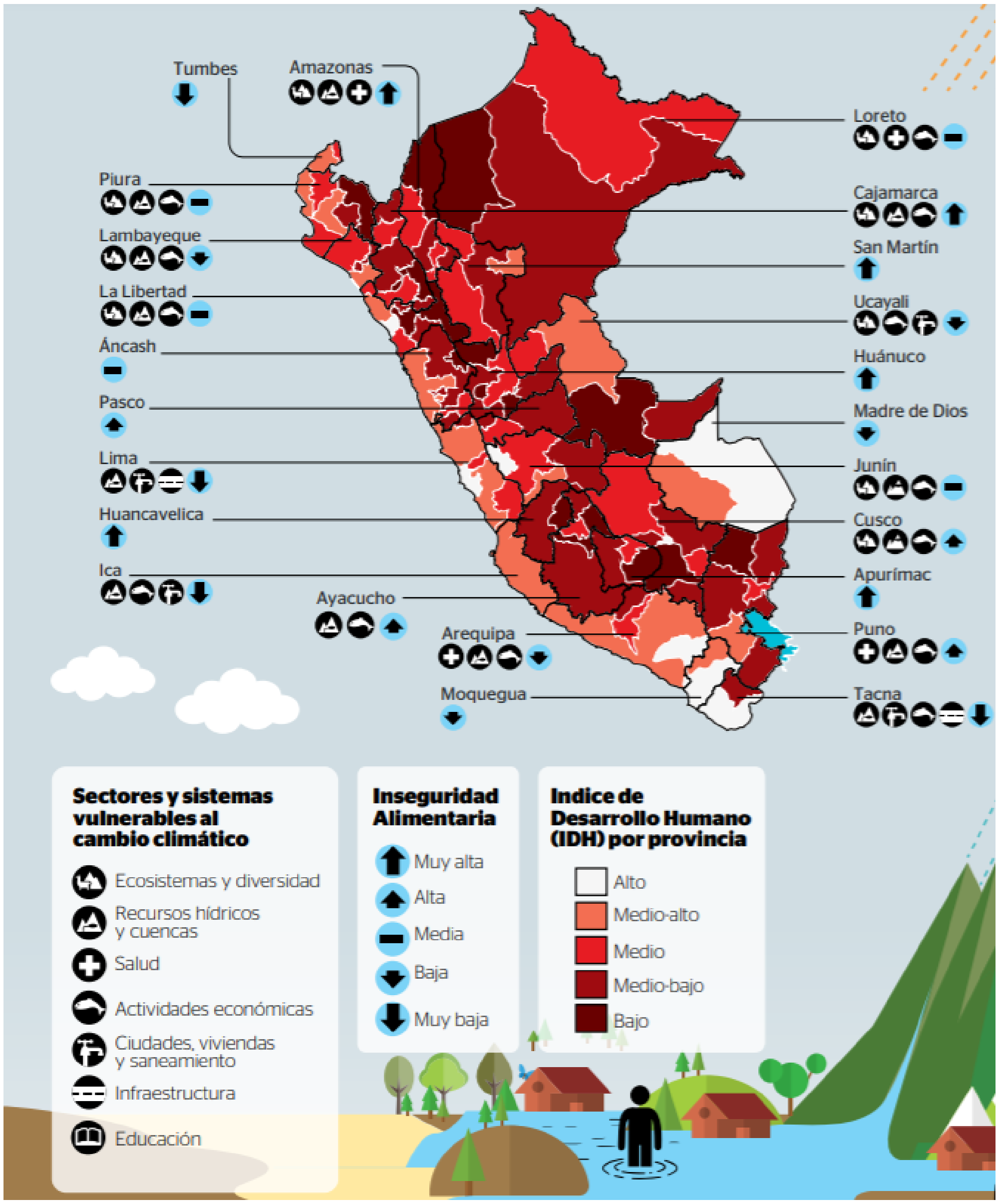
Source: Pabón-Caicedo et al. 2018, p. 42

Figure A130: Susceptibility due to the population of economically active persons engaged in economic activities in the agricultural sector



Source: Pabón-Caicedo et al. 2018, p. 41

Figure A131: HDI levels, food insecurity and vulnerable sectors to climate change in Peru



Source: MINAM 2016, p. 168

In terms of capacity, there is limited information on the specific regional adaptive capacities and coping capacities in the Peruvian Amazon region. The NDC and iNDC notes the relevance of capacities and resilience building, however there is limited information on the existing capacities at the regional or provincial level. Nonetheless, the Third National Communication[806] states that the Amazonian population is seen as particularly vulnerable to climate change due to their reliance on natural resources and ecosystems, and due to the substantial projected impacts attributed to climate change (see climate risks and impacts in the following section).

MINAM (2016), highlights the relevance of implementing the following measures to strengthen resilience and reduce vulnerability to climate change: Sstrengthening climate information and related

[806] MINAM 2016

operational capacities, improving the resilience of infrastructure to climate change and climate-related hazards, improving accessibility to public services (e.g. potable water and sanitation), coverage of health services, garbage and waste management), and strengthening institutional capacities to plan, manage and monitor climate change and related measures to strengthen resilience.

Climate risks and impacts on the bioeconomy and local livelihoods

Climate Risk Peru

On the GermanWatch Climate Risk Index for 2021,[807] Peru is ranked 46th in the world, and in terms of fatalities, Peru ranks 37th. The scoring takes into account the extent to which the country is affected by climate related extreme weather events and its impacts.

Peru`s Intended National Determined Contribution (INDC) notes that Peru has seven out of the nine characteristics to be recognized by the UNFCCC as a "particularly vulnerable" country (low-lying coastal area, arid and semi-arid lands, areas liable to flood, drought and desertification, fragile mountain ecosystems, disaster-prone areas, areas with high urban atmospheric pollution and economies highly dependent on income generated from the production and use of fossil fuels), and that these features are intensified by anthropogenic processes, causing degradation of ecosystems and environmental pollution. Given the aforementioned threats and risks, the Government of Peru (2020) states the country´s commitment to the following prioritized sectors in terms of climate change adaptation: i) agriculture, ii) forests, iii) fisheries and aquaculture, iv) health, v) water (including transversal water resources) vi), tourism and vii) transport.[808]

In the context of bioeconomy, it is important to note that, while exposure and vulnerability are hazard-specific, the general developmental conditions of a country are a critical driver of both. Settlement patterns determine who and what is located in or close to hazard-prone areas. Agriculture, for instance, is much more sensitive to climatic conditions than are many other sectors.[809] The INDC emphasizes the need to build the resilience of particularly vulnerable populations, including: rural populations dependent on subsistence family farming and/or with weak market linkages, many of them grouped in peasant and indigenous communities; small farmers; artisanal fishermen; native communities; small forest producers; and, from a health perspective, infants, women and seniors.[810]

Climate Risk for the Amazon

Climate change will continue to have major impact on rural livelihoods and key sectors in the Peruvian Amazon. The following highlights some of the adverse effects on the health and livelihoods of the population as well as vital ecosystems in the Amazon region due to climate change:

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. Potential impacts could include: changes in productivity, crop failure, increased or changing need for production inputs, losses and damages due to hazards (floods, droughts, fires),

807 Eckstein et al. 2021

808 Tourism and transport have been newly added into the NDC (in comparison to the 2015 INDC).

809 UNDP 2013

810 Republic of Peru 2015

pest and disease outbreaks,[811] among others. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.). In a study by Chavez Michaelsen et al. (2020), rural communities in Madre de Dios noted the agricultural sector is particularly vulnerable to climate change, and highly impacted by numerous climate-related hazards including fires, drought, intense rains, and wind (see Figure below). The same study found agroforestry production systems (e.g. Brazil nuts), timber production, and aquaculture and fishing are also highly vulnerable to climate change.[812]

Figure A132: Example of vulnerability matrix linking climate disturbances and impacts on livelihood practices in Madre de Dios in the Peruvian Amazon

Disturbance / Livelihood	Floods	Fire	Drought	Cold Fronts	High-Speed Winds	High Temperatures	High-Intense Rain
Human Livelihoods	3	3	3	3	2	3	3
Agriculture	2	3	3	2	3	2	3
Parksand Protected Areas	1	1	1	1	2	2	2
Livestock	1	3	3	1	1	2	2
Fishing	1	2	3	2	1	2	3
Village Infrastructure	1	1	1	1	1	1	3
Brazil-nut	1	3	3	1	2	3	2
Timber	2	3	3	1	1	1	2
Road Infrastructure	3	3	1	1	3	1	3

1=low impact 2=medium impact 3=high impact

Source: Chavez Michaelsen et al., 2020, p.10

- Climate change and climate-related hazards (such as extreme drought and flood events) may **limit access to food and foraging** in the Amazon region, impacting forest dependent persons and indigenous peoples.

Risk of negative impacts on freshwater ecosystems affecting local livelihoods

- Decreasing rainfall amounts further **threatens water supply** in some areas within the Peruvian Amazon region, as aquifer and surface water recharge potential is reduced, which is further exacerbated by agricultural expansion.[813] This not only affects water security for communities, but also impacts transportation and mobility of remote communities dependent on waterways for transporation (MINAM 2016).

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811 MINAG 2012

812 Chavez Michaelsen et al. 2020

813 IDB and CEPAL 2016e

- Annual recurring drought events threaten water quality and quantity for fisheries sector, leading to water quality deterioration (changes in pH, oxygen, temperatures). For example, in Madre de Dios, this aquaculture was ranked as one of the most vulnerable livelihood activities. Fishing was further found to be particularly affected by drought and floods, and to a lesser extent by fire, cold fronts and high temperatures (Chavez Michaelsen et al. 2020). This can impact food security in communities dependent on fish for protein (MINAM 2016).

Risk of damages and losses to infrastructure and economic sectors

Climate-related hazards further result in **direct losses and damages to infrastructure**, including homes, tourism infrastructure, farm infrastructure, and transportation infrastructure, among others.[814] At the national level in Peru, accumulated losses in the tourism sector from 2011 to 2100 could reach 1.1% of the national GDP.[815]

Risk of injury, illness, death and adverse health impacts

Climate change poses a public health risk. Climate-related hazards result in injury, illness and/or death. Often women, children, disabled persons and the elderly are particularly at risk. In addition, it may result in an increase of water- and food-borne diseases, increasing temperatures and climate variability may lead to an increase in diarrhea, acute respiratory infections, among others.[816] Respiratory illnesses are also expected to increase with an increased incidence and intensity of wildfires.

- Climate change has the potential to increase air and soil temperatures that could **create the necessary conditions for a wider distribution of disease transmitters** such as mosquitoes, ticks and rodents. Consequently, conditions for the spread of diseases (e.g. malaria, dengue, yellow fever) and epidemics would be more likely to occur.[817] In Peru, the Amazon region is one of the major vector-borne disease hotspots, where malaria corresponded to 75% of mosquito transmitted diseases between 2000-2011. Climate change impacts in the health sector are projected to cause an accumulated loss of 0.02% of the GDP by 2100.[818]

Risk of ecosystem transformation, and loss of ecosystem services and biodiversity

- **Forest health productivity (both NTFPs and timber) may also be impacted by climate change** with changing productivity due to changing climate conditions, outbreaks of disease, and potentially losses due to climate-related hazards.[819] Growth rates may be particularly affected by drought, extreme heat and changing precipitation patterns.
- Increasing droughts and dry conditions may also lead to an **increased frequency and intensity of wildfires** in the Amazon region,[820] which is further exacerbated by forest degradation and fragmentation and other land use activities (see below). Anthropogenic activities also are an

[814] MINAM 2016

[815] IDB and CEPAL 2016a

[816] MINAM 2016

[817] USAID 2017

[818] IDB and CEPAL, 2016b

[819] MINAM 2016; Chavez Michaelsen et al. 2020

[820] Prüssman et al. 2016; USAID 2018

important contributor to this, as some communities may not be not aware of risk-reducing practices in particularly dry periods.[821]

- The effects of **increasing climatic exposure** may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, open roads, and deforestation usually cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change (e.g. erosion and sedimentation could contribute to an increased risk of flooding, exacerbated by projected increases in precipitation).
- **Deforestation and forest degradation in the Amazon exacerbate the exposure to climate hazards, and overall impact of climate change on ecosystems and local livelihoods.** Deforestation and forest degradation can contribute to: soil degradation, erosion and sedimentation,[822] reduced soil moisture, soil organic matter and soil organic carbon, biodiversity loss, reduced forest health, pest and disease outbreaks, and increased exposure to floods and fires, among others. IDB and CEPAL (2016e, d) note that there is a strong expansion of agriculture in the Amazon region, resulting in deforestation and forest degradation that further exacerbates climate risk and vulnerability in the region.[823] In the Peruvian amazon, the increased use of certain grasses in cleared pasture lands may further increase fire risk in the dry season, as increasingly used species such as Brachiaria sp. are highly flammable, and further exacerbate climate vulnerability.[824] In addition, the conversion of forests into grasslands or cropland, potentially contributes to climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness.[825] Various studies[826] note the importance of closely monitoring the **risk of forest dieback** in the Peruvian Amazon, especially along its eastern border, as rainfall recycling plays an important role in this region.

The following Table provides a summary of potential climate risks on the main sectors covered by the proposed GCF program, where possible providing examples from Peru.
A49

Table A41. Overview of potential climate change impacts on key sectors covered by the proposed program

Sector	Potential impacts
Agriculture	▪ Changes in crop suitability for certain areas (esp. due to inundation, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures ▪ Changes in crop yields and productivity of key crops in inland areas ▪ Loss of crops due to forest fires. ▪ In a study in Madre de Dios, agriculture was found to be one of the most at risk sectors to climate change, which is highly impacted by fires, droughts, high-

[821] e.g. Chavez Michaelsen et al. 2020

[822] MINAM 2016

[823] IDB and CEPAL 2016e, d

[824] Chavez Michaelsen et al. 2020

[825] Bovolo et al., 2009; Staal et al. 2020

[826] USAID 2011; Staal et al. 2020

	speed winds, and intense rainfall, and moderately impacted by cold fronts, floods and high temperatures. In addition, the same study found nearly 54% of respondents highlighted crops loss as the main impact of forest fires.
Timber and NTFPs[827]	▪ Decrease in NTFP quality and availability due to inadequate growing conditions, shocks (drought, flood, fires) and pest and disease outbreaks ▪ In Madre de Dios, a recent study found many people have been affected by severe drought and forest fires (e.g. in 2005), that resulted in loss of crops, reduced plantation and timber production, and loss and damages to NTFPs (e.g. shea, brazil nut, fruits). Survey respondents further noted concern over the impact of climate change and drought on future brazil nut yields and timber production. ▪ Brazil nut production in Madre de Dios was noted as being particularly impacted by fire and drought, and moderately impacted by high-speed winds and intense precipitation.
Aquaculture & Fisheries	▪ Annual recurring drought events threaten water quality and quantity for fisheries sector ▪ Water quality deterioration (changes in pH, oxygen, temperatures) ▪ For example, in Madre de Dios, this aquaculture was ranked as one of the most vulnerable livelihood activities. Fishing was further found to be particularly affected by drought and floods, and to a lesser extent by fire, cold fronts and high temperatures.
Tourism	▪ Damage to key tourism hotspots and tourism infrastructure due to climate related hazards creating higher operational costs (insurance, evacuation, back-up systems) ▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (malaria, dengue). ▪ Unsustainable tourism can exacerbate climate risk (e.g. soil compaction, degradation). ▪ Risk of decreased attractiveness of key tourism features (waterfalls) due to precipitation variability, forest fires, flood damage, etc.
Ecosystem regulation services	▪ Decrease in biodiversity (threatened species) due to changes in habitat, climate change and climate-related hazards. Strong fluctuations in annual rainfall could increase the risk pest and diseases, and ultimately the risk of forest dieback. ▪ Decrease in opportunities for traditional hunting and consumption practices. ▪ Changes in ecosystem functions, including regulatory and cultural services ▪ Risk of loss of key ecosystem functions including regulatory, production and cultural services

827 Examples of NTFPs that are high in demand from the Peruvian Amazon include: cochineal (an insect from which the dye carmine is derived), brazil nuts, hearts of palm, and cat's claw (USAID 2011).

	▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience)
Forests	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Deforestation-drought cycles will increase the risk of increasing intensity and frequency of wildfires, resulting in biodiversity loss, and the loss of ecosystem functions ▪ Increasing inundation and siltation along rivers threaten forest resources and amazon ecosystems ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume ▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities ▪ Tree mortality due to invasive species, forest fires, excessive heat and dryness, especially along forest edges ▪ Risk of forest dieback and transition to savannah ecosystems

Source: World Bank CC Portal, n.d.; USAID 2018; Chavez Michaelsen et al. 2020

Climate change benefits from bioeconomy investments

A number of economic valuation studies on the impacts of climate variability have been made such as the Study of the Economic Impacts of Climate Change, which have shown that the costs of climate change impacts heavily outweigh the costs of implementing adaptation actions.[828] That said, USAID (2011) highlights the challenges of scaling up climate change adaptation in the Amazon, noting "…*Direct adaptation measures in Amazonia will require greater participation of settlers and indigenous populations in changes to land tenure and land use, emphasizing sustainability and intensification vs. extensification of agriculture, and development of sustainable non-timber forest products and services.*",[829]

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. While the specific benefits vary with the investment and specific context (e.g. country, region, site-conditions, etc.), many of the program's investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g. agroforestry, ecotourism)

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[828] MINAG 2012

[829] USAID 2011, p. 31

Bioeconomy sectors and actors

Perennial agriculture and agroforestry

Agriculture is one of the main sectors of the Amazonian economy, both in monetary terms and in terms of employment generation. In Table A42, we present a list of 12 crops that represent 91.4% of all productive agriculture registered in the 2012 agricultural census. Coffee is the main crop by area and market value, covering 378,622 hectares (25.4%), followed by managed pasture with 375,976 hectares (25.2%). Cocoa, achiote and forestry are the main native permanent crops, covering 129,906, 18,294 and 14,483 hectares respectively. In total, native permanent crops cover more than 164,313 hectares of agricultural land.

Table A42. Main crops in the Peruvian Amazon

Category	Cultivation	Extension (Hectares)	Coverage (%)
Exotic permanent	Coffee	378,622	25.4
Exotic permanent	All managed pastures	375,976	25.2
Permanent native	Cocoa	129,906	8.7
Exotic permanent	Banana and bananas	122,093	8.2
Exotic Annual	Corn	116,084	7.8
Exotic Annual	Rice	82,719	5.5
Native Annual	Yucca	71,573	4.8
Exotic permanent	Oil palm	26,739	1.8
Permanent native	Timber plantations	18,294	1.2
Permanent native	Achiote	14,483	1.0
Exotic permanent	Orange	13,675	0.9
Native Annual	Coca	13,618	0.9
Sub-total		1,363,782	91.4
Total (inc. other crops)		1,490,498	

Source: CENAGRO, 2012, IV National Agrarian Census

The census data are already more than 8 years old, which limits their accuracy, however CENAGRO is the only information available regarding the relative importance, at the biome level, of the selected crops with respect to other crops. According to CENAGRO and other published data, we estimate that between 79% and 90% of deforested lands are under *de jure* or *de facto* ownership by smallholders, indigenous peoples and riparian populations. Working on bioeconomy financing with these actors is not only key to achieving the desired socio-environmental impacts, but also because of the significant financial scale of this group.

Agroforestry is a widespread practice among small producers and Amazonian communities, whose inclusion in the bioeconomy can not only increase biodiversity and organic carbon stocks at the territorial level, but also contribute to the implementation of the Cession in Use for Agroforestry Systems (CU-SAfs), a legal mechanism provided by the Forestry and Wildlife laws (LFFS for its acronym in Spanish) that promotes the conservation or recovery of the provision of goods and services of forest ecosystems and/or natural vegetation in transformed areas of public domain, through the consolidation of 'sustainable systems of permanent production'.[830]the granting of CU-SAFs contracts to pre-established natural persons in forest lands (where the delivery of property titles is not allowed), the aim is to formalize sustainable productive activities implemented for forestry production and recovery purposes, facilitating access to financing mechanisms through the possibility of constituting mortgages or real guarantees on the area granted in cession. [831]

Successful implementation of the CU-SAFs is important for more than 1 million hectares, of which about 452,000 hectares are forests. These areas are home to about 123,000 smallholder families without land titles. From an environmental perspective, a "total and successful" implementation of the CU-SAFs in the Amazon region could make it possible to conserve the forests on the beneficiaries' land and restore their non-forested areas with agroforestry systems. This would contribute to 20% of the Land Use, land use change and silviculture (USCUSS) sector and to an increase in the stock through the establishment of agroforestry. Having 20% or more of the land under agroforestry systems is a condition of the CU-SAFs mechanism. Taking into account this criterion, 84,870 producers (69% of the total identified) comply with having at least 20% or more of the land under agroforestry systems, of which 36,146 have forest area. The potential beneficiaries of the CU-SAFs are producers linked to the market, most of whom grow crops for commercialization. Some 81.4% of the producers have at least 50% of their production destined for sale. Despite this, they are producers who do not benefit from access to credit or from being linked to services provided by the public sector, companies or cooperation projects. The level of access to technical assistance and advice does not even reach 10% of producers.

Regarding size, Zegarra (2009) defines small producers as those with between 0 and 10 hectares in high forest and between 0 and 15 hectares in low forest. Following this definition, 96,523 producers (78%) are small, while 27,274 (22%) are medium-sized. As for market orientation, 100,789 (81%) are market oriented, while 23,008 (19%) are not. In terms of income diversification, 55,762 producers (45%) have off-farm income (both agricultural and non-agricultural), while 68,038 producers (55%) do not have this type of income.

It is recommended that cocoa (*Theobroma cacao*) and coffee (Coffea arabica) be included in the investment portfolio, and that the inclusion of achiote (*Bixa orellana*) and camu-camu (*Myrciaria dubia*) agriculture and indigenous agroforestry systems, including combinations with potential commercial timber trees such as capirona (*Calycophyllum spruceano)* and bolaina (*Guazuma crinita)*, be investigated during the implementation stage of the program. It is recommended to exclude agroforestry systems with pine and eucalyptus, which are non-native trees that are known to displace local biodiversity.

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[830] Robiglio, V., Vargas, R., Suber, M. 2018. The Assignment in Use for Agroforestry Systems. Potential beneficiaries, their geographical distribution and estimation of the potential contribution to climate goals in Peru. In: Apoyo al Desarrollo de Cesión en Uso para Sistemas Agroforestales en Perú. Lima: ICRAF.

[831] This mechanism embodies the perspective of the National Agrarian Policy (PNA), approved by D.S. N°002-2016-MINAGRI on March 17, 2016, and the National Forestry and Wildlife Policy (2009).

Aquaculture Sector

Although it shows great potential, aquaculture development in the Amazon is in its early stages, both for local and national consumption, with paco (*Piaractus brachypomus*) and gamitana (*Colosomma macropomum*) being the two species with the best economic results to date. The business model is semi-intensive, with relatively little investment in the aquaculture ponds, but with investment in balanced feed that ensures good growth rates. This technified feed represents between 70-80% of production costs in most cases. The first steps have just been taken to consolidate an export chain, whose efforts are concentrated on paiche (Arapaima gigas).

Currently, well-managed Amazonian aquaculture has profit margins of between 25% and 47%. These margins are present in a local market that pays between S/. 15 and 30/kg for paiche and between S/. 10 and 12/kg for gamitana and paco. When extending production to national and international markets, where volume, consistent quality, and more competitive prices are required, it is necessary to introduce new knowledge and state-of-the-art technologies to increase productivity and significantly reduce production costs, thus increasing competitiveness vis-à-vis substitute aquaculture products, mainly imported from Asia. It is also necessary to present the products in a (semi-) processed form to cover niches in domestic and international markets and seek better sales margins.

Another fundamental aspect to improve is the cold chain, since without the integral development of the cold chain it will not be possible to reach new markets. This implies the installation of ice plants, training of transporters on how to handle and transport the product under adequate sanitary conditions, promotion of private investment, among others. As business incubators, the CITEs in the Amazon should play an important role in this development. It is recommended that aquaculture with paco, gamitana, piache, shad, boquichico and other native species be included in the investment portfolio. It is recommended that aquaculture with tilapia and trout, which are non-native species that exclude local biodiversity, be excluded.

Non-timber forest products and timber concessions and plantations

Among the best known non-timber forest products of the Peruvian Amazon are some that have important global markets, such as the Brazil nut (*Bertholletia excelsa*), the latex of the shiringa (*Hevea brasiliensis*), and the fruit of the acaí (*Euterpe oleracea*), and others with a national market, such as the fruit of the aguaje (*Mauritia flexuosa*). There are also more than a hundred other non-timber forest products that are used in Amazonian communities and traded in local markets in Peru, and whose broader social and commercial value has yet to be consolidated[832].

It is recommended that Brazil nuts, and aguaje (*Mauritia flexuosa*) be included in the investment portfolio, and that the potential for including acaí and other non-timber forest products, whose harvesting is still local or incipient in Peru, be investigated in depth during the program implementation stage.

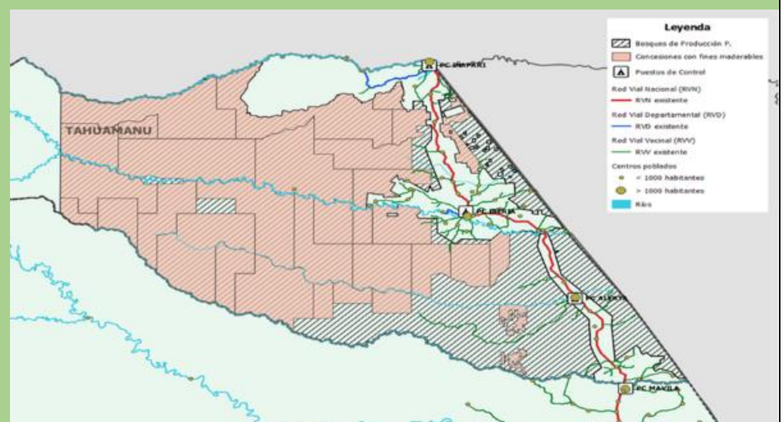
[832] SERFOR, 2019. Guide to Non Timber Forest Products in Madre de Dios.

Case Study: Tahuamanu Forestry Concession Cluster

Vertically integrated wood product manufacture and sustainable management of natural forests via long-term concessions on public land can play a key role in the Amazonian bioeconomy. Peru's department of Madre de Dios (MdD) was selected to show how professionally managed entities can generate sufficient economic returns and socio-economic impacts to build a local constituency that protects important forest areas from conversion to other land uses. The specific area of analysis is located in the Province of Tahuamanu which covers 1,179,327 ha in Peru's Eastern Amazon region bordering Brazil and Bolivia. Tahuamanu includes 829,476 ha of forests under permanent production known as BPPs (for its acronym in Spanish) (Map 1) with the vision:

"Productive and competitive conservation of forest products and services, oriented to guarantee the provision of those products and services to generate the economic and social well-being of the local population, serve as a buffer zone for the territorial reserves of the indigenous communities in voluntary isolation, and contribute to a reduction in GHG emissions."

This pragmatic vision is based on the well-documented reality that the main driver for deforestation in Peru is economic and that despite ~ 96% of all forest conversion resulting from agriculture and cattle (Geist and Lambin, 2002), agricultural intensification will not result in less forest conversion. As the Madre de Dios government clearly articulates, the standing forest must generate revenues and local benefits in order to remain standing.



Tahuamanu's BPPs are well suited to forest production under a wide range of management mechanisms including timber and non-timber concessions, and community permits, due to various factors including:

- Relatively high proportion of high-value commercial species with strong demand in the export market (despite a low volume per hectare);
- Excellent road infrastructure connecting this remote region to Peru's main ports on the Pacific Coast;
- History and culture of commercializing both timber and non-timber forest products (Brazil nut or "castaña"); and
- Consolidated block of intact forest surrounded by a buffer area ("ZI" per the Spanish acronym for "Zona de Influencia") where a range of sustainable economic activities (including forestry) could reduce deforestation drivers on timber concessions.

Tahuamanu concessionaires have made several notable accomplishments:

- Well-capitalized and experienced managers have acquired concessions and consolidated various smaller contracts into larger holdings (average concession size is 36,635 ha) which can take advantage of economies of scale to be profitable (many have been functioning for over 15 years);
- In recognition of their success in changing baseline conditions that would have resulted in forest conversion, several timber concessions including Maderacre – Maderyja and Paujil have successfully sold carbon credits in the voluntary market.
- Larger operations with Peruvian, Brazilian and Chinese capital have invested in processing machinery: there are 14 primary sawmills in the department with a milling capacity of 184,000 m3/year. Wood drying, planning and secondary manufacturing allows companies to directly sell final products to foreign markets.
- 547,399 ha of Tahuamanu's concessions have achieved FSC certification and an additional 53,394 ha have been certified on indigenous community lands. on 334,400 ha (representing roughly over 72% of the total BPPs in the PMG

The socio-economic impacts of these timber-focused activities are significant.

- In 2015, the forestry and wood products manufacturing sectors injected US$48.3 million into the economy of Madre de Dios. Based on the 168,285 m3 of round wood harvested in that same year, each m3 generated US$287 for the local economy (FOREST 2020).
- Given the average level of commercial volumes harvested per hectare in MdD (3.63 m3/ha), on a per area basis, concessions in this region inject US$1,042/ha into the local economy.

Nature tourism

Although the Amazonian departments still account for a small share of national tourism and contribute modestly to the total income of the tourism sector in relation to other departments of the country, there is a significant growth trend in the flow of tourists to the Amazon, 7.5% per year on average in the period 2008-2018. Between 2010 and 2018, hotel accommodations in departments with Amazon destinations welcomed 5.5% of Peru's guests, of which according to our estimates, about 2.2%, or one third of the guests, were tourists visiting Amazon attractions. In relation to tourism revenues, it is estimated that the arrival of international nature tourists to Amazonian departments generates about US$200 million, and it is also estimated that the average expenditure is still below its potential[833].

A nature tourism product needs to combine three attributes: 1) one or more exceptional tourist attractions that justify the time and expense of getting to the destination, 2) be relatively close to good access infrastructure (airport and/or paved roads) so that getting to the destination does not involve too much time or risk, and 3) be part of a tourist circuit that has complementary services at the destination such as lodging en route, travel agencies and other attractions. Community-based nature tourism, often located in remote locations, is especially sensitive to the right combination of these attributes. It is recommended that community-based nature tourism be included in the Program portfolio.

Case study: Nature tourism at Posada Amazonas, Perú

In the tropical rainforest of southeastern Peru, on the Tambopata River, 180 families of the Native Community of Infierno share nearly 10,000 hectares of forests, oxbow lakes, and clear-running streams. Their land is in the Tropical Andes biodiversity hotspot, an area of the Pan Amazon habitat to more species of plants and animals than any other place on earth. Though the forests and traditions of Tambopata are threatened by outside forces—land speculation, commercial agriculture, illegal gold mining, logging, and more—the residents of Infierno are stewards of their natural capital. They use tourism as one of the tools for protecting what they value.

In 1996, the Community partnered with Rainforest Expeditions, a Lima based company founded by two entrepreneurs with a history of research on macaws in Tambopata. They created a joint venture partnership to build and operate an ecotourism lodge, Posada Amazonas, and agreed to split profits, with 60% to the community and 40% to the company, and share equally in management. A community-based "Comite de Control" of 10 members, would oversee decision-making on all things related to product development, investment, marketing, management, and revenue-sharing. They agreed on a 20-year timeline. In that span, Infierno's residents should gain the skills and knowledge to assume full management of the lodge. The people of Infierno built the lodge themselves, using locally harvested wood, palm fronds, and wild cane. They depended on significant support in architectural design and capital financing from their partners at Rainforest Expeditions. They completed construction of the lodge in two years, and opened their doors (and canoes and trails and canopy tower) to tourists in 1998. Initial financing for the project was $500,000, which came partly from a loan by the Peru-Canada bilateral aid program, as well as a capacity building grant from the Sustainable Development Program at the MacArthur Foundation.

A typical tourist itinerary includes rainforest hikes, ethnobotanical walks, night walks and information sessions, and visits to Infierno to learn about local culture and farming practices. A 35-meter tower provides canopy access and a view of the Tambopata from a macaw's-eye view. A highlight for many tourists is a sunrise float on a large catamaran in one of the community's oxbow lake, Tres Chimbadas. There, visitors can search for a family of endangered giant otters and other lake species, including caiman, piranha, and hoatzins (www.perunature.com/es/amazon_lodge/posada-amazonas).

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833 GGGI, DIE and SERFOR, 2015. Tourism as a strategy for the conservation and sustainable use of forests.



Posada Amazonas attracts 6,000-7,000 tourists annually, averaging $100 per night in the first 10 years and $250 per night in the last 10. The lodge generated annual profits of over $225,000 in its first decade, and approximately $500,000 annually most recently, as per the following detail:

Year	Sales	Earnings	Nights sold	Cost/night
2019	$2,408,000	$596,000*	9,309	$253/night
2018	$2,350,000	$551,000*	12,967	$181/night

** Since 2016, 75% distributed to Infierno, 25% to Rainforest Expeditions, with 15% of the Inferno's earnings are reinvested in the lodge.*

From the community profits, 70–80% has been split among 150 families for their personal use (ranging from $150 per household in 2001 to $653 in 2006 to $805 in 2007). These amounts represent 20–30% increase to the average household income. The remaining revenues are used to improve Infierno's infrastructure with works such as a secondary school, a computer facility, additional road access alongside the community, and a potable water well and tank system. When the original 20-year contract ended in 2016, the company and the community returned to the negotiation table. They agreed the partnership had been fruitful, edifying, and productive for both. They had each contributed their skills, knowledge, and resources, and they had each benefitted. They had also created something organically new: a hybrid business model, connecting an indigenous community with a private company and establishing a for-profit enterprise that delivered net returns to conservation and development. They agreed to change the terms of the contract slightly, now with Infierno gaining a greater share of the profits. The spirit of the partnership remains strong, and the forests, waters, and wildlife of the Tambopata are stable and thriving, at least in that part of the river, thanks to this pioneering experiment.

Ecosystem services sector

Not all ecosystem services are quantifiable or tradable. The most developed sector in the Peruvian Amazon is climate regulation services, in which duly quantified carbon stocks are used to compensate, and thus neutralize, the carbon footprint of individuals and companies. By their very nature, certain services lend themselves to be valued under private schemes, others under public-private schemes and still others exclusively in the public sphere. In general, this is a new market and new sectors are being defined based on the development of regulations, technology and our consumption or non-consumption behavior. Beyond carbon, services with growth potential in Peru include water regulation services (water footprint management), soil maintenance services (soil generation and erosion control) and biodiversity maintenance services (environmental compensation and habitat banks).

The business model of climate regulation services consists of offering individuals and companies the opportunity to offset or neutralize greenhouse gas emissions (GHG, known as carbon footprint) from their activities or operations, via carbon capture and storage in natural ecosystems. The unit of generation and purchase/sale is tons of carbon dioxide equivalent (tCO_2eq) arising from the variety of conservation, restoration, agroforestry and a variety of other projects.

Case study: From timber to ecosystem services at Green Gold Forestry, Peru

Established in 2008, GREEN GOLD FORESTRY PERU SA, ('GGF') is a vertically integrated, FSC-certified sustainable hardwood company owning modern sawmilling facilities in Iquitos, Loreto, Peru. GGF is Peru's largest forestry concession holder, with 254,000 ha under management. With the Green Gold Loreto 1 Project, GGF is taking 183,445 hectares of production forest concession area out of the planned logging cycle and into management for ecosystem services. GGF's theory of change is that if Loreto's production forest concessions are managed for carbon storage and non-timber forest products, rather than logging, they can make consistent profits and generate improved and sustained benefits for forest communities. GGF's vision is to develop the project area as a center for ecotourism and scientific research, and support community-centered enterprises that create improved incomes for locals and contribute to the UN Sustainable Development Goals.

Within the project area, logging will cease, together with the establishment and maintenance of logging roads, skidding trails and other infrastructure. Thereby, emissions will be eliminated from the extraction and processing of logs, from collateral mortality of felling operations, and from roads, skidding trails and other infrastructure. The emissions reductions are anticipated to average around 450,000 tCO_2 per year. The forest will be protected from disturbance, allowing carbon content to accumulate over time, taking advantage of the overall trend of carbon accumulation in Amazonian forests. Any negative effects that biodiversity may have experienced from logging operations will be allowed to recover. The long-term effects of disturbance and degradation on 'intact forests' are significant and the project will avoid these effects and allow the natural ecosystem to thrive.

The primary project activity is conservation of the existing forest ecosystem, i.e., the avoidance of any logging, mining, hunting or unsustainable NTFP collection. The project will work with neighboring communities to establish an active conservation program for their benefit and for that of the climate and the forest's biodiversity and ecosystem health. Conservation of the forest will be ensured by:

1. Involving the neighboring communities in the project, to ensure their participation in and commitment to forest conservation, by making them project stakeholders and beneficiaries. The project is partnering with Peruvian NGO CEDIA with experience in community outreach and monitoring. GGF also already has dedicated staff for community work as part of its FSC certification.
2. Regularly patrolling the project area with teams of forest rangers, who will be hired from neighboring communities and trained and equipped to adequately and safely deal with potential incursions;
3. Erecting signs along all fluvial access points and existing logging roads to inform and warn potential intruders of the conservation status of the project area;
4. Remote monitoring using drone and satellite surveys.

Effective avoidance of intrusions by outsiders will be ensured through a visible and regular presence of project staff in the project area, as well as ecotourism expeditions and scientific research expeditions. Peru has a national REDD+ policy that requires all projects to be part of a jurisdictional REDD+ program from 2021. However, development of national and jurisdictional reference levels has so far exclusively focused on deforestation and has not included forest degradation. This makes it impossible for the Green Gold Loreto 1 project to participate in a jurisdictional REDD+ program until such reference levels have been developed. The project is working on securing an exemption from the Ministry of Environment and Mining (MINAM) to operate independently until such time as appropriate jurisdictional reference levels have been developed. The project was conceived in late 2018, started its VCS formulation process in early 2019 and started implementation in August 2020. GGF's logging season on average runs from August until February each year, depending on rains. In August 2020 GGF did not resume its logging activities. The project is currently undergoing VCS validation. Project activities' running costs (operational, equipment and overheads) are estimated to be around $2m per year. GGF has already secured limited funding to cover costs until the first tranche of carbon credits can be sold. Project investments are estimated to amount to $5million in the next few years. These include investments into fruit picking and other NTFP businesses, tree planting on degraded community areas (outside the logging concession), and possibly restoration of degraded community lands.

GGF will seek to raise additional finance in 2021 to support the expansion of community enterprises and the related increase in operational costs. GGF sees potential to replicate this project on other forestry concessions in Loreto. There are no other

FSC-certified companies operating in Loreto and the logging sector is rife with illegal practices. The goal is to provide the state of Loreto and the nation of Peru with income from forestry concessions that allows carbon dioxide uptake by forests, and also contributes to the sustainable development of Amazonian communities. GGF will look for grant, debt and/or equity investment for this replication phase.

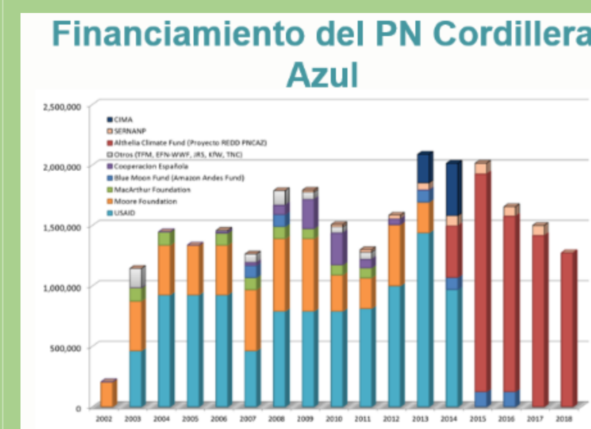
Source: Jan Fehse in coordination with Green Gold Forestry

Case Study: CIMA REDD+ Project in Cordillera Azul National Park, Peru

Cordillera Azul National Park (PNCAZ) ranges from forests lowlands (at 300 meters) to mountain peaks (at 2,650 meters) and protects an eastern outlier of the Andes that has been isolated sufficiently long for massive speciation to occur. It covers portions of seven provinces in four departments in Peru: Loreto, San Martín, Ucayali and Huánuco. The REDD+ Project area encompasses 1,351,964 hectares inside the Park, officially established in May 2001, and avoids deforestation in one of Peru´s last large, intact expanses of lower-montane forest. The surrounding buffer zone extends to more than 2.3 million hectares, making the Park and its buffer zone equivalent in size to Switzerland.

In 2002, the Centro de Conservación, Investigación y Manejo de Áreas Naturales - Cordillera Azul (CIMA), a private, non-for-profit organization signed an agreement with the Peruvian Government to support the management of the Park. In 2008, following Peruvian regulations, CIMA signed a Management Contract for the PNCAZ for a 20-year period to provide integral technical and financial support to the Park. The contract includes legal authorization from SERNANP (*Peru´s National Protected Area Service*) to commercialize ecosystem services, allowing CIMA to obtain revenues from the sales of carbon credits from avoided deforestation activities (the REDD+ project), to be invested in the Park´s management.

Due to expanding deforestation that threatens the Park, in 2007 CIMA and its scientific and technical partner, the Field Museum, decided to develop and implement a REDD+ Project as a way to conserve and finance the Park, as well as sustainable livelihood activities in the buffer zone. Population in the buffer zone has doubled in the 20 years of its existence. In fact, the buffer zone around the Park has some of the highest deforestation emissions in Peru. The main strategies to protect the Park and avoid deforestation are strengthening Park protection through involvement of local people, engaging stakeholders in improved land use practices and sustainable activities that lead to land and natural resource conservation, and also contribute to improve the quality of life in buffer zone communities and settlements.



Today, PNCAZ is one of two Peruvian protected areas recognized by IUCN to be in the Green List, a recognition of the high quality and successful management of the Park. The project meets two carbon and conservation certification standards: the Verified Carbon Standard (VCS) and the Climate, Community and Biodiversity Standard (CCBS). The initiation of the 20-year management contract in 2008 served as the start of the REDD+ project. However, it was only by the end of 2014 when the project started to provide funds for the management contract. Since the establishment of the Park, up to 2014, it has been funded through grants provided by charitable funds from the Gordon and Betty Moore Foundation, Blue Moon Fund, MacArthur Foundation, among others and international technical cooperation, mainly USAID. Since 2014, over 90% of funding for the Management Contract has been provided by the sale of REDD+ credits, thus attesting to the critical role of the REDD+ project in supporting the activities in and around PNCAZ. Up to 2018, the project has generated over 25 million carbon credits and some more will be validated through the end of 2020. As from 2021, credit issuance should be nested and integrated into the Peruvian NDC commitment to the Paris agreement.

CIMA has worked with buffer zone communities since 2002 to ensure that the project activities incorporate and reflect the values and aspirations of the different local populations. The project activities are highly participatory, with local people leading the efforts and developing skills that enable success in the long run. These activities include economic and ecological land use zoning, improved land use practices and conservation-compatible economic activities. Aside from providing funding for the Park´s operation, over US$3 million have gone to social investments to benefit the parks neighbors. One of the first investments is a post-harvesting cocoa mill, that can process some 500 tons/year, working with over 200 farmers. They benefit from a better price and receive technical assistance to improve the quality of their crops, while committing to zero deforestation on their lands. This model is still under development. CIMA and the Peruvian government have agreed to establish an endowment with the proceeds of the sale of carbon credits to fund the Park's protection and all management activities in perpetuity. This objective should become reality in the coming year.

Source: Gonzalo Varillas and Lily Rodriguez from CIMA-Cordillera Azul

Development, research and technical programs

The main existing national development, technical cooperation and civil society support programs linked to the bioeconomy in the Amazon are listed in Table A43[834]:

Table A43: Support programs

Project/Program	Executing entities	Cooperating entities	State	Total amount (US$million)
Mitigation of Deforestation in Chestnut Concessions in Madre de Dios	PROFONANPE	GEF-BID	Completed	1.6
Tourism Emprende-Amazon Component (40%)	MINCETUR	MEF	Execution	2.1
Joint Declaration between Peru, Norway and Germany on REDD+ and the Promotion of Sustainable Development in Peru - Phase 1 and 2.	MINAM (PNCB) - MINAGRI	NICFI-BMUZ	Execution	50.0
Joint Statement between Peru, Norway and Germany on REDD+ and the Promotion of Sustainable Development in Peru - Phase 3	MINAM (PNCB) - MINAGRI	NICFI-BMUZ	Design	250.0
Bio Challenge - Innóvate Peru	Innóvate Peru-PRODUCE	IDB	Execution	5.0
National Forest Inventory and Sustainable Forest Management in the Face of Climate Change in Peru	MINAGRI(SERFOR)	FAO	Execution	3.5
Forestry investment program	MINAM(PNCB)	PIF-IDB/WB	Execution	50.0
Project of Cadastre, Titling and Registration of Rural Land in Peru. Third Stage (PTRT-3) - PE-L1026	MINAGRI	IDB	Execution	40.0
Perú Bosques: The Peru Environmental Management and Forest governance support activity	CHEMONICS	USAID	Execution	38.6
Program Contribution to Environmental Goals (Proambiente)	GIZ	BMUB	Execution	23.0
Forest Conservation Program in the Departments of Amazonas, Lambayeque, Loreto, Piura, San Martin, Tumbes, and Ucayali	MINAM(PNCB)	JICA	Execution	20.0
Program for Sustainable, Inclusive and Competitive Forestry Development in the Peruvian Amazon	MINAGRI(SERFOR)	CAF	Execution	20.0

834 Preliminary list developed based on literature review and interviews, which should not be considered exhaustive.

Sustainable Productive Landscapes in the Peruvian Amazon	UNDP	GEF	Execution	18.3
Amazon Forest Sector Initiative PFSI-USFS	USFS	USAID	Execution	17.0
Securing the Future of Peru's Protected Areas	SERNANP	GEF	Execution	9.0
Transforming Management of Protected Area/ Landscape Complexes to Strengthen Ecosystem Resilience	UNDP	GEF	Execution	8.9
Strengthening Biodiversity Conservation through Natural Protected Areas (Pronanp)	SERNANP	KFW	Execution	6.2
Building the Resilience of Wetlands in the Province of Datem del Marañón, Peru	PROFONANPE	Green Climate Fund	Execution	6.3
National Innovation Program for Fisheries and Aquaculture	PRODUCE	IDB	Execution	40.0
Amazon Peru Co-Management	SERNANP	BMUB-GIZ	Execution	5.7
Decentralization Support for Community Forest Conservation (CBC II)	MINAM(PNCB)	BMUB-GIZ	Execution	5.7
Hatoyama Forest Conservation Program Hatoyama Initiative	MINAGRI(SERFOR)	JICA	Execution	4.5
Implementation of the REDD+ readiness proposal (R-PP) in Peru.	MINAM(PNCB)	FCPF	Execution	3.8
UN REDD National Program	MINAM(PNCB)	UN-REDD	Execution	3.8
Technical Assistance for FIP Program and Project Preparation	MINAM(PNCB)	FIP-BID	Execution	1.1

Commitments already underway total US$384.1 million, with the additional US$250 million of the Norway-Germany-Peru Joint Declaration conditional on deforestation reduction results. It is important to note that in the last three months, Peru has implemented important funds to support MSMEs and economic reactivation in general in coordination with BCRP, MEF, COFIDE and PRODUCE. No information has been obtained on the size of these economic flows to the Amazonian departments and whether there would be a bioeconomy component to these funds.

Enablers and barriers for bioeconomy development

The implementation of the bioeconomy will face complex legal and social barriers in the Peruvian Amazon frontier. Expansive agriculture and extractive mining continue to replace the tropical forest because the dominant development paradigm of the last century assumes that Amazonian forests have no economic and social value beyond land. To strengthen the bioeconomy, it will be necessary not only to better manage agriculture, but also to build social and economic systems that place significant value on standing primary forests. The following is a summary of the main conditions that must be met from the value chain perspective used in this study.

Standards, policy and governance

Achieving the bioeconomy in Peru requires a government with the capacity to transparently allocate land rights, regulate resource use, impose sanctions and arbitrate land conflicts in a fair, predictable and inclusive manner under the rule of law. Improving the State's land management capacity is intimately linked to preventing serious and chronic conflicts between natural resource exploitation interests, environmental conservation and the demands of local communities. Land classification and zoning, even at the local district level, is ultimately a public responsibility. Forest landscapes provide both; private goods and services, and multiple public services that must be managed jointly in a sustainable manner. It is clear, for example, that the CT-CUM is not only necessary for the formalization and adjudication of private lands, but also for land-use planning and governance processes. National authorities should assist regional authorities in refining CT-CUM studies at the district level. This would greatly help local authorities with the quality of their Concerted District Development Plans (CDDP) and will significantly reduce transaction costs and uncertainty for private investment wishing to work sustainably and legally in the Amazon.

For the bioeconomy to succeed, the political will must exist to create a culture of cross-sectoral coordination and collaboration, resulting in the generation of mutual trust in public-public and public-private interaction, as MINAGRI is currently leading[835]. The government must also be able to promote, in the long term, favorable market conditions for private agricultural and forestry enterprises, both locally and nationally.

Increasing land tenure security for individuals or communities that have values and interests in expansive agriculture or land-grabbing cattle ranching, rather than sustainable land and forest use, is not an effective strategy for reducing deforestation. Indigenous communities that are close to major roads and have adopted land rental practices, such as the Awajun people in the Alto Mayo watershed[836], show very high deforestation rates.

The practice of regularizing land claims after deforestation is widespread. The current agricultural policy, which rewards deforestation by recognizing it as proof of "*peaceful and productive land possession*", needs to be amended. The National Integrated Cadastre System, created by Law 28294 in 2004, is incipient. The following institutions joined its Council [837]only in 2016: MINAGRI (national authority for rural lands); MINAM and SERNANP (elaborates the national cadastre in relation to Natural Protected Areas); SERFOR (elaborates the national cadastre in relation to forests) and MINCUL (elaborates the national cadastre of indigenous reserves).

The current methodology of the National Agrarian Census (CENAGRO) does not adequately capture either land uses (forestry vs. agriculture vs. natural forest cover) or land use dynamics (productive vs. fallow land) and needs to be updated, as Colombia has already done. By collecting more detailed

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835 MINAGRI, 2020. Roadmap to consolidate the Public-Private Coalition for sustainable jurisdictions and deforestation-free production chains in Peru. Lima, Peru.

836 AIDESEP and FPP, 2014. Making the invisible visible: Indigenous perspectives on deforestation in the Peruvian Amazon. pg.106.

837 The National Cadastre System created by Law 28294 was modified by Legislative Decree in December 2016.

district-level data on the location of productive, degraded, deforested and forested land, public and private actors will be able to make better investment decisions.

Improving coordination among public entities involved in land formalization and titling in the Amazon is key, but not sufficient. Public entities responsible for forest and agricultural land management must also develop more effective strategies to address the challenges of migration, and effectively participate in new landscape approaches to natural resource management. For this, clearly defined roles and competencies must be agreed upon and implemented through joint action protocols, via participatory and adaptive processes.

Supply-side practices and economics

As detailed above, there are significant investment opportunities to increase agricultural, aquaculture, forestry and tourism production. There are successful examples where small-scale producers have partnered with collectors or processors with financial capital and technical sophistication. These interactions should not be seen as unilateral and paternalistic relationships between "rich-modern" and "poor-traditional" farmers, but as an opportunity to exploit complementary capacities and assets (degraded land + local knowledge, on the one hand; technology + financial capital, on the other) to achieve more sustainable land management practices for all. To foster these interactions, policies should be designed to reward and facilitate positive interactions, technology sharing and collective management between different socio-economic groups and land users, rather than focusing on each group and product separately. The role of the state is vital to provide the enabling conditions for these landscape-level collaborations, and to proactively engage in scaling up success stories[838].

Demand-side economics and practices

There is a growing global commitment to zero deforestation supply chains, which can become a driver of the bioeconomy in Peru. Peru is already a regional leader in the production of certified agricultural products, including coffee and cocoa, and can leverage this national knowledge to expand into other sectors. Landscape-level production, monitoring and certification for the production of deforestation-free products is being piloted in Peru. These landscape-level partnerships can serve as a consolidated platform for sustainable enterprises to attract foreign investment and leverage financing, and also strengthen governance capacity through the integrated management and monitoring systems that are being developed to accompany them.

Financial services

Financial services are at an important stage of development in the Peruvian Amazon, as evidenced by the increase in the operations of banking, non-banking, COOPACs and social finance entities in the last decade. However, the level of penetration of these services is still limited, with an emphasis on the provision of credit and a generalized absence of funds for investment in the earliest stages of business.

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[838] Gardner et al., 2014. Governing for sustainability in agricultural-forest frontiers: a case study from the Brazilian Amazon. Stockholm Environment Institute.

Both mechanisms should be strengthened. These financial services must be accompanied by financial technical cooperation, which not only provides support to financial entities that address bioeconomy financing (for example, in training on the different capital and credit needs of the business models and chains to be financed), but also directly in financial inclusion and education for micro and small producers at the base of the value chains of the most innovative sectors (aquaculture, non-timber forest products, nature-based tourism and ecosystem services).

Cooperation and technical services

Landscape management institutions at the national level (MINAM, MINAGRI, SERFOR, OSINFOR) and at the regional and municipal level (DRA, ARA, ARFSS and regional economic development offices) remain weak in terms of policy implementation and actions on the ground, as well as effective monitoring and control capacities. Financial support should continue for the PNCB-MINAM Monitoring Unit and the different services it has begun to provide (long-term forest cover monitoring, deforestation warning services, among others), and the strengthening of CENAGRO, in coordination with the relevant units in SERFOR, MINAGRI and the Presidency of the Council of Ministers (PCM). Monitoring and evaluation of bioeconomy metrics at the territory/landscape level has clear advantages, such as harmonizing sustainable production metrics and streamlining the evaluation of different financing channels and stakeholders: farmers, companies, investors, donors and government institutions. Existing frameworks and data management systems such as the National Geographic Information System (SAYHUITE), the National Environmental Information System (SINIA), GEEOSERVIDOR, GEOBOSQUES, Regional Environmental Information Systems (SIAR) and INFOCARBONO could support environmental information and legal compliance.

Risks of bioeconomy financing in Amazonia

Bioeconomy investment is not without risk and measures must be taken to avoid environmental and social damage from its implementation. Of particular concern are a) the displacement of environmentally degrading activities to other deforestation/degradation frontiers and/or the clearing of secondary forests rich in carbon and biodiversity; b) loss of biodiversity due to intensification of production methods; c) risks to local people's rights (e.g. land conflicts, lack of free, prior and informed consent); and d) increased corruption and illegal activities due to the influx of new economic resources.

Effective strategies to date to formalize and reduce deforestation and degradation in the Amazon, and thus contain these risks, have been:

(1) Support the establishment of national, regional and private protected areas, which provide water, pollination and local climate regulation services to agricultural areas of the landscape, and contribute to the strengthening of other sectors of the local economy (i.e. nature tourism and emerging markets for ecosystem services).
(2) Address indigenous land claims, implementing complementary measures to ensure that indigenous communities maintain a culture that continues to value and sustainably manage forests, in order to halt the increase in land rentals and deforestation that has been occurring on some indigenous lands.

(3) Land titling and land management for small farmers and migrants at the landscape level. This should be implemented sequentially, in whole districts or provinces, in contrast to the current segmented approach that increases the risk of land speculation.

Given the potential impact of bioeconomy financing, the monitoring of its impacts must be integrated into development programs and public policies, respecting the UNFCCC Cancun safeguards and other safeguard standards. There are also several systems for the certification of good agricultural practices that go beyond the general safeguard requirements. It is critical to note that the implementation of the current Peruvian legal framework around social and environmental rights would go a long way towards ensuring compliance with the safeguards, but an in-depth analysis of these linkages is needed. Key areas for this analysis include:

- The importance of addressing land tenure and land rights issues.
- The need for guidelines and model contracts to help ensure equitable agreements between communities and companies, and within associations and cooperatives.
- The potential role of capacity building within cooperatives/associations as a means to help improve social and environmental outcomes.
- The importance of including mechanisms to ensure positive social outcomes for small independent farmers who are often excluded from social protection systems.

Existing projects and projects under currently under development

The Peruvian Amazon Eco Bio Business Facility (Amazon EBBF) proposed by Profonanpe to the GCF, aims to establish in component 1 the enabling environment for REDD + with non-reimbursable grant resources from the GCF and in component 2 capitalize a facility with non-reimbursable seed grant resources from the GCF and provide technical assistance with non-reimbursable funds from the GCF. The component 2 facility will use the REDD + results payments from component 1 and seeks to mobilize additional external financing to support eco bio businesses (EBBs) with non-reimbursable funds for technical assistance, reimbursable grants, equity capital and additional debt resources from impact investors. The proposed facility will use non-reimbursable resources from the GCF (and those to be mobilized by impact investors) for technical assistance to eco bio businesses and will structure a reimbursable grant mechanism to support the 30 bio businesses.

A gap exists to provide these business with support to reach the post-pilot phase. A complementary activity could provide later stage financing of the aforementioned earl(ier) stage bio-businesses. For instance, the IDB Regenerate program if further supported by GCF resources could finance bio businesses in the post pilot/Minimum viable product (MVP) phase. These latter businesses would already have revenue inflows. While Profonanpe would offer local currency financing, and Regenerate would support later stage US Dollar denominated financing.
Thus, a new proposed project could scale the experiences of EBBF. For example, companies that participate in the EBBF could access an additional loan, which in turn would have the guarantee of the technical, financial and social solvency of the venture, having passed the EBBF filters and already having a collateral. Another opportunity could be to generate a more sophisticated value chain or higher added value (e.g. biotech, agrotech) and connection with anchor companies that require a type of financing that the EBBF does not offer.

The Green Climate Financing Facility for Local Financial Institutions in Latin-America implemented by CAF[839] and co-financed by the GCF focuses on providing credits through local financial institutions (IFLs) and technical support specifically for IFLs and support for SMEs (technical studies, training on climate project development).
The proposed IDB-GCF program is complementary to the aforementioned program and i) attends to the Amazon region to which the IFLs proposed by the CAF program do not have broad access, ii) provides access to green capital markets and iii) addresses institutional barriers for both public and private sector financial institutions. The IDB-GCF program proposal uses different instruments beyond loans and technical cooperation, including equity and non-reimbursable funds for investments to promote investment and develop guarantees that want to increase access to financing for small-scale bio-businesses. The technical assistance will allow the development and implementation of institutional frameworks and standardization that facilitate the mobilization of private resources for bio-businesses, the main objective of the IDB regional proposal.
In detail, the following differences have been identified which would make the two programs synergetic:
1. Climate focus on both adaptation and mitigation. The CAF program is focused on mitigation, while the IDB proposal focuses on both mitigation and adaptation.
2. Sector focus. CAF's proposal focuses more broadly on sectors associated with mitigation (including renewable energy generation, energy efficiency in buildings and industry). About 70% of the budget goes to these sectors, and only 30% to land use change. The IDB project, the entire mitigation budget goes towards land use change sectors focusing on lowering deforestation.
3. Geographical focus. The CAF proposal has a national focus, while the IDB proposal focuses on areas of the Amazon. Given the penetration of financial markets in the region, the IDB program is expected to significantly support bio-businesses in the Peruvian Amazon.
4. Financial instruments. The IDB program addresses some additional barriers also from the point of view of financial instruments. In addition to developing and improving the financing terms of LFIs green lines, the program:
1. Provides equity instruments and contingent recovery Investment grants- for companies in an early stage of development, whose ability to obtain bank financing under traditional debt parameters is still limited.
2. Supports the development of thematic bonds that can provide an additional funding alternative (in local currency and long-term) for the financing (direct or indirect) of bio-businesses. In the Peruvian green bond market, the country participated with 6 issuances for a total of USD 1 billion. All issuances have been oversubscribed, which indicates the potential for market growth and the need for technical assistance and financial guarantee instruments to encourage more complex issuances such as of sovereigns and other public sector entities. This is a potentially very significant and differentiating contribution, particularly in relation to the market transformation potential and the long-term sustainability of a program of this type, in the sense that although the concessional funding resources to the banking system will be extinguished At the end of each of these programs, the development of instruments that manage to efficiently and effectively mobilize resources from the capital markets dedicated to this sector of the economy can generate a paradigm shift access broader and more adequate to sources of capital for financial intermediaries and bio-businesses.

[839] https://www.greenclimate.fund/project/fp149

Cost-effectiveness

Based on scenario modeling, the estimated amount USD Cost per ton of CO2eq avoided or sequestered in Peru within the framework of this program would result in a cost of USD 1.03 /tCO2. This is very close to the average for the whole program (USD 0.98 / tCO2) and the average value for Brazil (USD 1.00). It is also higher than for Colombia (USD 0.41/ tCO2) and significantly lower than for the rest of the participating countries (for which it ranges between USD 1.7-3.5 / tCO2). The stated cost per tCO2 values are preliminary. See Annex 22a on the emission reduction calculation. The average cost of the program (and therefore also the estimated for Peru, which is very close) is very competitive in relation to the references of other programs financed by the GCF. in the same sector in Latin America, with values ranging between USD 1-5/ tCO2 for GCF projects).

Appendix 9 – Suriname Bioeconomy Context

Overview of policy, regulations and norms

Suriname has outlined its development priorities in its Policy Development Plan 2017-2021 (PDP). The Plan emphasizes the need for *"economic diversification, using the many possibilities provided by nature and at the same time protect the environment"*. It identifies utilization and protection of the environment as one of four priorities. The PDP is structured around the following pillars[840]:

- Strengthening development capacity
- Economic growth and diversification
- Social progress
- Utilization and protection of the environment

The four pillars provide a solid basis for alignment between Suriname's PDP and its Nationally Determined Contribution 2020 (NDC), namely the two most holistic policy tools that the country has. This is important as Suriname's NDC implementation will be more effective now that it is well integrated within the wider policy context. This policy alignment was achieved via stakeholder consultation mainly during the update of the country's intended NDC (2015). Recommendations were provided, underlining the need for a more representative suite of economic sectors to be included in the 2020 NDC, building on available data. This policy integration touches key issues[841]:

- **Forest cover:** A government commitment to maintain 93% forest cover. A detailed REDD+ Strategy and Investment Plan has been prepared and has been integrated in the 2020 NDC.
- **Mining:** The large impact mining has on forests and biodiversity. The PDP speaks about the need to balance the need for development and the protection of the environment. Several projects have been initiated in the sector and the government expects to include the sector in the 2025 NDC update.
- **Closer integration of mitigation and adaptation:** Both in the field of agriculture and in infrastructure investment it is necessary to integrate climate measures to cover both mitigation and adaptation. The 2020 NDC includes agriculture and transport and infrastructure.
- **Sea level rise:** Vulnerability of Suriname's low-lying coastal zone is acknowledged in both the 2015 NDC and the PDP. The 2015 NDC recommends partial relocation, a response measure not included in the PDP and has been abandoned.
- **Other issues:** The risk of systemic climate impacts in the interior are raised, but a lack of data remains a hurdle in articulating a policy response. Research needs are included in the 2020 NDC.

For the most part, these two main policies also reflect the consensus on how climate-resilience is key to Suriname's development, particularly to achieving the UN Sustainable Development Goals (SDGs). At the national policy level, the mutually supporting nature of the two agendas is very straightforward: delivering on its NDC will help Suriname achieve the SDGs, and achieving the SDGs will facilitate Suriname's efforts to mitigate and adapt to climate change.

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[840] Government of Suriname. 2017. Policy Development Plan 2017-2021. Paramaribo.

[841] Government of Suriname. 2019. Second Nationally Determined Contribution. Cabinet of the President. Coordination Environment.

As a member of CARICOM, Suriname joined the ranks of the Small Island Developing States (SIDS) in 1981 and aligns itself with the Alliance of Small Island States (AOSIS). Although Suriname geographically is not a small island, as a low-lying coastal country it faces similar development challenges, such as limited resources, environmental fragility, high costs of transportation and energy, and vulnerability to climate change and natural disasters.

GDP, income and productivity

Suriname is an upper-middle-income country of 614,749 people and a GDP per capita of US$6,854 in 2019. That same year, Suriname's economy marked its third year of positive growth (2%) since the 2016 crisis. Agricultural products and refined mining products were the main contributors to this economic growth; the share of agriculture in Suriname's GDP was 10.39%, industry contributed approximately 32.74% (gold and oil), and the services sector contributed about 50.16% (led by trade and transport activities that are closely linked to the commodities industry). Commodities account for almost 90% of export revenues and 40% of government income, making the economy vulnerable to international price volatility[842].

Suriname is a mineral rich country and its major export products are gold and oil. The contribution of the mineral sectors in 2017 to GDP, exports and government revenues it was approximately 22%, 80% and 37%, respectively. Since 2000, the rise in international commodity prices resulted in a strong expansion of the Surinamese economy. GDP rose from less than US$1 billion in 2000 to over US$5 billion in 2014, before the 2015 crisis. The economic slowdown and recession were due to the international commodity crisis of 2012–2016 which led to a sharp fall of world market prices of the major export products in this period and the complete shutdown of the bauxite industry in 2015. The peak of the recession occurred in 2016 when the economy shrunk by approximately 8%. Due to the recession, employment in the private sector dropped by approximately 8.8% in 2016 in comparison to 2014[843].

Although the central government narrowed the fiscal deficit in 2019, it remained high, at 10.8% of GDP year-on-year. Total revenue and total expenditure increased by 10.2% and 7.8%, respectively. From the end of 2019 to August 2020 Suriname's total public debt ratio increased by 24 percentage points to 105.8% of GDP. As a large portion of the country's public debt is in foreign currency, the debt to GDP ratio will increase significantly following the devaluation of the Surinamese dollar. The shortage of United States dollars, which have been difficult to access since 2018, was a major concern for Suriname in 2019 and continues to be in 2020. While the official exchange rate has remained steady at 7.52 Suriname dollars (Sur$) to US$1 since 2018, the parallel rate has increased significantly. The shortage of United States dollars and rising parallel rate led to a 17.6% jump in year-on-year inflation in March 2020. Due COVID-19 the fiscal deficit and public debt ratios are expected to

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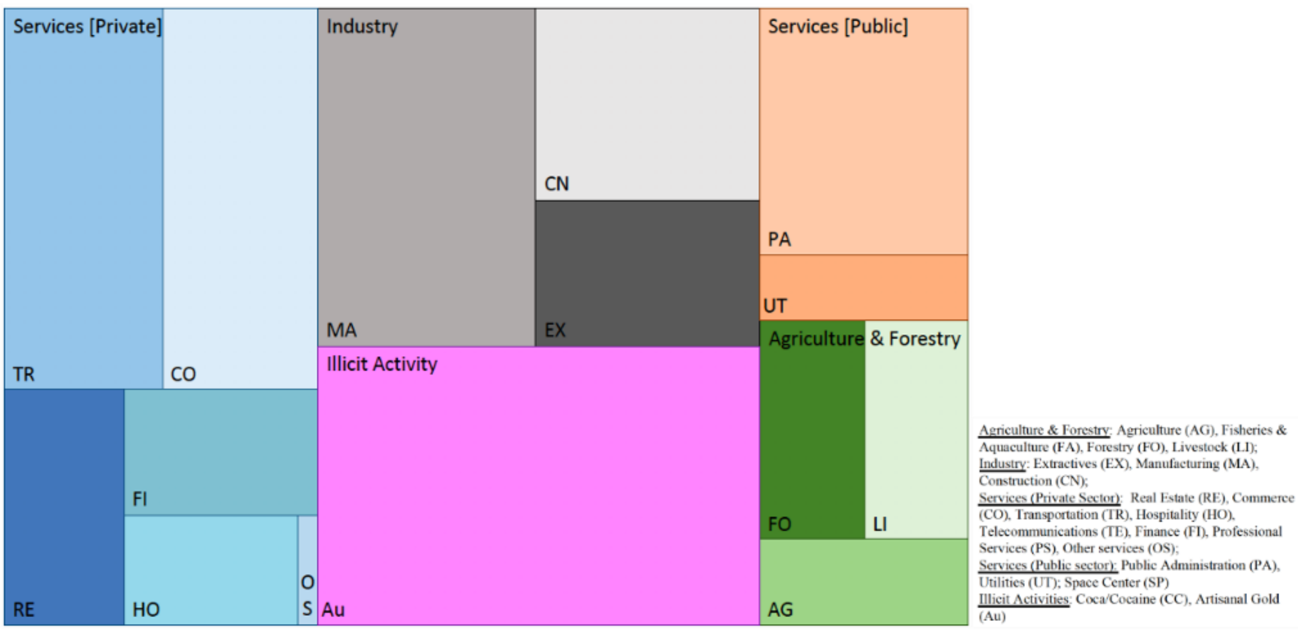
[842] ECLAC. 2020. Economic Survey of Latin America and the Caribbean 2020: Main conditioning factors of fiscal and monetary policies in the post-COVID-19 era. United Nations.

[843] ILO. 2019. Suriname Decent Work Country Program 2019 – 2021.

increase, while economic output will likely contract. As a result, the growth rate experienced for 2020 was around -7%[844].

Agriculture currently accounts for about 9% of GDP, and rice, bananas, fish, and shrimp already generate around US$100 million of exports per year. There are an estimated 1.5 million hectares of arable land, but only about 5% of that is currently under production. Suriname has preferential market access to the Caribbean through CARICOM and export connections to Europe through the Netherlands. Subsector analysis has identified significant potential for increased production and exports of higher-value products in existing and emerging subsectors, such as high-value fruit and vegetables, which could create new jobs as well as increase linkages with the existing 10,000 smallholder farmers and 4,000 fisherfolk[845].

Figure A133: The relative contribution of sectors and subsectors to the GDP of Suriname



Source: Killeen (2021) [846]

Despite the competitive opportunities, the weak legal and regulatory frameworks and limited institutional capacity hinder economic development, diversification, and sector governance. There are also gaps in the regulatory framework to manage environmental and social impacts of economic activities, creating risks for sustainable development and for new private investors. Gaps in the provision of public goods for high-potential value chains also limit competitiveness, diversification, and investment opportunities. Firm level constrains also limit competitiveness, investments, and

844 ECLAC. 2020. Economic Survey of Latin America and the Caribbean 2020: Main conditioning factors of fiscal and monetary policies in the post-COVID-19 era. United Nations.

845 CIIP. 2018. Suriname Investment Climate and Sector Support: Agribusiness Sub-Sector Diagnostic - A deep dive into horticulture and fisheries and cross-cutting finance and logistics constraints. Washington, D.C.: World Bank.

846 Killeen. 2021. A Perfect Storm in the Amazon Wilderness: Success and Failure in the Fight to Save an Ecosystem of Critical Importance to the Planet. The White Horse Press.

growth in diversified economic activities, especially among Small and Medium Enterprises (SMEs). The Government of Suriname (GoS) seeks to achieve economic growth and diversification through good governance, private entrepreneurship, and investment[847].

Social and environmental context

Suriname has an area of 163,820 km^2, divided into 10 administrative districts: Brokopondo, Commewijne, Coronie, Marowijne, Nickerie, Para, Paramaribo, Saramacca, Sipaliwini, Wanica. It is an ethnically diverse nation and multilingual society, reflecting its history. The official language is Dutch. Most of the population is concentrated along the northern coastal strip. The country has a population of about 614,749 people (2019 estimate). More than half of the population lives in and around Paramaribo, both district and capital. The interior is sparsely inhabited. Suriname is home to four distinct Indigenous Peoples (Kaliña, Lokono, Trio, and Wayana) comprising up to 5% of the population. It is also home to six Tribal communities (known as Maroons)[848].

Supported by rising commodity prices of its mineral and oil exports, Suriname's economy grew at an average of 4.4% per year from 2000 to 2012, well above the 2.4% average for Caribbean small states, and per capita income reached US$9,350 in 2014. But as global commodity prices fell, the economy entered a severe recession and per capita income fell to US$6,990 in 2016. The economy is estimated to have stabilized in 2017 and 2018, driven by operations of a new gold mine. There is no official measure of poverty in Suriname, but recent estimates place overall poverty around 26%. Aggregate consumption trends indicate decreasing poverty during the 2000-12 growth period, although increasing subsequently with the economic downturn. Currently Suriname is considered an upper-middle income economy with a high human development index score[849].

Suriname is a High-Forest-Low-Deforestation (HFLD) country, has more than 14.7 million hectares of forests (covering 93% of its territory), and is considered to be the most forested country in the world. National deforestation has been monitored by the Forest Cover Monitoring Unit (FCMU) within the Foundation for Forest Management and Production Control (SBB - Dutch abbreviation)[850]. While Suriname has historically been a HFLD country, information from this source points out relatively high intensity deforestation in the Greenstone belt and an increase in deforestation rates from 0.02% in the 2000-2009 period to 0.05% in the 2009-2015 period. This acceleration may show that the country is initiating its forest transition[851]. A post-deforestation Land Use Land Cover 2000-2017 study shows that the main driver of deforestation is mining (bauxite, building materials, gold and oil) with almost 69%, and within mining mainly gold mining, being responsible for 66% of total deforestation. Infrastructure development, with around 18% of total deforestation, agriculture with 5% and urban

847 World Bank. 2019. Project appraisal document on a proposed loan in the amount of US$23 million to the Republic of Suriname for a competitiveness and sector diversification project. Finance, Competitiveness and Innovation Global Practice. Report No: PAD3081.

848 Government of Suriname. 2020. Second Nationally Determined Contribution of the Republic of Suriname 2020-2030.

849 ILO. 2019. Suriname Decent Work Country Program 2019 – 2021.

850 Government of Suriname. 2019. National REDD+ Strategy of Suriname. Paramaribo.

851 Forest Carbon Partnership Facility. 2017. Mid Term Progress Report – Suriname.

development with 3% have also been identified as relevant drivers of deforestation[852]. Commercial timber logging in Suriname is considered a contributor to forest degradation but not to deforestation, since only selective logging takes place due to, among others, the limited number of commercial tree species, the minimum allowed diameter at breast height to be cut and the promotion of sustainable forest management (SFM) by the government. Commercial logging is taking place only north of the 4° N latitude within the forest belt, covering an area of around 4.3 million hectares, of which 2.5 million ha are currently issued under logging licenses[853].

In terms of conservation, 14.7% of the country's land area is within protected areas. Inside the protected areas the total deforestation was limited over the past 14 years, amounting only 321 ha. Suriname's forest carbon stocks are formally conserved in the protected area system. The country has 16 legally established protected areas, and 4 proposed ones (since the 80s). The 16 areas cover more than 2.1millions ha, and the proposed areas would cover an extra 0.8%. The Central Suriname Nature Reserve, located in the Interior, is by far the largest (>1.5 million ha – 9.7% country surface). The other reserves are no larger than one thousand km^2, and most of them are located along the coast. The notable exception is the Sipaliwini Nature Reserve in the south of Suriname, which was established to protect the country's largest savanna landscape[854].

Suriname is currently drafting a new Nature Conservation Law in a participatory process, to enable improved management of its protected areas. This law will replace the Nature Conservation Act of 1954. In line with the UN Convention on Biological Diversity (CBD) Aichi targets, it is expected that the area with a protective status will expand to at least 17% of the terrestrial land by 2020. This will lead to the expansion of the national network of legally protected areas to accomplish 100% representation of all ecosystems and biological species, according to the National Biodiversity Action Plan (2013), the National Forest Policy (2005) and Suriname's National REDD+ Strategy (2019).

Suriname is part of the Guiana Shield tropical forest ecosystem, one of the largest contiguous and relatively intact, forested ecoregions of the world. These forests provide important goods and services at local and global levels, including income and food security for forest dependent communities and climate change mitigation and biodiversity preservation for society at large. About 10% of the country's population, mainly Indigenous and Tribal Peoples (ITPs), live in the country's forests and depend directly on the forest and its resources for their living. Almost 62,000 ITPs are distributed across 10 communities, 4 of which are of indigenous and 6 of tribal origin. Because of the geographical spread of the communities and characteristics of a certain area, each community can experience particular challenges and opportunities with regard to social-economic development and maintaining ecological integrity[855].

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[852] NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

[853] Government of Suriname. 2018. FREL submission – REDD+ Program.

[854] NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

[855] Government of Suriname. 2020. First Summary of Information on REDD+: Safeguards of Suriname.

Climate profile

Data and knowledge gaps

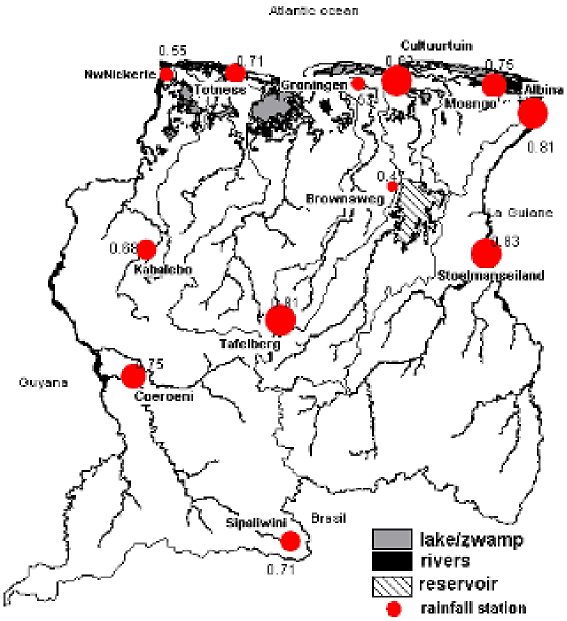
This report provides information at the national level and, where possible, tries to focus on the Amazon region –the proposed target region of the proposed GCF program. This report has been compiled based on available literature, including Government Reports and reporting to the United Nations Framework Convention on Climate Change (UNFCCC), World Bank Climate Change Knowledge Portal, and studies by international and national organizations working on climate change.[856] Much of the accessible climatological data for Suriname is compiled by the Meteorological Service (MDS), supplemented by data from weather and hydrometeorological stations, as well as from agencies such as the General Bureau for Statistics, universities and research institutions, donors and technical partners, and relevant ministries. Detailed information on climate variables, trends and projections is available through the country's second National Communications (SNC) to the UNFCCC from 2016. Other information is available through the country's National Adaptation Plan (2019) and Nationally Determined Contribution (NDC 2020).

It is important to note that information on climate risk and vulnerability varies per region in Suriname, and remains an area where substantial additional research is needed. The country's climate change reporting is limited by its lack of specific data and scientific analysis on topics such as meteorology, topography, erosion, biodiversity, forestry, and socio-economy –which are key determinants of climate risk and vulnerability, especially from rural and forested areas. The available climate and hydrology data sets have significant gaps in historical records; most of the meteorological stations do not have records exceeding a 30-year period, among others, due to the civil war, which led to the closure of all stations in the Hinterland between 1986 and 1992. Problems in data quality are also attributable to outdated or uncalibrated instruments in use by the MDS. Gaps in spatial data coverage also exist due to a low number of weather stations, particularly around the Amazon region (see Figure below) and the lack of technical and financial capacities.[857] In particular, climate risk and vulnerability studies are limited in Suriname's Amazon region, where most studies focus on the national level, or in more densely populated, coastal regions in the country. This is an issue of uneven population distribution (90% of the Surinamese population inhabits the low-lying coastal areas), but also of inaccessibility around the denser Amazon region. In comparison with the central Amazon rainforest, climate risk characteristics of the northern Amazonia rainforests of the Guiana Shield region (Suriname, Guyana, French Guiana, and parts of southern Venezuela and northern Brazil) are even less known.

[856] see list of references

[857] Berrenstein and M.C.A. 2016

Figure A134: Distribution of rainfall stations in Suriname



Source: Nurmohamed and Naipal 2006.

As such, it is important that the following report builds on existing information, and should be interpreted with caution given the aforementioned data and knowledge gaps. It is recommended the program not only promotes activities with adaptation benefits, but also explores synergies to strengthen adaptation monitoring and reporting in the Amazon.

Overall climatology

Suriname's geographical location just 6° north of the equator gives it a warm and moist climate, characterized as tropical wet and hot. It is generally controlled by the bi-annual passage of the Inter – Tropical Convergence Zone (ITCZ). According to the Köppen classification, Suriname has three climate types, namely monsoon, tropical rainforest and a humid-dry climate.[858] Inter-annual variations in climate are caused by the El Niño Southern Oscillation (ENSO). El Niño episodes bring dry conditions throughout the year, and bring warmer temperatures between June and August, while La Niña episodes bring wetter conditions throughout the year and cooler temperatures between June and August.[859]

Temperature

Suriname sees uniformly high temperatures and high humidity, with an observed mean in relative humidity of 81%. Mean temperature ranges between 25°C and 27.5°C throughout the year in the north, and a little cooler, at around 23°C to 25°C, in the southern regions, including the Amazon. The average daily temperature can vary from 26°C in January to 31°C in October; in the coastal region it is 27.4°C, with a daily variation of 5°C. The difference between day and night temperatures in the coastal region can be 6.5°C on average. There is relatively little variation in temperature between the seasons.

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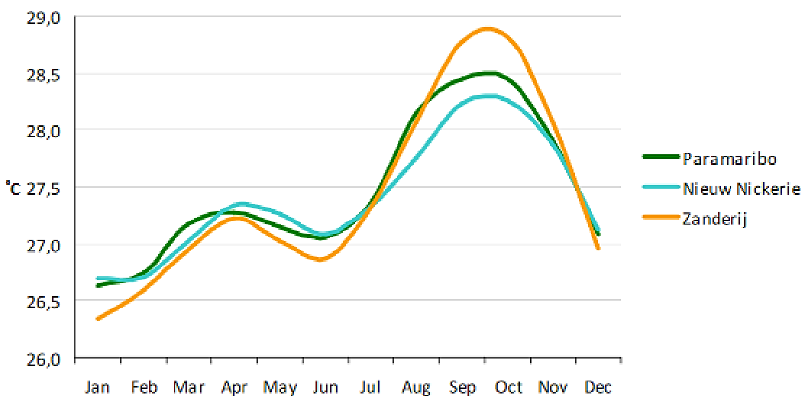
858 Berrenstein and M.C.A. 2016

859 World Bank, n.d.

January is the coldest month (average 26.6°C) and October the warmest (average 28.5°C). Annual variation of the average temperature is 2°C to 3°C. The Interior, including the Amazon region, has relatively similar figures, although variation of daily temperature here can be larger (10°C to 12°C).[860] While the following Figure shows average temperatures from northern regions, similar trends may be assumed for the southern Amazon region, with a higher daily temperature variation.

Figure A135: Average monthly temperatures in coastal Suriname based on 20 years of data



Source: Berrenstein and M.C.A. 2016.

<u>Precipitation</u>

The amount of precipitation varies across the country. Average annual rainfall in Suriname is 2,200mm; however, localized rainfall varies over the terrain where the coastal plains receive on average 1,500-1,750 mm. Paramaribo (northern coast) receives 2,210mm rainfall annually, Coronie and Nieuw Nickerie (north-western coast) respectively receive 1,561mm/year and 1,808mm/year. The central region (including Stoelmanseiland) received receives between 2,500-3,000mm. Kwamalasamutu (south Suriname, around the Amazon region) receives up to 2,109mm/year (see Figure below)).

Variation in monthly rainfall results in two wet and two dry seasons for the northern part of Suriname. However, in the southern part, including the Amazon region, only one major wet and one dry season is distinguished. The major wet season is discerned between May and July when most of the country receives 250-400mm per month, and a minor wet season from November to January, which brings around 150-200mm of rainfall per month. A short dry season is seen from February-April with mean monthly rainfall of 100mm, and a long dry season from August to December, with less than 100mm of rainfall per month[861]

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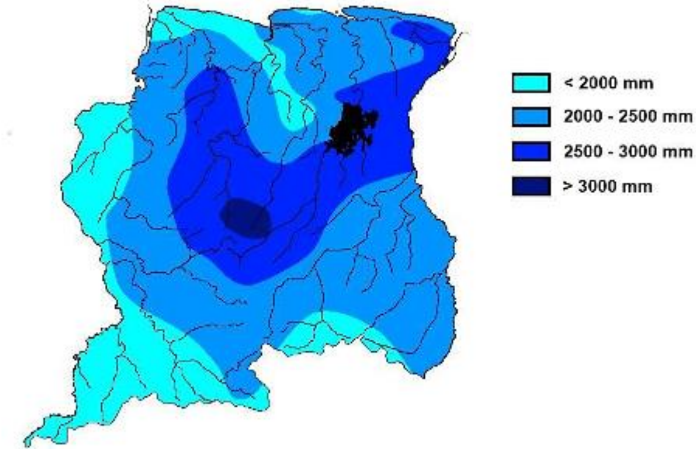
[860] Berrenstein and M.C.A. 2016

[861] World Bank n.d.

Figure A136: Average annual rainfall in Suriname with spatial differences



Source: Berrenstein and M.C.A. 2016.

Climate-related natural hazards

The major climate-related natural hazards in Suriname are summarized in the table below. Suriname is south of the hurricane belt and therefore evades this threat. River flooding and wildfires are categorized as 'high' risks across the entire country and particularly in Sipaliwini district. Data is also available for the two sub-regions in this district which contain the Amazon; Coeroeni experiences high wildfire risk and medium risk of extreme heat, and Tapanahony experiences a high river flood risk and medium risks of wildfires and extreme heat.

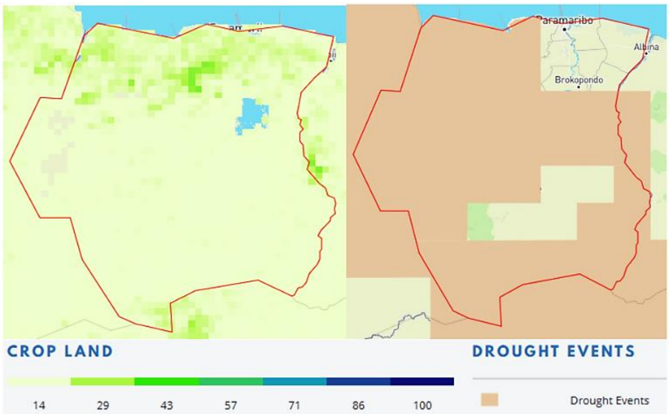
Table A44: Climate-related natural hazards across Suriname, per region

	River flood	Landslide	Extreme heat	Wildfire	Water scarcity	Cyclone
National						
Suriname	High	Low	Medium	High	Very low	Very low
Amazon region						
Sipaliwini	High	Low	Medium	High	Very low	Very low
Coeroeni (Sipaliwini Amazon sub-region)	Low	Low	Medium	High	Very low	Very low
Tapanahony (Sipaliwini Amazon sub-region)	High	Low	Medium	Medium	Very low	Very low

Source: GFDRRR No Date. https://thinkhazard.org

The proportion of crop land in the Amazon region of Suriname is rather low (<14% to 29%) and drought events are experienced across the southern, north- and central-western regions (see figure below).

Figure A137: Drought vulnerability of cropland in Suriname



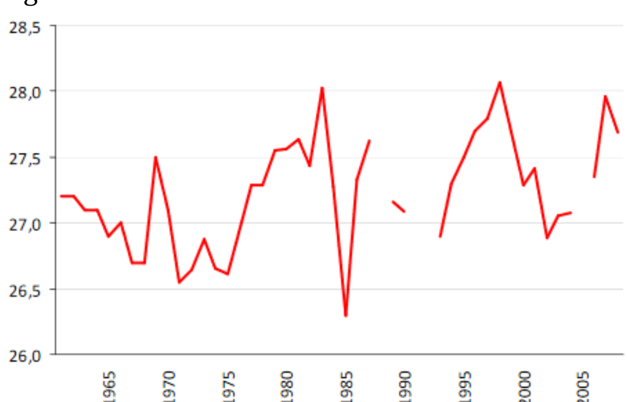
Source: World Bank n.d.

Observed trends of climatic variables

Temperature

The observed trend in temperature for the norther part of the country has been recorded by a single weather station located in the capital city of Paramaribo. Over a 40-year period, the weather station has recorded an average temperature range between 26.3°C and 28°C (see Figure below). The southern part of the country displays a higher interannual temperature variation, despite of the similarities in temperature trends between the north and south regions of the Suriname. However, it must be noted that this weather station has urbanized surroundings, which may influence air surface temperatures.[862]

Figure A138: Observed trends in mean annual temperature, 1965-2005



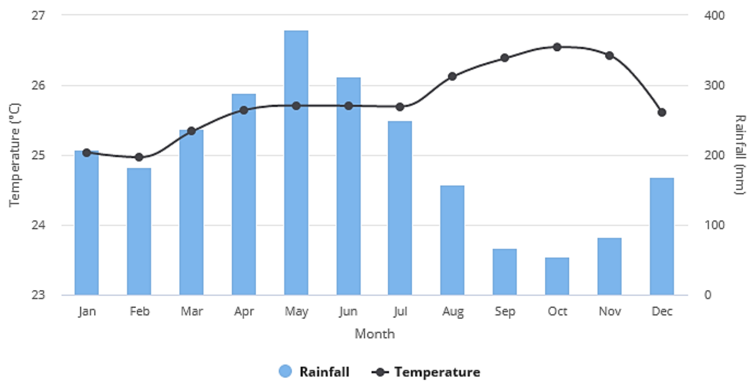
Source: Berrenstein and M.C.A. 2016.

The average monthly temperature and rainfall trends indicate that mean annual temperature has increased by 0.2°C since 1960, at an average rate of 0.05°C per decade (see Figure below). This increase rate is considered to be less rapid than the global average and is more extreme in the north than in the southern or Amazon regions of Suriname. The observed rate of increase is most rapid in

[862] Berrenstein and M.C.A. 2016

May-July, at about 0.1°C per decade. The average number of hot-days per month in December-February has increased by an additional 24% between 1960 and 2003. Similarly, the number of 'hot-nights' per year increased by an additional 28% in the same period. Warming effects are more abrupt in the western part of the country and slower in the Amazon region. [863]

Figure A139: Average monthly temperature and rainfall in Suriname from 1901 - 2016

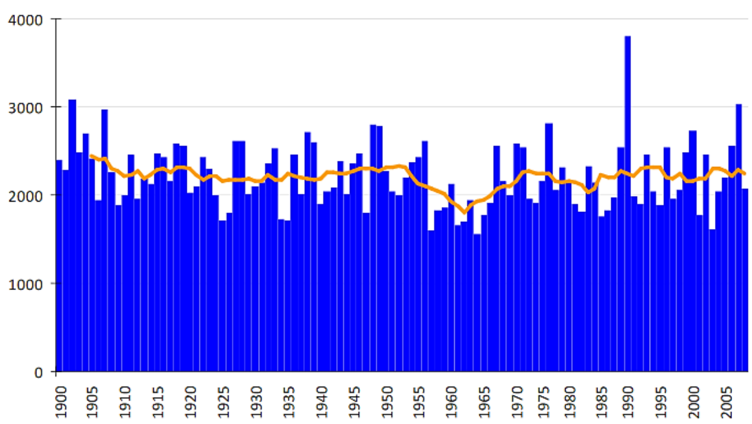


Source: World Bank Climate Change Portal n.d.

Precipitation

In Suriname, there has been no statistically significant trend observed for mean annual rainfall since 1960. Long-term trends are difficult to identify due to the large inter-annual variability in rainfall (see Figure below), which is even higher in the southern and Amazon regions.[864]

Figure A140: Annual rainfall averages between 1900 to 2008, averages taken from Paramaribo where the *moving orange line represents the 10-year average*



Source: Berrenstein and M.C.A. 2016.

Climate-related natural hazards

[863] World Bank n.d.

[864] World Bank n.d.

Suriname has been experiencing loss and damage across key sectors due to climate-related natural hazards, especially from river floods. Heavy rainfalls in 2008 flooded villages and crops both in Suriname's eastern coastal and inland areas (including the Tapanahony region in the Amazon). In the southern Amazon and bordering regoin, an estimated 30% of the livestock, 65% of crops, and 90% of the fishing industry were impacted. Greater rainfall variability due to climate change has been reported over the past decades, which also increased the occurrence of droughts, and to some extent, landslides in some areas.[865]

Additionally, almost 30% of the country is within a few meters above sea level, making it susceptible to coastal flooding. As nearly 90% of Suriname's population (two thirds of whom live in the capital, Paramaribo) and most of the country's fertile land and economic activity are located in the 384 kilometer-long coastal plain, sea level rise represents a significant climate and development challenge, both historically and at present.[866]

Climate change projections

The climate change projection data shown uses the CMIP5 ensemble models from the World Bank Climate Change Knowledge Portal, and the PRECIS climate change model under the Special Report on Emissions Scenarios (SRES) A1, A2, B1, and B2[867]. According with the IPCC SRES report[868], the scenarios describe the following conditions:

- "*A1: convergent world; rapid economic growth; a global population that peaks at mid-century and declines thereafter; rapid introduction of new and more efficient technologies; convergence among regions, capacity building, and increased cultural and social interactions; and substantial reduction in regional differences in per capita income.*
- *A2: heterogeneous world; self-reliant nations and preservation of local identities; fertility patterns across regions converge very slow, which result in continuously increasing global population; economic development is regionally oriented and per capita economic growth and technological change are more fragmented and slower.*
- *B1: convergent world; global population peaks in mid-century and declines thereafter; rapid changes in economic structures towards a service and information economy, with reductions of material intensity; introduction of clean and resource-efficient technologies; emphasis on global solutions economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives.*
- *B2: heterogenous world; local solutions to economic, social, and environmental sustainability; continuously increasing global population but with a lower rate than A2; intermediate levels of economic development; less rapid and more diverse technological change than in B1 and A1".*

Temperature

RCP4.5 projections indicate that mean annual temperature will increase by 0.95°C in 2020-2039, 1.32°C in 2040-2059, 1.76°C in 2060-2079, and 1.85°C for the period 2080-2099. Additionally, it is projected that the highest monthly temperature variations will occur during the end of June until early

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[865] GFDRR n.d.

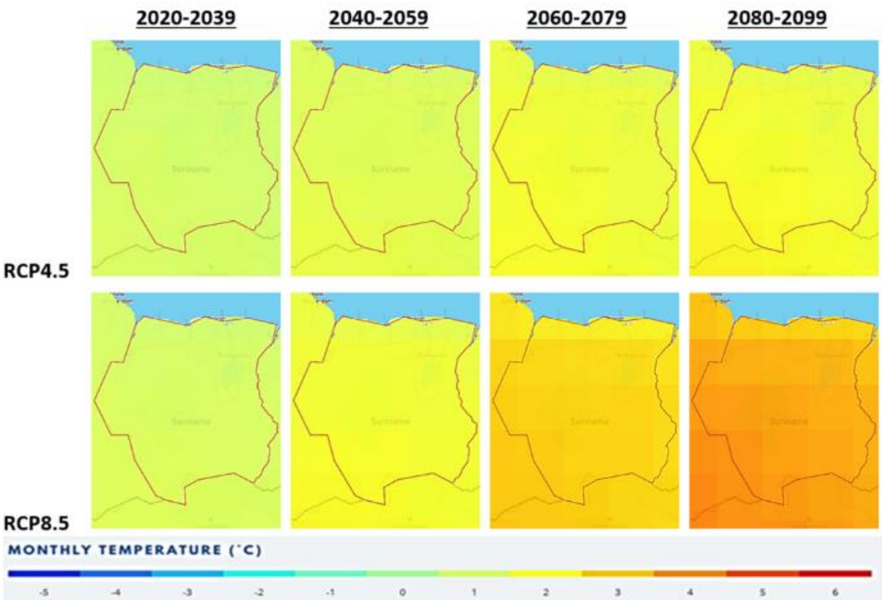
[866] GFDRR n.d.

[867] Berrenstein and M.C.A. 2016

[868] IPCC 2000, p. 4-5

November. Under RCP8.5, the mean annual temperature will increase by 0.8-3.1°C by the 2060s, and 1.3-4.7°C by the 2090s; where a slightly higher warming rate is projected in the south-western regions -including the Amazon region (see Figure below).

Figure A141: Change in monthly temperature of Suriname based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099



Source: World Bank Climate Change Portal n.d.

All projections additionally indicate substantial increases in the frequency of days and nights that are considered 'hot' in the current climate. Annually, hot days and nights will increase their occurrence on 20-59% and 38-93%, respectively by the 2060s, and on 20-81% and 56-99%, respectively by the 2090s. Seasonally, days that are considered hot are projected to occur on 20-98% by the 2090s, with the fastest rates occurring in August-October and February-April. Nights that are considered hot for each season will occur on 59-99% in every season by the 2090s with the fastest rates of increase occurring in August-October and November-January. Projected increases in 'hot' days and nights are more rapid over coastal and ocean regions than in the interior or Amazon regions. Finally, all projections indicate decreases in the frequency of 'cold' days and nights. Cold days are expected to become exceedingly rare, occurring on maximum 5% of days in the year, and potentially not at all, by the 2090s. 'Cold' nights do not occur at all by the 2090s in any season.[869]
The following table contains a summary of projected changes of temperature-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A45: Projected changes of temperature-related climate variables in Suriname (at the national level), compared to 1986-2005

Variable	***RCP 2.6***				***RCP 4.5***				***RCP 8.5***			
	2020-39	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***	***2020-39***	***2040-59***	***2060-79***	***2080-99***
Maximum daily	1.04	1.44	1.38	1.25	1.15	1.82	2.21	2.37	1.52	2.37	3.58	4.80

[869] World Bank n.d.

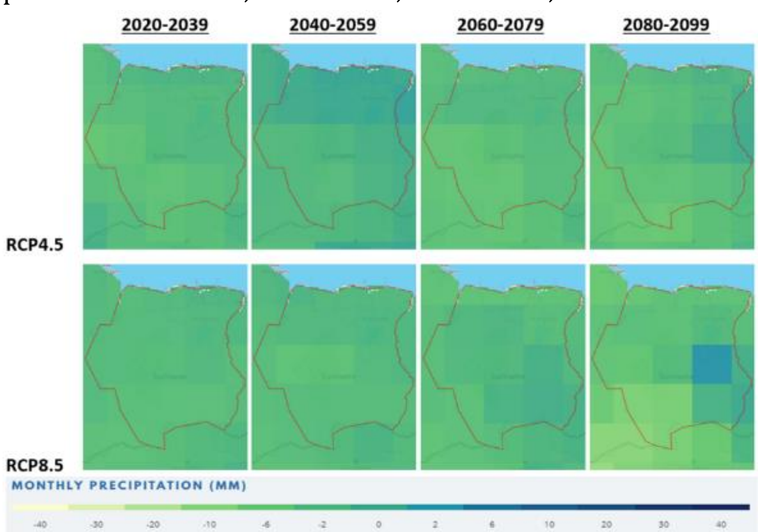
temperature (°C)												
Minimum daily temperature (°C)	0.91	1.25	1.23	1.14	0.96	1.48	1.91	1.98	1.07	1.92	2.92	3.89
Hot days (above 35°C)	20.11	25.68	24.87	22.81	22.08	39.52	56.39	56.79	31.03	59.66	104.18	156.90
Hot days (above 40°C)	0	0	0	0	0	0	0	0	0	0.04	0.98	6.58

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Precipitation

Projections of mean annual rainfall based on RCP4.5 show a decrease of (-) 2.33mm for the period 2020-2039. A decreasing trend of projected monthly precipitation is observed for the periods 2040-2059, 2060-2079, and 2080-2099 with values of -1.31mm, -3.46mm, and -4.28mm, respectively. The Amazon region will experience both increases and decreases in different areas (see below). The period from May to June will see the biggest changes in precipitation.

Figure A142: Change in monthly precipitation in Suriname based on RCP4.5 and RCP8.5, for the periods 2020-2039, 2040-2059, 2060-2079, and 2080-2099



Source: World Bank Climate Change Portal n.d.

Regional Climate Model (GCM) rainfall projections indicate large decreases in rainfall in all seasons across the country. The maximum decreases are projected for the September-November season. Furthermore, the proportion of total rainfall that falls in 'heavy' events increases slightly in most GCM model predictions, changing from -6% to +11% by the 2080s.[870]

870 World Bank n.d.

The following table contains a summary of projected changes of precipitation-related climate variables according with RCP2.6, RCP4.5, and RCP8.5 compared to the baseline data 1986-2005.

Table A46: Projected changes of precipitation-related climate variables in Suriname (at the national level), compared to 1986-2005

Variable	RCP 2.6				RCP 4.5				RCP 8.5			
	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99	2020-39	2040-59	2060-79	2080-99
Days with rainfall >20mm	-0.44	-0.46	-0.21	-0.40	-0.29	0.01	-0.21	-0.08	0.03	0.61	0.16	0.23
Rainfall of very wet days (%)	-30.48	-25.03	-20.05	-19.78	-5.01	-1.62	-6.68	-7.13	-4.49	-4.52	-13.87	-25.14
Maximum daily rainfall (10 year RL) (mm)	0.23	1.14	2.91	0.34	1.42	4.30	2.01	1.07	2.16	6.23	4.57	5.69
Maximum daily rainfall (25 year RL) (mm)	3.10	3.17	4.73	1.92	3.39	6.79	4.50	4.72	4.20	8.15	7.10	11.91
Projected change in annual rainfall (mm)	-26.02	-83.65	-11.54	-20.52	-97.29	-43.06	-70.25	-80.14	44.03	-31.80	26.42	-18.75
Severe drought likelihood	0.10	0.10	0.11	0.14	0.10	0.20	0.24	0.29	0.17	0.22	0.36	0.60
Probability of heat wave	0.09	0.13	0.12	0.13	0.11	0.19	0.29	0.32	0.13	0.28	0.54	0.75

Source: CPIM5 ensemble model projections from World Bank Climate Change Knowledge Portal

Climate-related natural hazards

Suriname is at risk from several natural hazards, including hurricanes and storms, floods, and droughts, which are all expected to increase in intensity with climate change. While Suriname lies outside the hurricane belt, the country's weather is occasionally affected by the tails of hurricanes. In addition, and even of more concern, is an increase in "*sibibusis*", local storm events characterized by heavy rain and bursts of strong, localized rotating wind. These events have resulted in flooding, saltwater intrusion and landslides. Local gales occur before storms, generally at the end of the rainy seasons and can reach maximum wind speeds of 20-30m/s. Such gales occur over the entire country, including the Amazon region, and may destroy trees and houses.

Closely associated with the *sibibusis* events is flooding. Storm surge and intense rainfall (which are expected to increase) have caused severe flooding of roads in the coastal capital and in the interior. By estimates, a one-meter rise would impact over 6.4% of GDP, 7% of the population, and 5.6% of agricultural land. The impact to agriculture is of particular concern as the sector is critical to Suriname's economy.

Droughts are typically associated with El Niño events. Climate change projections indicate that annual rainfall may decrease and temperature will increase; therefore, drought conditions may become more common, yet equally difficult to predict.[871]

Exposure and vulnerability

Exposed elements are described in detail in the accompanying chapters of the country profile. With regards to vulnerability, it is key to focus on sensitivity and capacity:

In terms of sensitivity, there are various biophysical considerations:

- **Flooding:** The susceptibility of slopes and soils to flooding is very high and high, respectively, within the Amazon region of Suriname (see following two figures).[872] In terms of hydrological endowment, the region has moderate to very low susceptibility to floods due to this biophysical characteristic.[873]
- **Droughts:** Suriname's Amazon region is susceptible to droughts when considering its hydrological endowment, with moderate to very high susceptibility.[874]

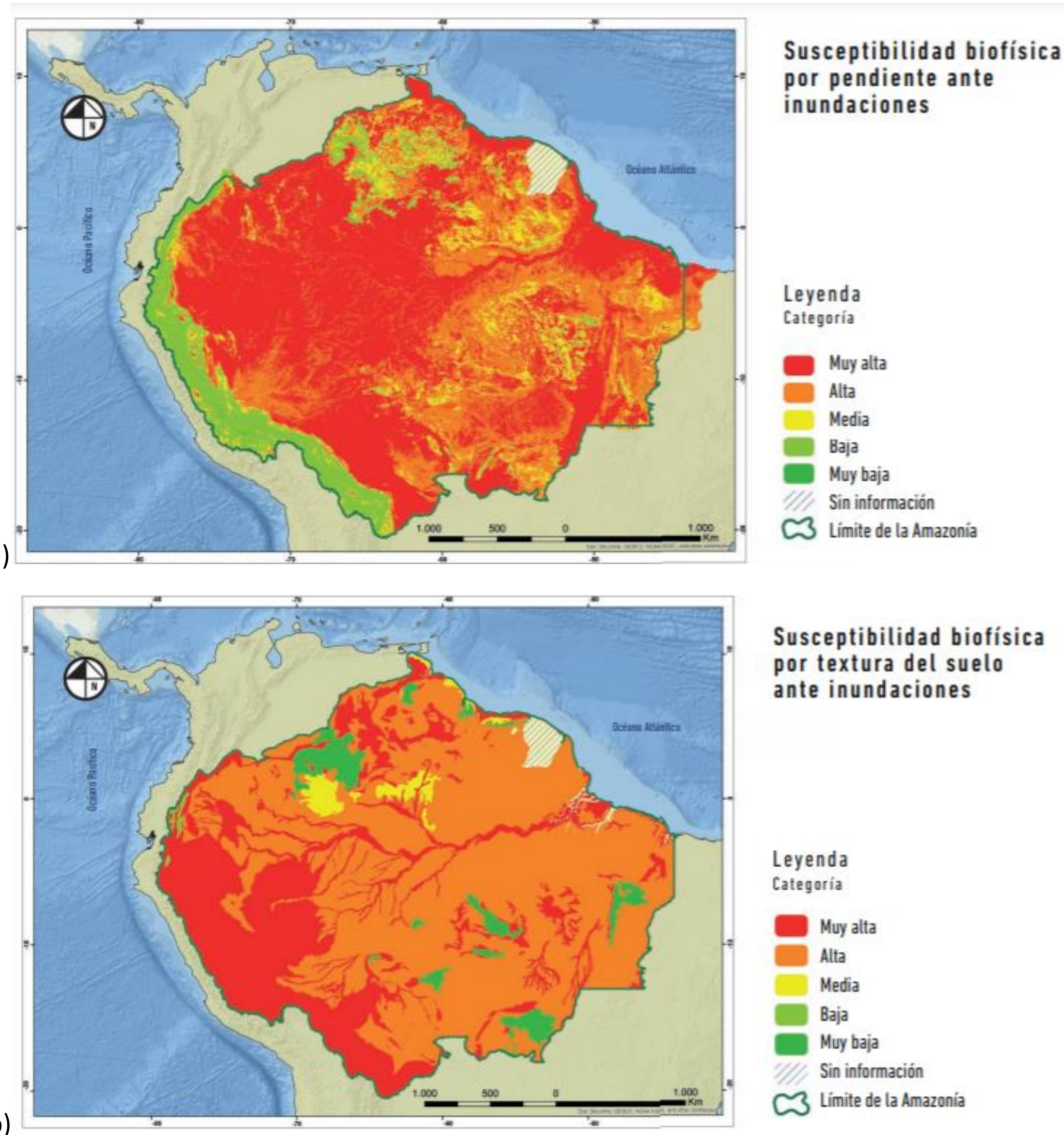
871 World Bank n.d.

872 Pabón-Caicedo et al. 2018

873 Pabón-Caicedo et al. 2018

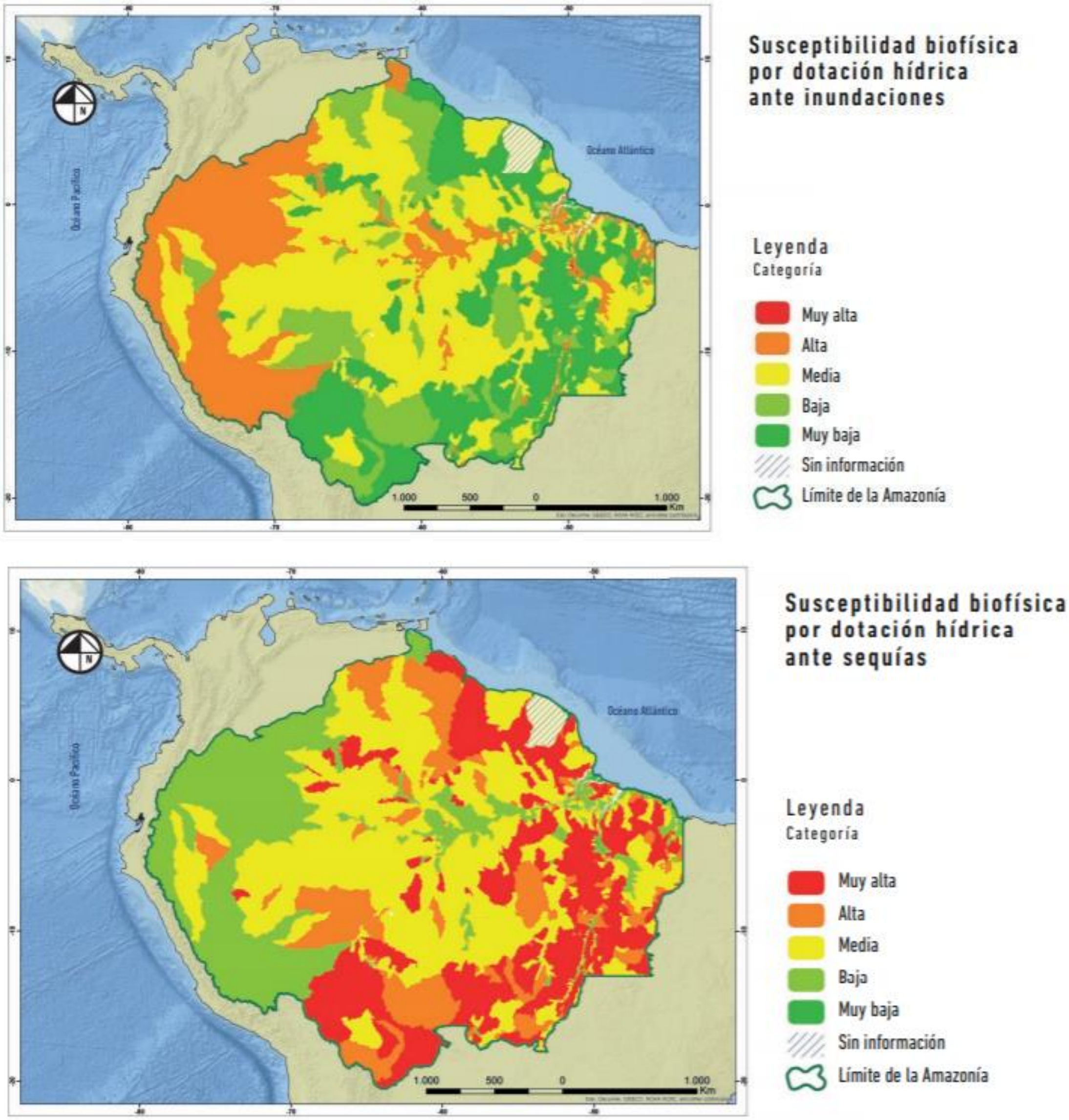
874 Pabón-Caicedo et al. 2018

Figure A143: Biophysical susceptibility of a) slopes and b) soil textures against floods in the Amazon Basin



Source: Pabón-Caicedo et al. 2018, p. 42

Figure A144: Biophysical susceptibility in terms of hydrological endowment to a) flooding and b) droughts in the Amazon Basin



a)
b)

Source: Pabón-Caicedo et al. 2018, p. 42

In terms of capacity, there is limited information on the specific adaptive capacities and coping capacities in Suriname's Amazon region. The Second NDC notes the relevance of capacities and resilience building, however there is no information on the capacities at the regional level.[875] The Second NDC notes "*Scientific capacity is constrained and Suriname lacks knowledge of climate change risk for the agricultural sector in the near term, as well as the rate and scale of slow-onset changes, and the magnitude of their consequences in the long term*"[876], thus there is a need to build capacities in the agriculture sector. The NDC further has a strong focus on REDD+, and mentions the need for building up national research and innovative programs, and to support the diffusion and scaling up of climate-

[875] Govt. of Suriname 2019b

[876] Govt. of Suriname 2019b, p. 17

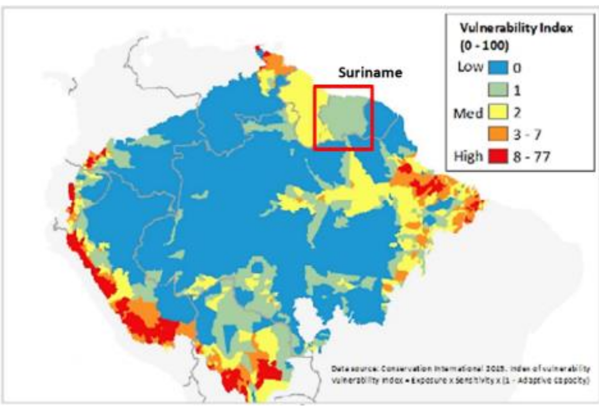
smart systems.[877] It mentions the role of shifting cultivation within Suriname's interior by vulnerable communities, and the role of REDD+ to also pilot supporting such communities with more permanent agricultural systems to strengthen resilience.[878]

Climate risks and impacts on the bioeconomy and local livelihoods

Climate Risk Suriname

Overall, Suriname is considered to face a low level of climate risk compared to countries in the wider Amazon/Caribbean area.[879] The following Figure shows the vulnerability index for the Amazon basin, where Suriname scores 1 out of 100, putting it in the 'low' category. On the GermanWatch Climate Risk Index for 2021, Suriname is ranked 130th in the world for overall risk, 106th terms of fatalities, and 130th in terms of climate related losses suffered. The scoring takes into account the extent to which Suriname is affected by climate related extreme weather events and its impacts.

Figure A145: Index of Vulnerability in the Amazon basin



Source: USAID 2018.

The major threats posed by climate change in the country are flooding, drought and high winds during extreme weather events. Indigenous communities, often located near rivers, are prone to localized flooding.[880] The following table summarizes three key flooding events in the past 50 years and the resulting casualties. Specific information regarding climate hazards in the Amazon region is not available, however it is assumed that given the prevalence of rivers in the Southern parts of the country, localized flooding occurs from time to time. The 2006 flooding events caused an estimated crop loss of approximately $13 million. Cassava, the food staple of the majority of the agricultural communities in the interior (including the Amazon), incurred the most damage, at approximately $6.4 million.[881]

Table A47: Key natural disaster events in Suriname, 1900 to 2012

877 Govt. of Suriname, 2019b

878 Govt. of Suriname, 2019b

879 USAID 2018

880 World Bank n.d.

881 UKAID 2012

Natural Disaster	Date	Fatalities	People affected
Flood	1969	N.A.	4,600
Flood	2006	3	25,000
Flood	2008	2	6,548

Source: Schmeitz, 2014

Climate Impacts and Risk for the Amazon

Several adverse effects on the health and livelihoods of the population as well as vital ecosystems in the Amazon region can be inferred from the possible effects of climate change:

Risk of food insecurity, production losses and damages in the agricultural sector:

- Climate change is projected to **impact production systems** in diverse ways that could jeopardize food security, affect human health, and lead to losses and damages in the agricultural sector and related livelihoods. While there are limited studies available on the Amazon region in Suriname, potential impacts could include: changes in productivity, crop failure, increased or changing need for production inputs, losses and damages due to hazards, shifting production zones, pest and disease outbreaks, among others, altogether leading to loss of outputs and incomes. It should be noted that impacts will vary depending on the specific production systems, and on other factors (location, producer type, inputs used, infrastructure and equipment, etc.).[882]
- In the country's interior, including in the Amazon region, Indigenous and Tribal Peoples rely on the forest as a source of food, fuel, medicine and agriculture, using shifting cultivation practices. Changing climate trends and increased frequency and intensity or hazards will **reduce the amount of forest-sourced food and material available to these communities**, which will impact their food security and livelihoods, increasing overall vulnerability.[883]

Risk of damages and losses to infrastructure and other economic sectors

- Climate change and climate-related hazards (such as extreme drought and flood events) may **increase losses and damages** in various sectors in the Amazon region. Other climate-related hazards (e.g. increase in wildfires) will result in more losses and damages to communities in the Amazon, as well as infrastructure (e.g. housing, small-scale farms and tourism infrastructure), as well as jeopardize tourism opportunities and incomes.[884]

Risk of injury, illness, death and adverse health impacts

- With an expected increase in intense rainfall and flooding, the need for large-scale evacuations, as well as deaths, infrastructure damage and health impacts will increase the overall risk faced in the Amazon region.[885]
- Climate change is expected to generate negative health impacts, including: death and injury from climate-related hazards, air pollution (incl. from forest fires), increased cardiovascular and

[882] World Bank n.d.

[883] Govt. of Suriname 2019

[884] Govt. of Suriname 2019a; UKAID 2012

[885] Govt. of Suriname 2019a

respiratory disease due to increased temperatures (particularly affecting the elderly), among others.[886]

- Climate change has the potential to increase air and soil temperatures that could create the necessary conditions for a **wider distribution of disease transmitters** such as mosquitoes, ticks and rodents. Consequently, conditions for the spread of water and vector-borne diseases (e.g. schistosomiasis, leishmaniasis, dengue fever, malaria etc.) and epidemics would be more likely to occur.[887]

Risk of ecosystem transformation and loss of ecosystem services and biodiversity

- Climate change will have diverse impacts on ecosystems, including potentially (Govt. of Suriname 2019a): **biodiversity loss, forest degradation,** flooding and direct damage to ecosystems potentially changing ecosystem function and/or the provision of ecosystem services, changes in biodiversity conservation, and outbreak of diseases.
- Beyond this, **deforestation and forest degradation in the Amazon exacerbate the impact of climate change** on ecosystems and local communities. Deforestation leads to increasing erosion and sedimentation, which can in turn increase flood risks, and result in riverbed rise and riverbank cutting. The conversion of forests and savannah into grasslands potentially causes climate feedback loops that reduce precipitation and increase temperatures through changes in the albedo and surface roughness.[888]
- Forest degradation may also contribute to **pest and disease outbreaks, and reduced provision of other key ecosystem services**. Studies on the Guianas Shield (including Suriname and its Amazon region) show a negative correlation between growth rates of trees and increases in annual average temperature, annual maximum temperature and intensity of the dry season. This will result in stress and reduced net primary production and, causing impacts on **ecosystem structure, and fragmenting forest margins**. These areas are then more vulnerable to stresses such as increased wind speed, turbulence, elevated temperatures, reduced humidity, increased sunlight, increased drought and fire risk, etc.[889]
- The effects of **increasing climatic exposure** may deepen for sensitive ecosystems with anthropogenic or intrinsic stressors, such as land-use change, infrastructure development, and deforestation usually cause significant impacts on natural systems and may alter the way that ecosystems respond to climate change (e.g. erosion and sedimentation – exacerbated by intense rainfalls – could contribute to an increased risk of flooding).

The following Table provides a summary of potential climate impacts on the main sectors covered by the proposed GCF project:

Table A48. Overview of potential climate change impacts and projected risks on key sectors in Suriname's Amazon region

[886] Govt. of Suriname 2019a

[887] Berrenstein and M.C.A. 2016

[888] Prüssmann et al. 2016

[889] Bovolo et al. 2011

Sector	Potential impacts and risks
Agriculture	▪ Changes in crop suitability for certain areas (esp. due to river and coastal inundation/flooding, rainfall decrease, temperature increase and drought) ▪ Interruptions to crop growth cycle from warmer temperatures ▪ Changes in crop yields and productivity of key crops (esp. cassava, rice, banana, vegetables and fruits) in inland areas ▪ Loss of arable land
NTFPs	▪ Decrease in NTFP quality and availability due to inadequate growing conditions, shocks (drought, flood, fires), pest and disease outbreaks and increasing pressure on natural forests
Aquaculture & Fisheries	▪ Annual recurring/intense drought events threaten water quality and quantity for fisheries sector ▪ Water quality deterioration especially in freshwater fisheries, due to changing temperature and rainfall (changes in pH, oxygen levels etc.) ▪ Oxygen depletion and high-water temperatures in brackish-water lagoons, freshwater swamps and rainforest creeks causing catfish, snook, tilapia, mullet and tarpon mortality, and disrupting reproduction of three key catfish species ▪ Decline in fish populations
Tourism	▪ Damage to key tourism hotspots and tourism infrastructure creating higher operational costs (insurance, evacuation, back-up systems) that cannot be borne by majority small-scale tourism operations ▪ Damage to forest resources due to wildfires ▪ Risk of reduced attractiveness of tourism in areas with increasing disease incidence (schistosomiasis, leishmaniasis etc.) ▪ Risk of decreased attractiveness of key tourism features due to precipitation variability (particularly for rainforest treks, wildlife and bird watching, river tours and community-based tourism)
Ecosystem regulation services	▪ Decrease in biodiversity (particularly among fish and threatened species) due to changes in habitat, bushfires and changing climatic conditions ▪ Changes in ecosystem functions, including regulatory, production and cultural services due to cascading effects of dry conditions ▪ Risk of biodiversity loss, endangered flora and fauna ▪ Risk of reduced ecosystem capacity to regulate key hazards (flood control and drought resilience)
Forest	▪ Loss of carbon stocks, and reduced evapotranspiration and rainfall recycling ▪ Increased emissions from deforestation and forest degradation ▪ Diminished capacity of forests to provide protective services against climate-related events and extreme weather ▪ Decline in forest productivity, tree growth and reforestation viability due to drought, reduced humidity, reduced precipitation volume

	▪ Forest degradation and interruptions to landscape connectivity ▪ Risk of increased conflict/land use competition with and forest-adjacent communities ▪ Reduction in availability of key forest products such as food, fuel, and construction and craft materials

Source: World Bank CC Portal n.d.; Govt. of Suriname 2019a; Govt. of Suriname 2019b; Berrenstein and M.C.A. 2016; UKAID 2012.

Climate change benefits from bioeconomy investments

The proposed GCF program will help to catalyze private sector investments in the bioeconomy, with diverse climate change mitigation and adaptation benefits. As per its NDC, submitted in 2020, Suriname aims to diversify the national economy by ensuring sustainable alternative livelihoods for forest-dependent communities and using nature-based solutions. This includes promotion of forest and non-timber forest products (NTFPs), nature or eco-tourism, and agroforestry.[890] The country's NAP also lists the increase in reforested areas, agroforestry, enrichment of buffer zones, soil conservation, sustainable fisheries management, and eco-tourism as key focal areas or targets for the development of its forestry, fisheries and land use sectors.[891]

While the specific benefits vary with the investment and specific context (e.g. country, region, site-conditions, etc.), many of the program´s investments are expected to generate positive adaptation impacts, including:

- Increased ecosystem resilience in response to climate change
- Diversified and strengthened livelihoods, and sources of income in the Amazon region
- Scaling up and replication of climate-resilient agriculture, forestry and other land use activities (e.g. agroforestry, ecotourism)

The program is aligned with the NDC, Nap and National Climate Change Policy Strategy and Action Plan, among other key strategies and policies.

NDC: Suriname submitted its second NDC in December 2019. As low-lying coastal country and, considered, a small island developing State (SIDS), Suriname and its population face vulnerability as economic activities are concentrated in the coastal zone. Therefore, Suriname's NDC incorporates adaptation elements, including its 2019 National Adaptation Plan (NAP) as part of its climate strategy. Among its conditional and unconditional mitigation contributions, Suriname's NDC presents a package of policies and measures with sectoral sub-targets, including enhanced contributions from four of the country's six emitting sectors: forests, electricity, agriculture, and transport, which together cover an estimated 70% of emissions. In its NDC submission, Suriname emphasizes its efforts to protect its natural resource and forests serving the global community as a biodiversity hotspot and a carbon sink. Suriname commits to maintaining 93% forest cover. Suriname's forests store 13.1 $GtCO_2e$. Due to its vast forest areas and the amount of carbon there stored, Suriname is a carbon negative country[892]. On

[890] Govt. of Suriname 2019b

[891] Govt. of Suriname 2019a

[892] Government of Suriname. 2019. Second Nationally Determined Contribution. Cabinet of the President. Coordination Environment.

the organizational side, Coordination Environment, as the Policy Unit of the Office of the President, plays an important role in the implementation of climate related policies.

NAP: Suriname's NAP covers adaptation needs at two levels. First are the adaptation priorities at the strategic national level that will strengthen efforts across the board, now and in the future. The strategic level priorities covered under the NAP are[893]:

- Institutional arrangements, policies and capacities able to lead and coordinate national and sub-national climate change adaptation
- Data and information collection systems to fully support national and sub-national climate change impacts, vulnerability and adaptation decision-making
- The integration and institutionalization of climate change adaptation in broader Surinamese economic development policies, plans and programs
- National technical capacity that is fully trained and skilled at leading and implementing Suriname's climate change adaptation actions
- Climate change adaptation that respects Surinamese society and culture and reduces gender and social inequities and
- Identify and access financing and investment especially for innovation driven climate change adaptation technologies. Further strategic objectives, adaptation measures and outcomes for each priority are noted.

The second level refers to the economic sectors that are prioritized for adaptation based on climate risk and vulnerability. This approach considers all thirteen national sectors as identified and segmented in the National Climate Change Policy Strategy and Action Plan (NCCPSAP). These thirteen sectors are: Environment, Disaster Risk Reduction, Spatial Planning, Agriculture, Forestry, Mining, Energy, Water, Tourism, Infrastructure, Housing, Education and Health. These sectors can be further clustered into three "streams" as follows[894]:

- **Cross-cutting integrative Sectors:** These are sectors that overarch the functioning of the productive sectors and while they each have separate risk and vulnerability profiles in and of themselves, they can also be leveraged to affect multiple productive sectors at the same time, cumulatively, in parallel and even additively. The sectors clustered here are: environment, disaster risk reduction and spatial planning.
- **National productive capacity sectors:** These are the main economic drivers at the core of national development. They are the main foreign exchange earners and sources of employment in Suriname. As such, they are the focus of climate change adaptation efforts. These sectors are largely natural resource based and, in some cases, for example the water and energy sectors, they also serve a public-centric focus such as potable water supply and/or electricity generation, along with the broader economic contributions. The sectors clustered here are: agriculture, forestry, mining, energy, water, tourism, infrastructure and housing.
- **Cross foundational support sectors:** These sectors are the foundation of long-term building of national economic wealth, sustainability, resilience and sustained development. Essentially,

[893] Government of Suriname. 2019. National Adaptation Plan.

[894] Idem.

progression through growth, development and climate change adaptation in each of the productive and cross-cutting sectors noted above, will be handicapped without maintaining the viability and strength of these cross foundational support sectors. The sectors clustered here are: education and health. Again, while both these sectors require adaptation attention, their underlying foundational support for all other sectors is important.

Among all the economic sectors, agriculture is special because it is a source of emissions while at the same time being strongly impacted by climate change. This dual challenge frames Suriname's commitment to include the sector in the NDC. Therefore, land use planning and research and development of climate-smart farming are central to Suriname's climate action.

Suriname aims to diversify the national economy by ensuring sustainable alternative livelihoods for forest-dependent communities and using nature-based solutions. This includes promotion of forest and non-timber forest products (NTFPs), nature or eco-tourism, and agroforestry[895]. The country's NAP also lists the increase in reforested areas, agroforestry, enrichment of buffer zones, soil conservation, sustainable fisheries management, and eco-tourism as key focal areas or targets for the development of its forestry, fisheries and land use sectors[896].

National REDD+ Strategy: The overarching goal of REDD+ in Suriname is to support Suriname's efforts to continue being a HFLD country while receiving compensation for a more sustainable, inclusive, and diversified economy. The Suriname National REDD+ Strategy was implemented allowing broad participation of stakeholders from different groups within the society. The REDD+ Readiness phase will be completed in 2021. Suriname has complied with all four key components a country needs to be REDD+ Ready. To summarize, the National REDD+ Strategy was finalized in 2019, the Summary of Information was formulated and will be submitted to UNFCCC in 2021, the NFMS is operational and the first FREL was submitted in 2018. Besides a general focus on a broader diversification of the economy, the Suriname National REDD+ Strategy focuses on creating alternative livelihoods related to sustainable use of the forest resource. Specifically, the production of NTFPs and medicinal plants; the promotion of nature tourism and agroforestry initiatives are stimulated[897].

Bioeconomy sectors and actors

Agriculture

Suriname's agricultural sector is led by rice and banana production, but also consists of crops, including vegetables, plantains, citrus, fruits and cassava. The livestock sector remains important, with products such as poultry meat, beef, pork, milk and eggs. The relative importance of agriculture in Suriname's economy has declined over the last two decades, from around 18% of GDP in the mid-1990s to 9% in 2018. The banana industry faces strong competition from other Latin American producers, due to changes in the EU's preferential tariff regime, high production costs, low labor

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[895] Government of Suriname. 2019. Second Nationally Determined Contribution. Cabinet of the President. Coordination Environment.

[896] Government of Suriname, 2019a. Suriname National Adaptation Plan. Japan-Caribbean Climate Change Partnership.

[897] Government of Suriname. 2021. Forest Reference Emission Level for Suriname's REDD+ Program. Paramaribo, Suriname.

productivity, and frequent crop diseases. In the rice industry, high transportation and input costs undermine Suriname's competitiveness in international markets[898].

In spite of the decreasing relative importance of agriculture in the economy, the total export value has more than doubled between 2012 and 2018, partly due to depreciation of the Surinamese dollar. The total value of rice exports has gradually increased, while the banana export value has been more volatile, peaking at US$7.7 million in 2012, before falling to US$5.8 million in 2014, and increasing again to US$10.9 million in 2017. The sector has contributed 13% of exports on average over the past 10 years; but this sector is concentrated and dependent on commodities as well, with bananas, rice, fish, and shrimp accounting for 90% of the exported products[899]. All the existing ag sectors and sub-sectors are described below.

Table A49: Summary description of Suriname's agricultural subsector

Subsector	Major factors influencing subsectors
Aquaculture	Strong world demand. Existing fish processing and exporting infrastructure. Abundant land and inland water for fish farming. Expensive input costs for certified feed.
Bananas	Loss of preferential access to EU limits export market potential. Supply controlled by one existing company and market would appear to offer limited opportunity for additional investors.
Beef	Domestic demand presently met by existing production. Possible scope to use available land for export to Caribbean if production efficiencies can be improved.
Cassava	New government-owned factory presently underused. Good evidence of acceptable yields and potential for inclusive production throughout the country. Potential markets identified, but demand growth seems limited.
Cereals and animal feed	Domestic and regional market demand, with ability to decrease costly import bill. Regional comparative advantage for cereal production (land availability and climate) and existing feed industry players interested to integrate feed production.
Cocoa	Strong world demand for cocoa. However, production is so far unmechanized, and is reliant on out grower production globally; there is little current smallholder production in Suriname that commercial investment could take advantage of.
Coconut	Accelerating world demand for higher-value coconut products (virgin oil, water, cosmetics, etc.). Existing and old plantations as well as significant new smallholder plantings reported. Cost-effective collection and the viability of new plantings are undetermined.
Dairy	Potential for privatization of existing state-owned dairy but would need to compete against cheap milk powder imports and address existing deficiencies in milk production.
Fish and shrimp	Controls on fishing limit potential for export expansion and may lead to further declines in harvest. Potential for extra value addition, which would require quality upgrading at the subsector level.
Fruits	Significant Caribbean and European markets for citrus and other fruits. Good growing conditions with harvest mechanization or out-grower schemes possible. Existing processors could expand to carry out juicing for export and domestic market. Need for marketing standards and safety certification.

[898] Vandorpe; De Salvo; Shik. 2020. Analysis of agricultural and fishery policies and agriculture-related greenhouse gases emissions in Suriname. Agricultural Policy Reports. IDB.

[899] World Bank Group. 2017. Suriname Sector Competitiveness Analysis - Identifying Opportunities and Constraints to Investment and Diversification in the Agribusiness and Extractives Sectors. World Bank, Washington, DC.

Oil Palm	Good world demand for palm oil and palm kernel oil. Probable use of primary forest land would raise environmental concerns and reduce market potential, as oil could not be certified. Crop not yet mechanized and labor availability problematic.
Pork	Good recent investments in pig production and pork processing. As with other meat sectors, fast-growing domestic, regional, and global demand. Regional comparative advantage for production. Food safety barriers need to be addressed to increase access to export markets.
Poultry	Industry expansion constrained by import of cheap offcuts from USA. Existing companies able to supply present domestic demand but investor from Caribbean could facilitate market access in the region.
Rice	Relatively high-cost production. Ongoing efficiency investments being made by existing mills, access to improved seeds, and new cultivation techniques may expand export market opportunities for existing producers. But the subsector is well covered by existing producers and processors, limiting space for new investors.
Vegetables	Significant Caribbean and European markets for vegetables. With Global GAP certification, good possibilities exist to supply a range of vegetables to mainstream supermarkets in Europe and the Caribbean. Need to address cold storage logistics and marketing standards and certification.

Source: World Bank Group (2017)

The Ministry of Agriculture, Livestock, and Fisheries (MOALF) is the main agency responsible for agricultural development, with other involved ministries including the Ministry of Health, the Ministry of Environment, and the Ministry of Trade, Industry and Tourism (MTIT). MOALF has six departments: crops; livestock; fisheries; research, marketing and processing; planning; and administrative services. Its budget has fluctuated considerably in recent years as a result, initially, of a steep decline in Netherlands Development Assistance and of generally reduced government revenues from mining.

MTIT's role in agriculture has focused on agro-processing and trade and investment, including through its general mandate of economic diversification, investment climate reforms, and improved investment promotion. In recognition of the fact that Suriname cannot continue to be solely dependent on the extractive industries, new staff have been recruited to help facilitate industrial development. Efforts are being made to improve collaboration with MOALF, with emphasis on developing a value chain approach. The Investment and Development Corporation Suriname N.V. (IDCS) also has an important role in the agriculture sector, initially with a mandate to privatize agricultural State-Owned Enterprises (SOEs), currently focused on investment promotion including in the agriculture sector[900]. The MOALF has the administrative responsibility for a series of foundations and SOEs that are active in the agricultural sector. This includes the central fishing port, *Centrale Voor Vissershaven in Suriname* (Cevihas), the fruit plantation company, *Landsbedrijf Alliance (Alliance)*, the Anne van Dijk Rice Research Centre (ADRON), and the milk producer, *Melkcentrale Paramaribo* (MCP). No major privatization of SOEs was accomplished recently, but the government acquired the cassava processing company, Innovative Agro Processing (IAP) NV, in 2015[901].

[900] Government o Suriname. 2017. Policy Development Plan 2017-2021.

[901] Vandorpe; De Salvo; Shik. 2020. Analysis of agricultural and fishery policies and agriculture-related greenhouse gases emissions in Suriname. Agricultural Policy Reports. IDB.

Around 95% of the country is tropical rainforest. In that context, about 1.5 million hectares are theoretically suitable for agricultural activities, of which 85% are located in the coastal plains and 15% on the river terraces in the interior. However, much of this land is inaccessible and also requires drainage infrastructure. Some suffers from brackish water. It is estimated that as much as 230,000 hectares (15% of the total) were cultivated in the past. Currently, only around 60,000 hectares are farmed. This decrease reflects a combination of unfavorable macroeconomic conditions, fluctuating world prices for example for rice, and poor management that caused many large SOEs to close since the 1980s. Of the 60,000 hectares under production, about 50,000 are for rice, almost all in the Nickerie District in the west of Suriname, and 1,950 are for bananas in Nickerie and Saramacca. Family holdings consist of 42,000 hectares, of which about 7,000 are actively cultivated, including for tree crops. Since 2000, there has been an increase in land cultivated in Nickerie, but a decline in other areas, reflecting the efforts to upgrade the rice and banana subsectors, largely with EU support in areas such as infrastructure development and research. Both state-owned land and privately leased land tends to be underutilized[902].

An agricultural value chain with potential for bioeconomy development in Suriname are the fruits and vegetables ones. They both are appealing to external markets with and increasing demand if sustainability aspects are well covered. The prioritization of these value chains also will have positive domestic and CARICOM food security outcomes, becoming a win-win alternative, especially if pursued via horticultural practices. A draft Agricultural Development Plan identifies melon, watermelon, lime and orange as being possible crops for development. To this list could be added other products like the berries of the Podosiri (acai) palm, which grows wild in Suriname, are considered one of the top "superfoods" due to their antioxidant properties and presumed health benefits [903.] Horticulture is the agribusiness sector that receives most investor interest, with small but expanding companies. One large foreign investment is already in place: UNIVEG group acquired the banana plantation in 2014. Very limited local market (500k inhabitants) but growing regional and global demand for tropical fruits and vegetables. Despite accelerating trends in European and North American markets for locally produced foods with superior nutritional value (superfruits), import trends continue to reveal multibillion dollar markets for tropical fruits and vegetables, with some products achieving 2-digit growth. Horticulture sector investments are typically small in size (<$10m). Small scale in absolute terms but significant relative impact given small size of the sector and urgent need to diversify the economy. In this opportunity, Suriname's target market is no longer a calorie driven (commoditized, low brand identity and awareness, high competition – low margins, economic of scales, vertical integration), instead, focuses on higher value - higher margins for producers, small scale, high care where seasonality and logistic are key. However, one of the main constrain is access to finance. For instance, bank lending (other than trade finance) is difficult to access (160% collateral requirements) and expensive (up to 20% IR) [904].

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902 Dergalen et al. 2017. Analysis of agricultural policies in Suriname. Agricultural Policy Reports. IDB

903 World Bank Group. 2017. Suriname Sector Competitiveness Analysis - Identifying Opportunities and Constraints to Investment and Diversification in the Agribusiness and Extractives Sectors. World Bank, Washington, DC.

904 CIIP. 2018. Suriname Investment Climate and Sector Support: Agribusiness Sub-Sector Diagnostic - A deep dive into horticulture and fisheries and cross-cutting finance and logistics constraints. Washington, D.C.: World Bank.

The agricultural sector consists of both large-scale and modern subsectors and a large number of small family farms using traditional labor-intensive production practices with suboptimal inputs. The sector is comprised of an estimated 10,234 farms, of which 10,188 are considered family owned. Around 90% of land holdings are smaller than five hectares and about one third of these are smaller than half a hectare. The largest holdings (50 hectares and up) are all found in the coastal zone. Only 10% of farms employed labor other than family members. In 2011, the sector employed around 17% of the labor force, with an estimated 18,000 people working formally or informally in agriculture[905]. There are more than 100 SOEs operating across sectors in Suriname's economy, including petroleum, public utilities and transport, other services, and agriculture. Within agriculture and fisheries, SOE activities have included fruit, rice, bananas, and oil palm production estates; infrastructure and port provision; and processing. Larger SOEs include the milk purchaser and processer, Melkcentrale (MCP); a citrus farm (Alliance); a rice seed production and rice milling facility (SML); and the body that inspects and certifies commercial exports of fish and shrimps, Viskeuringsinstituut (VKI). MOALF is responsible for the salaries of the staff of many SOEs, as they are regarded as civil servants.

The main source of CO_2 production in Suriname is the combustion of fossil fuel (49%), followed by Land-Use Change and Forestry (31%), and Agriculture (19%). The GHG emissions sharply decreased in 1999 due to the closure of the Aluminum Smelter but show a relative increase from 2008 through 2012. Despite the recorded increase, Suriname remains carbon negative[906]. The agriculture sector is directly impacted by climate change, from extreme weather events as well as gradual changes to ecosystems. At the same time, it is a contributor to climate change by its emissions. The agricultural sector was responsible for 952.57 Gg CO_2e (16.7%) in 2008 emissions. The main sources being wetland rice cultivation and animal husbandry. The relative share of the sector in Suriname's GDP has decreased from 11% to 5.8%, while exports (esp. rice and bananas) have increased, rising to US$91 million in 2014[907]. Recent analyses show that this trend continues for the period 2015-2018. The rice sector is over-dominant in its contribution to GHG emissions (38%), mostly due to the methane emissions emitted from flooded rice fields and nitrous oxide, produced by soil microbes in rice fields (following by bananas, 21%). The sector with the highest value of production is thus, also the highest emitting sector. Some products that have a low profile in terms of production value, still contribute significantly to GHG emissions, such as milk and beef[908].

Forestry

Forestry affects roughly one third of Suriname's 14.7 million ha of forests. In addition to the 13.5% forest with a protection status, the National Forest Policy (2006) aims to leave the forest south of 4°N latitude unaffected by commercial logging, which is partly explained by the poor accessibility of the southern forest reserves, making commercial logging not profitable. According to the Forest Management Act (1992), forests are to be designated for different production purposes or uses. The

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905 Idem.

906 Government of Suriname, 2019. Second Nationally Determined Contributions.

907 Dergalen et al. 2017. Analysis of agricultural policies in Suriname. Agricultural Policy Reports. IDB

908 Vandorpe; De Salvo; Shik. 2020. Analysis of agricultural and fishery policies and agriculture-related greenhouse gases emissions in Suriname. Agricultural Policy Reports. IDB.

main classifications of forest designation are *permanent forest*, which includes permanent production forest, protected forest, and special protected forest; *conversion forest*, and f*orest to be temporarily maintained*. Since 2006, 4.5 million ha have been defined as *potential production forest*, but these areas have not been formally designated. Due to the lack of an integrated land use plan at the national level, in practice, therefore, mining (and even agriculture to a limited extent) takes place in these areas, thus making it difficult to practice sustainable forestry[909].

In terms of species, currently *Dicorynia guianensis* includes more than 30% of the national production. The dominant forest management practices currently applied in Suriname are summarized into two main management regimes. These types of management can also be linked to the type of agents (forestry operators) in the forestry sector[910]:

- **Conventional logging (extensive management):** here timber can be harvested without prior timber stock inventories and the demarcation and planning of roads and skidding trails. Extensive management, also known as conventional logging, is allowed in short-term forest concessions (<5,000 ha) and the majority of community forests and the so-called timber harvesting licenses (HKV's). Community forests (including HKV's) are issued to forest dwelling communities (villages) for the main purpose of fulfilling subsistence needs. Additionally, commercial logging in these forests is permitted, providing that the rules for commercial logging are applied. In practice this means that the cutting blocks must be demarcated and logged according to the Foundation for Forest Management and Production Control (SBB, Dutch acronym) approved cutting plan. These minimum requirements are the basis for SBB production control.
- **Controlled logging (Intensive management):** applies for all forest concessions from 5,000 ha upwards. Third party certification of controlled logging may be seen as a third level in forest management. This relates to how the FSC certified forest management units in Suriname work in compliance with the national controlled logging regulation and in compliance with the FSC standard. Intensive management implies the making of an overall forest management plan and the annual cutting plans. SBB provides the concession holder with the requirements for making these plans: forest inventory, infrastructure planning and the planning of annual cutting blocks. All plans need to be approved by SBB before the logging operations can start. SBB approval of the (annual) cutting plan comes with additional rules regarding sustainability and the concepts of reduced impact logging (RIL). For all concessions both the annual area fee and the volume-based retribution must be paid. Renewal, extension of the concession license, can only be granted for one period by law, meaning that for most of the concessions - apart from the long-term concessions - the concessionaire is theoretically not entitled to a second felling rotation (set at 25 years). The consequence of this is that all investments need to be recovered (depreciated) during one single harvesting rotation.

According to the type of license and the (combined) scale of operations (FMU), forestry operators engaged in commercial logging can operate under the conventional or the controlled logging regimes.

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[909] NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

[910] Ministry of Natural Resources and SBB. 2006. National Forest Policy of Suriname. Government of Suriname.

In 2015, close to 1.4 million ha (medium and large) concession forests were registered under the controlled logging regime (> 5.000 ha each). Of this, 0.4 million ha, managed by four companies, were FSC certified. In the same year nearly 1 million ha was under a small concession license (<5.000 ha) and community forests/HKV's. In 2015, close to 2.4 million ha was issued for timber harvesting. Besides concessions, this also includes all community forest and HKV's. Although not primarily issued for the purpose of commercial logging, these forests contributed close to 20% to the total timber production in 2015 (110,864 out of 568,657 m^3). The Suriname state receives a royalty/retribution of US$3.98 per m^3, area tax is 5 SRD/ha[911].

The contribution of the timber industry to the gross domestic product is 2.7% and the sector employs about 6,500 people, including personnel for logging, timber processing, log yards and timber markets. The contribution of timber export to the value of the national export was about 4%. The expectation is that the actual contribution of the forest sector to the national economy is higher than registered by the national account. Besides timber, other forest products such as Minor Timber Products and Non-Timber Forest products are extracted that are not or partially registered. The log production in 2019 was 1,069,000 m^3, of which 315,000 m^3 was exported. It is estimated that of the remaining 745,000 m^3, about 420,000 m^3 was locally processed by the sawmill industry in the country and about 334,000 m^3 was in stock to be exported in the next year. The recovery rate of rough sawn wood in sawmills in Suriname is about 45%. When producing export quality sawn wood, the recovery rate decreases to between 25-30%. Within a period of 10 years from 2010- 2019, the roundwood production in the country increased with about 400%, and the sawn wood production increased with about 150%. In the same period, the export of roundwood increased with about 500%. Timber export statistics show that in the past 10 years the assortment roundwood contributes more than 80% to the total export volume of timber. Due to foreign investments, mainly from Asian countries, most of the roundwood (about 85%) is exported to this region. The decline of the export to 315,000 m^3 in 2019 compared to 550,000 m^3 in 2018 is due to recent development in Asia, especially China and India. Expectation is that from the second quarter of 2021 the market will recover and the export of roundwood will continue to grow[912].

Table A50: Forest concessions by period, size and management regime

911 NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

912 Government of Suriname. 2021. Forest Reference Emission Level for Suriname's REDD+ Program. Paramaribo.

Name	Period	Maximum size	Management regime[19]	Number for Felling Blocks (SBB 2016)
Short term concession	Up to 5 years	5,000 ha	Intensive (controlled logging)	68
			Extensive (conventional logging)	154
Medium term concessions	5 to 10 years	50,000 ha	Intensive (controlled logging)	263
			Extensive (conventional logging)	219
Long term concession	10 to 20 years	150,000 ha	Intensive (controlled logging)	314
			Extensive (conventional logging)	54

Source: NIMOS, SBB and UNIQUE (2017)

The actual forest area under conventional logging is close to 932,541 ha, being 40%. 107 out of the total of 202 FMU-operators are engaged in conventional logging. The average scale of these small-scale operation is close to 6,000 ha each. The remaining 60% are managed under controlled management regime. Roughly 1.6 million ha have been issued as logging concessions and other forestry production titles, and 737,507 ha for community forest and 168,363 for Incidental Cutting Licenses (ICL). Of this, 396,880 ha was FSC certified in late 2015. At present, there are no ongoing activities to expand the forest area under (FSC) certification. There are 211 logging companies, 96 sawmills and one plywood factory in operation. Forestry operators (FMU managers) are not necessarily the same person that holds the forest concession license, the right to extract timber from concessions may be rented out. Also, forestry operators may engage in commercial logging activities from community forest. Based on the overall FMU size rather than on the concession size, forestry operators can be sub-divided in the following categories[913]:

- **Small scale operators:** The overall size of the FMU <5,000 ha. Operating in small concessions and/or community forests / HKV's. Applying a minimum required level of forest management and planning
- **Large scale operators:** The overall size of the FMU >5,000 ha. Operating in one or more concessions that are managed as one FMU. Applying controlled logging (intensive management)
- **Large scale (FSC) certified operators:** Large scale operators that have obtained (FSC) SFM certification.

Table A51: Concession size vs FMU size in 2015

[913] NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

Forestry concessions			Forest Management Units (FMUs)		
Type	**Area (ha)**		**Type**	**Area (ha)**	**# Operators**
Small concessions	193,034		FMU < 5,000 ha	193,034	63
Medium concessions	1,094,878		FMU > 5,000 ha	1,022,779	42
Large concessions	324,781		FMU certified*	396,880	3
Comm. forest/HKV	739,507		Comm.For./HKV	739,507	94
TOTAL	**2,352,200**		**TOTAL**	**2,352,200**	**202**

Source: NIMOS, SBB and UNIQUE (2017)

In the context of Suriname, most forestry practices are characterized as low impact selective logging based on Reduced Impact Logging (RIL) principles, and thus are not associated with significant levels of degradation. A number of rules apply to all forestry operations regardless of the harvesting license. These include for example, the demarcation of buffer zones, a minimum tree diameter of 35 cm, no more than 1 tree felled within a circle of 10 m, and maximum production of 25 m3/ha. The intention of the Forest Management Act (1992) and the conditions accompanying the concession license documents is to ensure every license holder applies controlled logging whereby license holders are required to conduct exploration and preharvest planning. However, companies or communities may ask the SBB for an exception from controlled logging because of unexpected conditions like overlaps with gold mining activities. If this is approved, a license holder is only obliged to indicate the area where they are planning to work (this area must be clearly delineated in the field, controlled and approved by SBB). Further planning activities relevant for controlled logging (e.g. pre-harvest inventory, skid trail planning) are not required. This latter type of forestry operations is known as conventional logging[914].

The forestry sector does not directly cause deforestation. When a domain forest will be converted to another land use e.g. mining or agriculture, an ICL can be applied for. With the ICL, the trees that are being removed can be traded commercially. According to Article 38 of the Forest Management Act, these licenses are subject to management rules and conditions that apply to all other timber harvesting licenses. Although the forest area under ICL has accumulated in 2015 to 5,336,317 ha, only a very limited area has been actually deforested. An exemplary case is the ICL of 52,000 ha attributed to the China Zhong Heng Tai to establish an oil palm plantation, which recently began operations. Out of the total 85,000 ha deforestation area in Suriname, 55% (47,245 ha) occurred in the production forest (this includes all concession types, as well as those not currently under production). The conversion mainly occurred towards the mining sector, with 68% of this deforestation due to mining. The risk of degradation caused by over-exploitation and/or undue damage to the residual forest stand is considered minimal. In 2003, SBB presented its ambition to nearly double the annual timber production to 500,000 m3/year by 2008. As the conditions were subsequently put into place, the timber production objective was first reached in 2015. However, due to Suriname's forest composition (i.e. tree species), the harvesting levels from selective logging are still far below the annual allowable cut per ha, in practice being only 7.4 m^3. The range is from 4.8 to 10.7 m^3/ha. Intensive management, improved planning and controlled logging, results in the higher production levels. The overall logging

[914] Government of Suriname, 2019. Second Nationally Determined Contributions.

intensity is well within the legal limits: 25 m^3/ha in combination with a 25 years rotation. The timber extraction rate may thus not be a cause of concern in the view of forest degradation. Forest that have been logged at these rates, are assumed to be able to fully recover in due time and being able to restock and restore the associated carbon stocks as further assessed in the opportunity cost assessment below. Nevertheless, further field research is necessary, because the carbon loss is not only determined by the extracted logs but also by the damaged trees, logging infrastructure and logs left behind[915].

Tourism

Tourism directly contributed US$119.7 million in 2019, contributing 2.6% to Suriname's GDP; although total arrivals are small (278,000 in 2017), they have grown an average of 8% per year over the past ten years. Tourism provided 5,700 jobs (2.8% of total employment) and also contributed 3.1% of 2019 exports through visitor spending[916]. Suriname offers a tourism product that is a mix of nature-based and adventure excursions in the Amazon and cultural attractions (e.g., multi-ethnic population and the historic center of the capital Paramaribo).

Restoration and ecosystem services

Suriname is the world's most forested nation; it is also a carbon negative country. It has a forest cover of almost 15 million hectares (93%) storing at least 11.9 Gigaton of CO_2. The sustainability of Suriname's development progress is highly vulnerable to climatic disasters, especially flooding because of rising sea levels, which has already had high human costs and created financial pressures for households, private businesses and public finances. The combination of these factors encouraged the GoS to pursue both a green economy and build REDD+ as a sustainable development mechanism by improving people livelihood and safeguarding a wise use of biodiversity. In global perspective, REDD+'s overarching international development goal is likely to catalyze forest transitioning countries towards a High Forest cover and Low Deforestation (HFLD) stationary steady stage to take advantage of Emissions Reductions Purchase Agreements (ERPAs), Carbon Exchanges, and Forest Bonds either on voluntarily or mandatory markets[917].

As a result, Suriname has crafted its blueprint through the National REDD+ Strategy (NRS) to advance towards a market-based mechanism (i.e. Carbon, Water, Biodiversity and Valuation for Ecosystem Services) which has been completed and approved in 2019. In this NRS, the government identified several policy instruments and institutional arrangements to be made about Suriname effectively complying with the requirements agreed under the common approach, and with UNDP rules and regulations, recognized by the Steering Committee, the Project Board including Indigenous People and tribal groups through the readiness phase and beyond.

[915] NIMOS, SBB and UNIQUE. 2017. Background study for REDD+ in Suriname: Multi-perspective analysis of drivers of deforestation, forest degradation and barriers to REDD+ activities. Paramaribo, Suriname.

[916] World Travel and Tourism Council. 2020. Travel and Tourism Economic impact 2020 - Suriname.

[917] Government of Suriname. 2019. National REDD+ Strategy of Suriname. Paramaribo, Suriname.

Consequently, the NRS supports the completion of the three pillars of REDD+ readiness such as a) REDD+ strategy for sustainable development; b) stakeholder engagement and capacity building; and c) tools and implementation. Thus, the Forest Carbon Partnership Facility (FCPF) funds has entirely been contributing to the design and consolidation of a national vision and strategy for REDD+ in Suriname and its corresponding implementation and sustainable financing plans. Of the three pillars of REDD+ readiness, Suriname has largely made advancements with a) organization and consultation; b) preparation of the REDD+ strategy; c) Forest Reference Emissions Level (FREL) / Forest Reference Level (FRL); d) National Forest Monitoring System (NFMS); e) Integration of Social and Environmental Safeguards (SESA). Among options suggested from the National REDD+ Strategy outcome, the most relevant for Suriname's implementation phase is establishing the National REDD+ Fiduciary Trust Fund (NRFTF) to be endorsed by stakeholders. This is one of the overarching goals for the Benefit Sharing Mechanism (BSM) among other socioeconomics catalyzers that will be able to fulfill the National REDD+ Vision[918] through the REDD+ readiness towards implementation phase[919].

Mangrove covers only a 0.5% of Suriname's land surface but plays an enormous role in the existence of the country's benefit. The 386 km of mainly muddy coastal zone of Suriname comprises a variety of productive coastal and marine ecosystems with extensive mangrove forests, salt marches, soft mudflats and fresh and salt water permanently interacting. The extensive mangrove forests covering about a total of 80,500 hectares (with an estimated carbon stock of 23,861,761 Mg CO_2e) occur along almost the entire length of the coastline as a fringe with an average width of approximately 3 km. More than two thirds of Suriname's mangroves are either located in nature reserves or in multiple-use management areas (MUMAs) which allow some level of development, but stress on careful management of mangroves and limited extraction[920].

It is now recognized globally that mangroves are an important asset with respect to coastal flood and erosion risk resilience, and this is indeed the case in Suriname and the greater Paramaribo area. The roots of mangroves reduce erosion and stabilize the shoreline. The trees and their roots attenuate (reduce) storm surges and wave action, reducing flood risk. The mangrove canopy decreases wind impacts. Mangroves have also been shown to be relatively resilient to the impacts of rising sea-levels. If managed appropriately they can therefore form a crucial element of a sustainable coastal resilience strategy. Furthermore, the benefits associated with mangroves are not just about flood and erosion risk. Mangroves provide diverse habitats, supporting strong ecosystems and associated agriculture and aquaculture benefits. Mangroves play an important carbon sequestration role, providing global benefits. Mangrove restoration and management can also create jobs, providing local improvements to livelihoods[921].

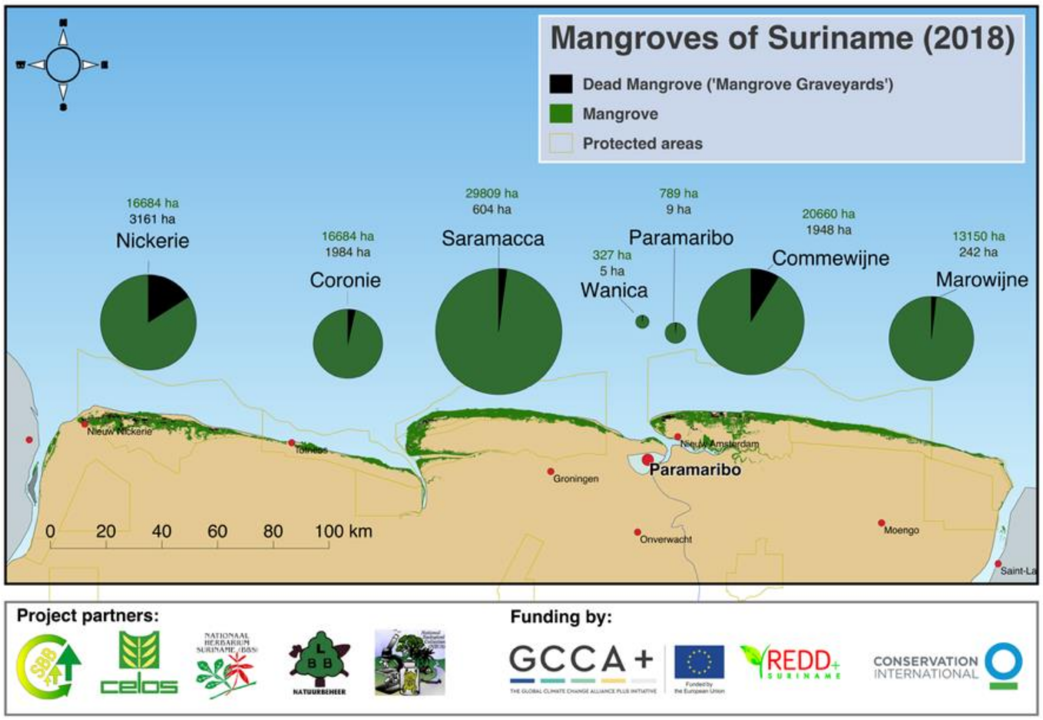
Figure A146: Mangrove distribution in Suriname

[918] "Suriname's tropical forest continues to contribute to the improvement of the welfare and wellbeing of current and future generations, while continuing to offer a substantial contribution to the sustainable development of our country and the global environment, enabling the conditions for an adequate compensation for this global service."

[919] Forest Carbon Partnership Facility. 2017. Mid Term Progress Report Suriname.

[920] CI. 2019. NBS Mangrove Project. GEF IW-6 ICM Mangrove Project – GEF ID #9949.

[921] GSURR. 2017. Suriname Coastal Resilience Assessment. World Bank Group.



Source: CI (2019)

Pressure on the coastal area occurs because of mangrove ecosystem degradation as well as the impact of climate change such as stronger waves and higher sea water levels. The environmental degradations are mainly caused by land degradation due to unwise human intervention such as urbanization and the overuse and overexploitation of natural resources (e.g., overfishing and poaching). Other threats are the pollution of water, air and soils from chemicals released from agricultural pursuits. In addition, the growing interest of these ecosystems for nature-tourism purposes is resulting in an increased number of visitors entering these ecosystems. Since these ecosystems are poorly managed, the uncontrolled number of visitors may result in pollution and disturbance of the biodiversity within this valuable ecosystem. Lack of enforcement and lack of awareness and education among most of the main stakeholders combined with the ignorance of the rules and regulations regarding the conservation of mangroves jeopardize the existence of the mangrove ecosystems. Continued loss of mangrove forests will have serious ecological and socio-economic impacts. The impacts of loss are disproportionately felt by communities who are dependent on mangroves regarding their livelihood. Cutting down mangrove also means releasing large amounts of carbon into the atmosphere (mangrove store up to 10x more carbon per hectare than forests on land) and increasing vulnerability to sea level rise and erosion. There are a wide range of stressors acting on the mangroves in the greater Paramaribo area and disentangling these to highlight clear causes and effects is complicated[922].

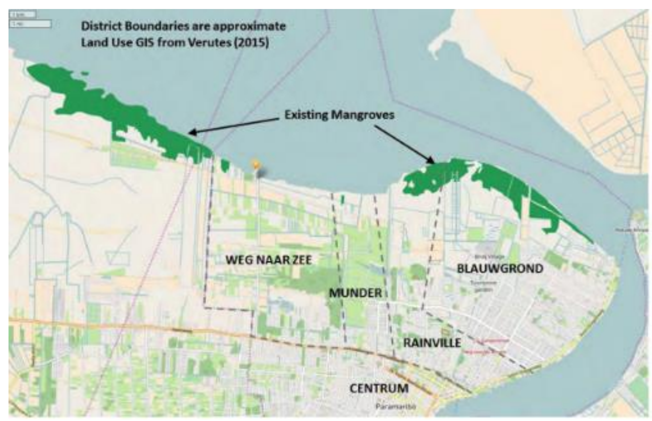
At a broad level, the key stressors influencing mangrove state are: (1) coastline change and the natural cycles of mudbank movements. (2) development pressures, and (3) climate change.

[922] Government of Suriname. 2019. The National Mangrove Strategy Suriname.

Figure A147: Residential development areas at Blauwgrond

Source: GSURR (2017)

Case study: NBS Mangrove Project[923]



It is estimated that the current value of carbon storage from mangroves in Suriname to be in the range of $300 million. Similarly, from a coastal protection standpoint, estimates of the value of mangroves just in Paramaribo alone exceed $100 million. Using another approach, valuing mangroves based on potential cost savings by replacing manmade seawalls yields values in the range of $1.5 billion to $3.6 billion (approximately $100,000 to $200,000 per hectare of mangroves). Although these valuations represent rough estimates, it is clear that mangroves provide significant values to a wide variety of stakeholders. Accordingly, a similarly broad financing approach should be use in order to incorporates values beyond just property protection to finance the cost of preserving mangroves, which could cost an estimated $3 million per year[924].

In general, the cost of restoring mangroves, according to the World Bank Data as of 2010 was about $52,000/ha in developing areas. According to several authors, the cost ranges from $225 from simple planting (very low success rate) to $216,000/ha.

Table A52: Mangrove restoration in the Paramaribo area

Coastal distance	1.44km (.3384 ha)
Population density	High
Future urbanization	High

The NBS Mangrove Project suggested that the optimal financial mechanism to restore mangroves in Suriname is a hybrid model consisting of: the ongoing REDD+, Community and Corporate Contributions, Oil Extraction Tax, Carbon Offsets, and a Green Bond program. This diverse set of funding sources would enable the sustainability of peak project funding needs such as restoration sites, and the continuous maintenance of the mangroves.

923 https://nbslmegef.wordpress.com

924 UCLA. 2019. Financing mechanism for mangrove conservation. Conservati

Estimated cost of restoration	US$73,094

Case study: The Central Suriname Nature Reserve Company

Suriname is one of the greenest countries on earth with a rich conservation heritage. Thanks in part to pioneering efforts like the Central Suriname Nature Reserve (CSNR), a 1.6-million-hectare reserve created by the government in 1998 and recognized as a UNESCO World Heritage Site in 2000. However, existing methods to monetize this ecological wealth, eco-tourism, carbon credits, and conservations payments, have not provided sufficient resources to be a driver of sustainable economic development. The country remains very reliant on traditional extractive industries and the cyclical nature of this sector has once again put a tremendous strain on the Surinamese economy. In the absence of financing alternatives, Suriname's natural endowment is today threatened by the extractives industries, such as oil and gas, mining (legal and small scale), unsustainable timber cultivation, and agriculture and fishing practices. In this context, the GoS is committed to securing a sustainable future, seeking REDD+ credits, and pursuing non-traditional funding mechanisms as part of its national green growth strategy.

The Intrinsic Value Exchange (IVE), a private technology and environmental exchange company based in the United States which has been authorized by the GoS to create, manage, and capitalize a trust company to commercialize the value of all the natural resources and economic rights originated in the CSNR through a local company (the CSNR Company). The primary mission of the CSNR Company is to value/price the ecosystem services derived from the natural assets of the CSNR and to convert those rights to financial capital using an exchange mechanism developed by IVE. These natural assets can be claims on benefit flows that produce private returns (e.g., water, genetic material, pharmaceutical, ecotourism), and public returns (e.g., carbon, biodiversity). If the latter, they represent an intrinsic value. An initial review by IVE identified 237 categories of services in the CSNR that can potentially be developed and monetized. Of these 237 services, IVE has identified three which already have demonstrated revenue streams, estimated at US$40 million annually, including carbon credits of US$2.7 million per year, sustainable fresh water harvesting of US$150,000 per year, and ecotourism of US$2.5 million per year. These monetized ecosystem service revenue streams will provide a base valuation for the CSNR Trust.

IVE would employ a capital markets toolset to monetize those assets and ecosystem services that cannot be readily monetized today. Only a handful of ecosystem services, such as carbon, have been monetized. Assessments in similar rainforests, such as in Ecuador, value these services in a range from $2,500 – 5,500 per acre per year. Applying this valuation to the CSNR's 1.6 million hectares, yields between US$4-8 billion per year in potential services. Assuming that only a small fraction of the natural assets and ecosystem service values of the CSNR are converted to financial capital, even 5%, this would represent a 10-fold or greater increase in capital formation over existing, or potential, conventionally monetized streams. IVE will use a Derived Equity instrument to incorporate the monetized revenue streams, the un-monetized ecosystem service values, and intrinsic values into a single equity pricing. The shares of the CSNR Trust will be brought to the market via an equity IPO to generate the capital for the CSNR Trust.

The equity in the CSNR Trust company will be divided amongst shareholders and stakeholders. As a stakeholder, the people of Suriname will benefit from the project through the continued conservation of the CSNR, and through the financing that will favor development of economic activity that is more aligned with a sustainable future. Suriname will also be expected to be a shareholder in the CSNR Trust, whose participation will reflect a valuation of their past conservation efforts in the CSNR. The capital created through the CSNR Trust via an equity IPO will create a green sovereign wealth fund for the government and people of Suriname, creating a capital flow and investment to invest in the protection of a globally important rainforest habitat, capitalize a sustainable economy – including renewable energy, sustainable agriculture, tourism, water resources -, combat climate change, and provide a shared national asset for country and individual wealth creation.

Financial system and financing for bio-businesses

The financial sector in Suriname comprises of 10 commercial banks, 12 institutions of insurance corporations, 23 credit unions. Together, these institutions operate 211 ATMs and over 4,000 point-of-sale (POS) machines. Branches of commercial banks increased from 29 in 2004 to 38 in 2017, while the number of ATMs increased on average by 20% per year from 2004 to 2017. The Central Bank of Suriname (CBS) supervised the entire sector. Regarding financial inclusion, the country made decent progress, as evidenced by the available financial access indicators. However, recent data shows that Suriname lags behind its peers in the region and exhibits data-availability issues[925].

Banks have close to 75% of assets of the financial system of which three large banks have three-quarter of banking system assets and deposits. Pension funds, insurance companies and credit unions make up the rest of the system. The public sector maintains a significant role in the financial sector via their ownership of 3 commercial banks and one development bank, as well as a 51% ownership stake in the third largest bank. The aforementioned 3 smaller commercial banks represent about 15% of banking sector assets. The public banks have had a weak financial performance for many years, affecting the development of the financial system[926].

According to the IMF Article IV Consultation in 2019, Suriname's banking system faces pressing vulnerabilities. Based on the latest data, the capital adequacy ratio for the banking system stood at 10.5% (above the 10% minimum requirement), but non-performing loans in the banking system remained high (12.5% of gross loans), and profitability was low (0.7% return on assets). At the same time, deposit and loan dollarization remain high. Total estimated assets of Suriname's largest banks are the following:

- DSB Bank : US$1,007 billion (annual report, 2018)
- Hakrin Bank : US$627.6. million (annual report 28, 2018)
- Republic Bank : US$473 million (2019 annual report, Suriname-based assets)[927]
- Finabank : $269 million (annual report, 2018)

The structure of the financial system in Suriname is highly concentrated in the banking sector. The high level of concentration in the banking sector could generate little competition and an environment of high interest rates. Domestic financing is not a binding constraint to growth. The results show that the cost of funding has declined while financial deepening has increased, resulting in the level of access to credit being somewhat better than countries with similar income. This suggests that the problem is not the lack of availability of local financing but rather the lack of demand, probably due to lack of good investment opportunities.

925 Fraser; MacDonald; Ooft. 2019. Towards Financial Inclusion: An Assessment for Suriname, Centrale Bank van Suriname Working Paper Series, No. 19/01, Centrale Bank van Suriname, Paramaribo.

926 IDB. 2016. Suriname Country Development Challenges.

927 The Republic Bank Limited of Trinidad and Tobago acquired Royal Bank of Canada's Suriname holdings in 2015.

Micro, small, and medium-sized enterprises (MSMEs) are dominant in the economy, accounting for 98% of all firms and 60% of total private sector employment. There are around 200 private companies with more than 50 employees in Suriname, but outside of mining these larger firms engage primarily in selling non-tradable services, which account for more than 50% of economic activity[928]. Agriculture is a historically important sector, but less than 7% of registered firms engage in agribusiness or other manufacturing. Tourism is a nascent services export industry, but most firms are small and coordination in the sector is very limited. The private sector broadly demonstrates low measures of entrepreneurial activity, weak accounting and financial management practices, and low access to finance[929].

SMEs account for nearly all private firms in Suriname and 60% of formal private sector employment, but they have limited business capacity and ability to invest in growth and competitive upgrading. The World Bank 2018 Enterprise Survey in Suriname finds that two thirds of firms lack at least one of three basic accounting practices, with smaller firms being more likely to lack these good practices. Few firms in Suriname are integrated into regional or global export value chains, and quality compliance is a constraint to competitiveness especially in emerging industries, with local farmers having limited ability to meet quality or quantity demands of export markets or the processing industry. Analysis of financing for agribusiness identified significant constraints in the demand for finance, including limited capacity for business plan development and undeveloped value chains that can be a mechanism for financing. There are private business development services in Suriname, but greater awareness of the benefits and stimulus of the market for commercial and export-oriented business development services are needed[930].

Development, research and technical programs

Compete Caribbean

Compete Caribbean is a US$40 million private sector development program jointly funded by the Canadian International Development Agency (CIDA), the United Kingdom Department of International Development (DFID) and the Inter-American Development Bank (IDB), to provide technical assistance grants and investment funding to support productive development policies, business climate reforms, clustering initiatives and SMEs development activities in 15 Caribbean countries, including Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominican Republic, Dominica, Grenada, Guyana, Haiti, Jamaica, St Lucia, St Kitts and Nevis, St Vincent and the Grenadines, Suriname and Trinidad and Tobago[931].

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928 Data on firm size are from the 2016 Business Census conducted by the General Bureau of Statistics Suriname.

929 World Bank. 2019. Project appraisal document on a proposed loan in the amount of US$23 million to the Republic of Suriname for a competitiveness and sector diversification project. Finance, Competitiveness and Innovation Global Practice. Report No: PAD3081.

930 CIIP. 2018. Suriname Investment Climate and Sector Support: Agribusiness Sub-Sector Diagnostic - A deep dive into horticulture and fisheries and cross-cutting finance and logistics constraints. Washington, D.C.: World Bank.

931 https://www.competecaribbean.org.

Competitiveness and Sector Diversification Project

The World Bank Group approved a US$23 million loan to support good international practices for sector governance and promote sector diversification in Suriname. This operation will contribute to private sector growth opportunities, boost job creation, and benefit more than 200 SMEs. The project will finance a combination of investments to enhance productivity of SMEs, and technical support to help improve the investment climate for agribusiness and tourism. It will also finance technical assistance for institutional strengthening and regulatory reforms in the mining sector. The project aims to facilitate opportunities for growth and diversification in agribusiness, tourism, and other emerging industries, especially for SMEs (which represent 98% of all firms in Suriname and 60% of total private sector employment). Agribusiness and tourism offer competitive opportunities to attract private investment and diversify the economy. The project will also support improved governance, transparency, accountability, and administration of the mining sector, including better management of environmental and social impacts. Project implementation will be carried out by the Ministries of Trade, Industry and Tourism and of Natural Resources.

IDB's projects

Relevant projects for bioeconomy in Suriname funded by the IDB are: Community Conservation of Mangroves (SU-T1135); Mainstreaming Climate Change in Sustainable Decision-Making Tools (SU-T1117); Sustainable Agricultural Productivity Program (SU-L1052); Business Climate and Innovation Program I (SU-L1049).

Enablers and barriers for bioeconomy development

Suriname's 2017-21 National Development Plan includes a pillar targeting economic growth and diversification, including optimal use of minerals and other natural resources for sustainable development. The National Development Plan seeks to achieve this through encouraging private entrepreneurship, facilitating private investment, and promoting exports. Good governance in the public and private sectors is a cross-cutting principle for the plan. Specific development strategies are established for mining, agro-industry, and tourism as priority sectors. The previous 2012-16 National Development Plan as well as the 2016-18 Stabilization and Recovery Plan highlighted similar objectives, reflecting the long-term policy commitment to private sector-led diversification.

In recent years, the Government of Suriname (GoS) has established a Competitiveness Unit Suriname (CUS) that is now a central department of Ministry of Environment, and the Ministry of Trade, Industry and Tourism (MTIT) to support business environment reforms. GoS has also initiated the operations of InvestSur in 2018 as the national investment promotion agency to facilitate private sector growth and investment. Suriname successfully applied in 2017 to be a candidate country for the global Extractive Industries Transparency Initiative (EITI) and has published the country's mining title maps online as efforts to improve transparency and governance in mining. Annual budgets approved by the National Assembly and annual ministerial planning documents establish the basis for a Mineral Institute to be established by the Ministry of Natural Resources (MNR). The National Assembly has also recently passed laws to improve food safety standards and the inspection regime. These efforts reflect the GoS' commitment to reforms, although significant needs remain to continue improving the enabling environment for private sector competitiveness and diversification.

A recent World Bank Group Sector Competitiveness Analysis (2017) identified opportunities for increased competitiveness and diversification within the established extractives and agriculture sectors. The tourism sector is small but growing, driven by small private firms that see competitive potential of Suriname's tourism offerings. But the private sector's ability to take advantage of these competitive opportunities in diversified economic activities is hindered by barriers in the enabling environment and at the firm level. Policy research on diversification in small economies like Suriname's indicates that removing such barriers to enable diversification into new products and markets within such established industries is more likely to be feasible than targeting new sectors.

Suriname's private sector was already challenged by an unfavorable business climate before COVID-19. The country's Doing Business ranking was 162 out of 190 countries in 2020. Suriname improved in the "registering property" pillar, while still performs poorly in getting electricity and dealing with construction permits. The improvement in registering property reflected the implementation of a unique identification number for properties, which improved the quality of the country's land administration system. Nevertheless, the country scored lower than regional averages in 7 of the 10 pillars covered by the Doing Business report. On the other hand, Suriname scored better than regional averages in trading across borders and paying taxes. The results of the 2018 World Bank's Enterprise Survey showed that the main constraints to business operations as identified by firms were: (1) access to finance, (2) inadequately educated workforce, and (3) political instability[932].

Suriname is ranked as the 38th most resource-dependent country out of a group of 73 countries. The country's commodity dependence is derived largely from crude oil and gold. In 2018, mining and oil exports comprised 86% of total exports of goods and services, while both commodities accounted for 36% of government revenues. In March 2020, crude oil prices fell by 50% compared to December 2019. From December 2019 to March 2020, gold prices increased by 8% over the same period (gold prices are expected to further increase as the crisis deepens, which would benefit Suriname's economy). The IMF's working hypothesis is that the average price of oil will be US$35.61 a barrel in 2020 and US$37.87 a barrel in 2021. Based on these assumptions and the slowdown in domestic economic activity due to COVID-19 restrictions, Suriname's economic growth is projected to decline by almost 5% in 2020. Inflation is expected to increase to 49% in 2020. The fiscal deficit is forecasted at 6.9% of GDP in 2020, the current account deficit is projected increase to 12% of GDP in 2020, and Gross debt is expected to grow from 56.2% of GDP in 2018, to 67.9% in 2020[933].

Suriname's current exports of non-traditional agribusiness products is extremely limited (only significant food exports are rice, banana, and fish/shrimp). Limited scope for large plantations and economies of scale but unique natural assets: Suriname needs to target niche high-value markets (e.g., organic, fair trade, unique taste or health properties, high quality brand). To do this, Suriname needs specialized companies with the necessary knowledge, capital, and market access. High quality

[932] Khadan. 2020. Suriname in Times of COVID-19: Navigating the Labyrinth. Technical Note No. IDB-TN-2025. IDB.

[933] Khadan. 2020. COVID-19: Socioeconomic Implications on Suriname. Technical Note No. IDB-TN-1920. IDB.

products require particular attention at every step along the value chain. Companies must be able to invest in technology, certification, and branding. In turn, these companies require conducive regulatory and institutional frameworks to help build a brand and strong trust in the market for high quality and safe ingredients. An overarching green growth policy and a commercial strategy to direct coordinated efforts around new non-traditional products is needed. Focused public sector efforts are required to strengthen critical functions underpinning agribusiness development, including agricultural R&D, extension services, standards and food safety. Targeted investment and export promotion efforts will help support emerging companies in the sector (with access to finance, business development services support, trade logistics capabilities, etc.) and attract qualified new entrants (investor outreach, investment site development, investment climate improvements)[934]. Agricultural research is carried out by the Centre for Agricultural Research in Suriname (CELOS), by the Anne van Dijk Rice Research Centre (ADRON), which works mainly on rice, and by the Ministry of Agriculture, Livestock, and Fisheries own technical departments. Reports from the private sector indicate poor coordination, lack of a market orientation, and poor linkages with extension services. Recent diagnostic work by the World Bank confirms many of these perspectives, finding that improving technology transfer linkages between the local research community and industry and improving the national quality infrastructure system would be two ways to improve the innovation system in general and for agriculture in particular.

Preferential trade agreements with key markets are in place for Suriname. The EU-CARIFORUM Economic Partnership Agreement offers duty- and quota-free access to the EU and its 500+ million consumers: within CARICOM, Suriname has duty- and quota-free access to a protected market of 15 countries, 15+ million consumers, and a large tourism sector. High-value specialty niches such as traditional Surinamese vegetables, organic and fair trade certified fresh and processed tropical fruits and vegetables, processed super fruits (acai, acerola) show accelerating levels of investment, albeit from a low base. A recent study on the potential of exotic specialty oils (e.g. Brazil Nut oil) produced from wild harvested nuts from the rainforest indicated strong development potential in Suriname[935].

Development of both fruit and vegetable production by smallholders requires attention to farming practices that can ensure zero-deforestation and certification in GlobalGAP or other standards. While not presently needed for sales to the diaspora in the Netherlands, it would be needed to expand exports to European supermarkets and is already often required within CARICOM, particularly where the market includes tourist hotels, which tend to require the same standards that their customers are covered by at home. Indeed, this is often mandated by travel companies. Unfortunately, smaller farmers in Suriname reportedly have significant difficulties in meeting such standards, for both fruits and vegetables. One company supplying both domestic and export markets works with seven out growers, while the leading juice processor started with 120 contract farmers but has only 30 remaining[936].

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[934] CIIP. 2018. Suriname Investment Climate and Sector Support: Agribusiness Sub-Sector Diagnostic - A deep dive into horticulture and fisheries and cross-cutting finance and logistics constraints. Washington, D.C.: World Bank.

[935] CIIP. 2018. Suriname Investment Climate and Sector Support: Agribusiness Sub-Sector Diagnostic - A deep dive into horticulture and fisheries and cross-cutting finance and logistics constraints. Washington, D.C.: World Bank.

[936] World Bank Group. 2017. Suriname Sector Competitiveness Analysis - Identifying Opportunities and Constraints to Investment and Diversification in the Agribusiness and Extractives Sectors. World Bank, Washington, DC.

Social, political, economic and environmental risks

Climate-related natural hazards

Suriname has been experiencing loss and damage across key sectors due to climate-related natural hazards, especially from river floods. Heavy rainfalls in 2008 flooded villages and crops both in Suriname's eastern coastal and inland areas (including the Tapanahony region in the Amazon). In the southern Amazon and bordering region, an estimated 30% of the livestock, 65% of crops, and 90% of the fishing industry were impacted. Greater rainfall variability due to climate change has been reported over the past decades, which also increased the occurrence of droughts, and to some extent, landslides in some areas. Additionally, almost 30% of the country is within a few meters above sea level, making it susceptible to coastal flooding. As nearly 90% of Suriname's population (two thirds of whom live in the capital, Paramaribo) and most of the country's fertile land and economic activity are located in the 384 kilometer-long coastal plain, sea level rise represents a significant climate and development challenge, both historically and at present[937].

Over centralized system

The GoS redistributes revenue earned from extractives through significant public sector employment, accounting for about 60% of total formal employment, including in more than 140 state-owned enterprises (SOEs) that engage in quasi-regulatory and service delivery functions as well as commercial activities. The large public sector creates fiscal risks for the country; following the commodity price downturn and recession, government revenue from mining fell from 10% of GDP to just 3%, and government debt tripled to 75.8% of GDP in 2016. Public enterprises and public sector institutions in general have limited capacity, including to manage the impacts of the main extractive activities on the country's natural assets, which include substantial forest coverage and natural water reserves.

Weak government institutions and governance

In 2016, the government embarked on a two-year IMF stand-by arrangement (SBA). Under the SBA, the IMF provided Suriname with US$$478 million of assistance, paid over a 24-month period. This assistance was meant to: (a) finance fiscal reforms, including the phasing out of electricity subsidies, wage restraints for the public sector, and increases in fuel taxes, (b) increase social cash transfers to soften the negative impacts of adjustments for low-income households, (c) enable a transition to a floating exchange rate system to increase foreign currency reserves and mitigate inflation, and lastly (d) implement structural reforms to improve the business environment, and enhance the productivity and competitiveness of the agricultural sector. The agreement with the IMF was then cancelled, as few

[937] GFDRR. No Date. Suriname Overview, Web. Global Facility for Disaster Reduction and Recovery.

reforms were executed[938]. Although IMF's SBA did not use the term "bioeconomy", many of its recommended investment measures were very aligned with it:

- Transforming the company registration and licensing regulations to improve the investment climate
- Investment in growth and diversification of export in agro-processing, wood processing and fisheries
- Development of the livestock sector
- Rehabilitation and restructuration of State Company Alliance (citrus production)
- Rehabilitation of Wageningen Pumping Station
- Development of cocoa production
- Development of coconut production
- Establishing 20 hectares of production of *Aloe vera* to processed to aloe gel

A new oil discovery on the coast of Suriname in 2020, worth an estimated 300 million barrels, is expected to increase Suriname's economic growth in the coming years. However, the start of 2020 also saw a US$$100 million-corruption scandal at the Central Bank, a further collapse of the currency, and a severe devaluation of Suriname's credit rating to junk status[939].

Several public agricultural enterprises have been associated with weak governance and poor institutional capacity and have suffered from economic and financial difficulties. Several SOEs have previously closed operations or gone bankrupt, with assets now unutilized. For example, there are three large estates were formerly used for oil palm production that are now largely unutilized. Most of the SOEs in the sector have a commercial orientation, suggesting that many may be unnecessarily duplicating the role of the private sector. There is official GoS policy to pursue privatization of agricultural SOEs. Investment and Development Corporation Suriname (IDCS) was initially established in 2010 with the primary mandate to sell agricultural SOEs, and at one time was responsible for six public agricultural enterprises with a total of 15,000 hectares of arable land. There was a successful sale of the government-owned banana company to an overseas investor in 2014, but otherwise there has been little progress with implementation the privatization agenda, with lack of legal clarity regarding how the transactions may be conducted. In 2016 the function of privatizing the estates was transferred back to MOALF, and the future of these public SOEs is presently unclear.[940]

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938 International Monetary Fund. 2019. 2019 Article IV consultation. Press release; staff report; informational annex; and statement by the executive director for Suriname. Washington, D.C.

939 Government of Suriname. 2021. Forest Reference Emission Level for Suriname's REDD+ Program. Paramaribo.

940 World Bank. 2019. Suriname Competitiveness and Sector Diversification Project: Rapid Social Assessment.

Appendix 10 – Value chain business sizing and economic data

Table A53: Cacao agroforestry

1 *Use of program resources (in US$)*

Coffee (Coffea arabica)	Micro#	Small&Med"	Large"	
Average financing	3,200	200,000	2,000,000	
Number entities Bolivia				
Financing Bolivia	0	0	0	
Number entities Brazil	18314	143	4	
Financing Brazil	58604800	28541299	7135325	
Number entities Colombia	9747.5	76	3	
Financing Colombia	31192000	15190909	5550178	
Number entities Ecuador	2220	17	1	
Financing Ecuador	7104000	3459740	1264057	
Number entities Guyana				
Financing Guyana	0	0	0	
Number entities Peru	15,400	120	3	
Financing Peru	49280000	24000000	6000000	
Number entities Surinam				
Financing Surinam	0	0	0	
Total entities	43,462	339	9	
Total (financing x entities)	146,180,800	71,191,948	19,949,560	**237,322,308**

\# Micro-businesses (smallholders) is amazon crop extent divided by Average Nr. Hectares multiplied by program adoption rate

" The number of small and med&large businesses follows the corresponding ratio to micro-businesses of pilot country.

2 *Entity profile under base case (anual)*

Coffee (Coffea arabica)	Micro	Small&Med"	Large"
Average Nr. Hectares (if applicable)	2.0	NA	NA
Average Productivity (tons/hectare- if applicable)	0.60	NA	NA
Average Production (tons)	1.20	500	10,000
Average Price (US$/ton)	1,900	2,570	2,600
Average employees (#)	1.2	20	50
Operating costs (% sales price)	75	90	90
Average sales (US$)	2,280	1,285,000	26,000,000

3 *Projection without financing, per historic data*

Coffee (Coffea arabica)	Micro	Small&Med"	Large"
Δ Hectares growth (if applicable)	0	NA	NA
Δ Productivity growth (if applicable)	0	NA	NA
Δ Production growth	0	0	0
Δ Sales growth	0	0	0

4 *Growth Targets post financing*

Coffee (Coffea arabica)	Micro	Small&Med"	Large"
Δ Hectares growth (if applicable)	50-yr5	NA	NA
Δ Productivity growth (if applicable)	10 - yr2	NA	NA
Δ Production growth	10-yr2 + 50-yr5	10-yr2	10-yr2
Δ Sales growth	10-yr2 + 50-yr5	10-yr2	10-yr2

Farm gate price - 10 year average (US$/kg):	1.90

	Extent Amazon Agrofores (ha)	Target Adoption rate (%)	Potential Adoption Extent (ha)
Bolivia	NM	0	
Brazil	91572	40	36628
Colombia	48738	40	19495
Ecuador	22000	20	4400
Guyana	NM	0	
Peru	154000	20	30800
Surinam	NM	0	
		Total	**91323**

Table A54: Coffee agroforestry

1 *Use of program resources (in US$)*

Cacao (Theobroma cacao)	Micro#	Small&Med"	Large"	
Average financing	3,600	220,000	2,200,000	
Number entities Bolivia	2240	9	1	
Financing Bolivia	8,064,000	1,964,185	1,402,989	
Number entities Brazil	19600	78	6	
Financing Brazil	70,560,000	17,186,619	12,276,157	
Number entities Colombia	3312	13	1	
Financing Colombia	11,923,200	2,904,188	2,074,420	
Number entities Ecuador	11660	46	3	
Financing Ecuador	41,976,000	10,224,285	7,303,060	
Number entities Guyana				
Financing Guyana	-	0	0	
Number entities Peru	28,100	112	8	
Financing Peru	101,160,000	24,640,000	17,600,000	
Number entities Surinam				
Financing Surinam	0	0	0	
Total entities	64,912	259	18	
Total (financing x entities)	233,683,200	56,919,277	40,656,626	**331,259,103**

Micro-businesses (smallholder producers) is Amazon extent divided by Average Nr. Hectares multiplied by program adoption rate

" The number of small&medium and large businesses follows the corresponding ratio to micro-businesses of pilot country (Peru in this case).

2 *Entity profile under base case (anual)*

Cacao (Theobroma cacao)	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	2	NA	NA
Average Productivity (tons/hectare- if applicable)	0.72	NA	NA
Average Production (tons)	1.44	460	8,000
Average Price (US$/ton)	2,045	2,368	3,336
Average employees (#)	1.2	20	50
Operating costs (% sales price)	70	90	90
Average sales (US$)	2,945	1,089,280	26,688,000

3 *Projection without financing, per historic data*

Cacao (Theobroma cacao)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	5-yr2	NA	NA
Δ Productivity growth (if applicable)	3-yr2	NA	NA
Δ Production growth	8-yr2	8-yr2	8-yr2
Δ Sales growth	8-yr2	8-yr2	8-yr2

4 *Growth Targets post financing*

Cacao (Theobroma cacao)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	50-yr5	NA	NA
Δ Productivity growth (if applicable)	30-yr2	NA	NA
Δ Production growth	30-yr2 + 50-yr5	20-yr2	20-yr2
Δ Sales growth	30-yr2 + 50-yr5	20-yr2	20-yr2

Farm gate price - 10 year average:	2.045

	Extent in Amazon (Ha)	Target Adoption Rate %	Potential Adoption Extent (Ha)
Bolivia	11200	40	4480
Brazil	98000	40	39200
Colombia	16560	40	6624
Ecuador	58300	40	23320
Guyana	NM	0	0
Peru	140500	40	56200
Surinam	NM	0	0
		Total	**129824**

Table A55: Native palm species agriculture

1 *Use of program resources (in US$)*

Palm based ag (Acai (*Euterpe oleracea*) & others)	10ha Micro"	50ha Small&Med"	1250ha Large"	
Average financing	24,000	120,000	3,000,000	
Number entities Bolivia	220	33	1	
Financing Bolivia	5,280,000	3,960,000	3,960,000	
Number entities Brazil	4624	694	28	
Financing Brazil	110,976,000	83,232,000	83,232,000	
Number entities Colombia	440	66	3	
Financing Colombia	10,560,000	7,920,000	7,920,000	
Number entities Ecuador	440	66	3	
Financing Ecuador	10,560,000	7,920,000	7,920,000	
Number entities Guyana	220	33	1	
Financing Guyana	5,280,000	3,960,000	3,960,000	
Number entities Peru	422	63	3	
Financing Peru	10,128,000	7,596,000	7,596,000	
Number entities Surinam	220	33	1	
Financing Surinam	5,280,000	3,960,000	3,960,000	
Total entities	6,586	988	40	
Total (financing x entities)	158,064,000	118,548,000	118,548,000	**395,160,000**

" Assume hectarage distributed 40% microproducers, 30% small and 30% medium and large.

2 *Entity profile under base case (anual)*

Acai (*Euterpe oleracea*)	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	10	50	1,250
Average Productivity (tons/hectare- if applicable)	4.5	4.5	4.5
Average Production (tons)	45	225	5,625
Average Price (US$/ton)	248	248	248
Average employees (#)	2.5	8	120
Operating costs (% sales price)	65	65	65
Average sales (US$)	11,160	55,800	1,395,000

3 *Projection without financing, per historic data*

Acai (*Euterpe oleracea*)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	0	0
Δ Productivity growth (if applicable)	0	0	0
Δ Production growth	0	0	0
Δ Sales growth	0	0	0

4 *Growth Targets post financing*

Acai (*Euterpe oleracea*)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	0	0
Δ Productivity growth (if applicable)	50-yr2 + 50yr3	50-yr2 + 50yr3	50-yr2 + 50yr3
Δ Production growth	0	0	0
Δ Sales growth	50-yr2 + 50yr3	50-yr2 + 50yr3	50-yr2 + 50yr3

Farm gate price - 10 year average:	248	Whole fruit , unprocessed

	Extent Acai (ha)	Extent Palmito (ha)	Extent Morete (Ha)	Extent all Others	Target Adoption rate (%)	Potential Adoption Extent (ha)
Bolivia	1000	1000	3000	6000	50	5500
Brazil	198200	24000	3000	6000	50	115600
Colombia	1000	12000	3000	6000	50	11000
Ecuador	1000	12000	3000	6000	50	11000
Guyana	1000	1000	3000	6000	50	5500
Peru	100	12000	3000	6000	50	10550
Surinam	1000	1000	3000	6000	50	5500
					Total	**164650**

Table A56: Native species aquaculture

1 Use of program resources (in US$)

Piaractus & Colosomma	Micro#	Small&Med"	Large"	
Average financing	18,120	240,500	3,000,000	
Number entities Bolivia	180	4	1	
Financing Bolivia	3,261,600	962,000	3,000,000	
Number entities Brazil	2560	52	10	
Financing Brazil	46,387,200	12,506,000	30,000,000	
Number entities Colombia	320	7	1	
Financing Colombia	5,798,400	1,683,500	3,000,000	
Number entities Ecuador	15	1	1	
Financing Ecuador	271,800	240,500	3,000,000	
Number entities Guyana	15	1	1	
Financing Guyana	271,800	240,500	3,000,000	
Number entities Peru	1,666	24	2	
Financing Peru	30,187,920	5,772,000	6,000,000	
Number entities Surinam	15	1	1	
Financing Surinam	271,800	240,500	3,000,000	
Total entities	4,771	90	17	
Total (financing x entities)	86,450,520	21,645,000	51,000,000	**159,095,520**

Micro and small is the country fishpond extent divided by Average Nr. Hectares multiplied by program adoption rate

" The number of businesses follows the corresponding ratio of pilot country.

2 Entity profile under base case (anual)

Piaractus & Colosomma	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	1.2	13	NA
Average Productivity (tons/hectare- if applicable)	6	6	NA
Average Production (tons)	7.20	78.00	2,000
Average Price (US$/ton)	2,500	2,500	3,500.0
Average employees (#)	2	6	120
Operating costs (% sales price)	75	75	80
Average sales (US$)	18,000	195,000	7,000,000

3 Projection without financing, per historic data

Piaractus & Colosomma	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	5-yr2	5-yr2	NA
Δ Productivity growth (if applicable)	5-yr2	5-yr2	NA
Δ Production growth	5-yr2+5-yr3	5-yr2+5-yr3	5-yr2+5-yr3
Δ Sales growth	5-yr2+5-yr3	5-yr2+5-yr3	5-yr2+5-yr3

4 Growth Targets post financing

Piaractus & Colosomma	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	20-yr1+20-yr2	20-yr1+20-yr2	NA
Δ Productivity growth (if applicable)	20-yr1	20-yr1	NA
Δ Production growth	40-yr1 + 20-yr2	40-yr1 + 20-yr2	10-yr1 + 10-yr2
Δ Sales growth	40-yr1 + 20-yr2	40-yr1 + 20-yr2	10-yr1 + 10-yr2

	Extent in Amazon (Ha)	Target Adoption Rate %	Potential Adoption Extent (Ha)
Bolivia	1200	40	480
Brazil	15,200	40	6080
Colombia	2,100	40	840
Ecuador	100	40	40
Guyana	100	40	40
Peru	1600	40	640
Surinam	100	40	40
		Total	**8160**

Table A57: Native species timber plantations

1 *Use of program resources (in US$)*

Native sp. Plantations (Shizolobium & others)	5ha Micro	100ha Small&Med"	2000ha Large"	
Average financing	17,500	350,000	7,000,000	
Number entities Bolivia	960	48	1.2	
Financing Bolivia	16,800,000	16,800,000	8,400,000	
Number entities Brazil	3840	192	5	
Financing Brazil	67,200,000	67,200,000	33,600,000	
Number entities Colombia	960	48	1	
Financing Colombia	16,800,000	16,800,000	8,400,000	
Number entities Ecuador	960	48	1	
Financing Ecuador	16,800,000	16,800,000	8,400,000	
Number entities Guyana	480	24	1	
Financing Guyana	8,400,000	8,400,000	4,200,000	
Number entities Peru	960	48	1	
Financing Peru	16,800,000	16,800,000	8,400,000	
Number entities Surinam	480	24	1	
Financing Surinam	8,400,000	8,400,000	4,200,000	
Total entities	8,640	432	11	
Total (financing x entities)	151,200,000	151,200,000	75,600,000	**378,000,000**

"Micro and small business are assumed to hold 40% each of area & medium and large businesses 30%

2 *Entity profile under base case (anual)*

Native sp. Plantations (Shizolobium & others)	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	5	100	2,500
Average Productivity (m3/year/hectare)	10	10	10
Average Production (m3)	50	1,000	25,000
Average Price (US$/m3)	100	100	100
Average employees (#)	2	20	400
Operating costs (% sales price)	35	35	35
Average annualized sales (US$)	5,000	100,000	2,500,000

3 *Projection without financing, per historic data*

Native sp. Plantations (Shizolobium & others)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	10	10	10
Δ Productivity growth (if applicable)	2	2	2
Δ Production growth	12	12	12
Δ Sales growth	12	12	12

4 *Growth Targets post financing*

Native sp. Plantations (Shizolobium & others)	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	100	100	100
Δ Productivity growth (if applicable)	5	5	5
Δ Production growth	105	105	105
Δ Sales growth	105	105	105

	Extent in Amazon (Ha)	Target Adoption Rate %	Potential Adoption Extent (Ha)
Bolivia	24000	50	12000
Brazil*	96000	50	48000
Colombia	24000	50	12000
Ecuador	24000	50	12000
Guyana	12000	50	6000
Peru	24000	50	12000
Surinam	12000	50	6000
		Total	**108000**

Table A58: Non-timber forest products

1 *Use of program resources (in US$)*

Brazil nut & Acai & other NTFPs	Micro#	Small&Med"	Large"	
Average financing	5,545	420,000	3,200,000	
Number entities Bolivia	3154	147	15	
Financing Bolivia	17,488,006	61,597,830	46,931,680	
Number entities Brazil	8292	386	39	
Financing Brazil	45,980,896	161,958,055	123,396,613	
Number entities Colombia	267	12	1	
Financing Colombia	1,478,667	5,208,293	3,200,000	
Number entities Ecuador	267	12	1	
Financing Ecuador	1,478,667	5,208,293	3,200,000	
Number entities Guyana	267	12	1	
Financing Guyana	1,478,667	5,208,293	420,000	
Number entities Peru	860	40.0	4	
Financing Peru	4,769,624	16,800,000	12,800,000	
Number entities Surinam	267	12	1	
Financing Surinam	1,478,667	5,208,293	3,200,000	
Total entities	12,306	572	57	
Total (financing x entities)	74,153,193	261,189,056	193,148,293	**528,490,542**

Micro-businesses (BN concessionaries) is the BN extent divided by Average Concession size multiplied by program adoption rate.

" The number of small and med&large businesses follows the corresponding ratio to micro-businesses of pilot country.

2 *Entity profile under base case (anual)*

Brazil nut & Acai & other NTFPs	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	600	NA	NA
Average Productivity (tons/hectare- if applicable)	0.006	NA	NA
Average Production (tons)	3.75	150	1,000
Average Price (US$/ton)	4,870	7,600	9,000
Average employees (#)	2	30	50
Operating costs (% sales price)	50	80	80
Average sales (US$)	18,263	1,140,000	9,000,000

3 *Projection without financing, per historic data*

Brazil nut & Acai & other NTFPs	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	NA	NA
Δ Productivity growth (if applicable)	0	NA	NA
Δ Production growth	0	0	0
Δ Sales growth	0	0	0

4 *Growth Targets post financing*

Brazil nut & Acai & other NTFPs	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	NA	NA
Δ Productivity growth (if applicable)	15-yr2	21-yr2	21-yr2
Δ Production growth	15-yr2	21-yr2	21-yr2
Δ Sales growth	15-yr2	21-yr2	21-yr2

	Extent Brazil Nut (ha)	Extent Acai (ha)	Extent Oils (ha)	Extent others	Target Adoption rate (%)	Potential Adoption Extent (ha)
Bolivia	3464600	120000	120000	80000	50	1892300
Brazil	4550780	5200000	120000	80000	50	4975390
Colombia	0	120000	120000	80000	50	160000
Ecuador	0	120000	120000	80000	50	160000
Guyana	0	120000	120000	80000	50	160000
Peru	712200	120000	120000	80000	50	516100
Surinam	0	120000	120000	80000	50	160000
					Total	**8023790**

Table A59: Community-led nature tourism

1 Use of program resources (in US$)

Community-led-nature tourism	Micro	Small&Med"	Large"	
Average financing	12,400	96,000	2,100,000	
Number entities Bolivia	40	18	2	
Financing Bolivia	496,000	1,728,000	4,200,000	
Number entities Brazil	80	36	4	
Financing Brazil	992,000	3,456,000	8,400,000	
Number entities Colombia	40	18	2	
Financing Colombia	496,000	1,728,000	4,200,000	
Number entities Ecuador	40	18	2	
Financing Ecuador	496,000	1,728,000	4,200,000	
Number entities Guyana	10	4	1	
Financing Guyana	124,000	384,000	2,100,000	
Number entities Peru	40	18	2	
Financing Peru	496,000	1,728,000	4,200,000	
Number entities Surinam	10	4	1	
Financing Surinam	124,000	384,000	2,100,000	
Total entities	240	108	12	
Total (financing x entities)	3,224,000	11,136,000	29,400,000	**43,760,000**

" The number of small and med&large businesses follows the corresponding ratio to micro-businesses of pilot country.

2 Entity profile under base case (anual)

Community-led-nature tourism	Micro	Small&Med	Large
Average Nr. Hectares (if applicable)	10,000	NA	NA
Average Productivity (paxdays/hectare- if applicable)	0.40	NA	NA
Average Production (paxdays/annum)	2,000.00	10,000	50,000
Average Price (US$/paxday)	60	70	120
Average employees (#)	10	40	100
Operating costs (% sales price)	80	80	80
Average sales (US$)	120,000	700,000	6,000,000

3 Projection without financing, per historic data (accounting for COVID impact)

Community-led-nature tourism	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	NA	NA
Δ Productivity growth (if applicable)	0	NA	NA
Δ Production growth	-50	-50	-50
Δ Sales growth	-50	-50	-50

4 Growth Targets post financing

Community-led-nature tourism	Micro	Small&Med	Large
Δ Hectares growth (if applicable)	0	NA	NA
Δ Productivity growth (if applicable)	0	NA	NA
Δ Production growth	0	0	0
Δ Sales growth	0	0	0

	Extent in Amazon (Ha)	Target Adoption Rate %	Potential Adoption Extent (Ha)
Bolivia	500000	50	250000
Brazil	1000000	50	500000
Colombia	500000	50	250000
Ecuador	500000	50	250000
Guyana	100000	50	50000
Peru	800000	50	400000
Surinam	100000	50	50000
		Total	**1750000**

Appendix 11 – Data sources for geographical analysis

Geographic scope of program map

Countries limits: ESRI, 2019. Data and Maps for ArcGIS.

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope. For the delimitation of the Program Area Map we took the Pan Amazon boundary and subtracted Venezuela and French Guiana using countries layer.

Maps – Land cover

Brazil:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Brasil, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Ecuador:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Ecuador, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Colombia:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Colombia, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Guyana:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Guyana, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Peru:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.

Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Peru, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Suriname:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Suriname, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Pan Amazon:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Countries limits: ESRI, 2019. Data and Maps for ArcGIS.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].

Maps – Land rights

Brazil:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories: Instituto Socioambiental (ISA), 2020. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Protected Areas: Instituto Socioambiental (ISA), 2020. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Forest Authorizations: Cadastro Nacional de Florestas Públicas Atualização, 2019.

Colombia:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories: Agencia Nacional de Tierras, 2019. Mapa Digital de Resguardos Indígenas. República de Colombia. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Protected Areas: Parques Nacionales Naturales de Colombia, 2019. Mapa Digital Parques Nacionales Naturales según la categoría. Escala 1:100.000. República de Colombia. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Forest Reserves: Mapa Digital Parques Nacionales Naturales según la categoría. Escala 1:100.000.República de Colombia. Parques Nacionales Naturales de Colombia 2019. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)

Ecuador:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories: EcoCiencia, 2019. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Protected Areas: Ministerio de Ambiente y Agua del Ecuador (MAAE), 2020. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)

Guyana:

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories: Indigenous Affair - Guyana, 2009. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download).
Protected Areas: Iwokrama International Centre for Rain Forest Conservation and Development, 2012. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download).
Forest Resources Allocation Map of Guyana: Guyana Forestry Commission 2016.

Peru:

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories: IBC-SICNA 2019. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Protected Areas: Ministerio del Ambiente (MINAM)-Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP), 2019. In RAISG, 2020 (https://www.amazoniasocioambiental.org/en/maps/#download)
Forest Concessions: Ministerio de Desarrollo Agrario y Riego (MINAGRI) - Servicio Forestal y de Fauna Silvestre (SERFOR), 2017.

Suriname:

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Protected Areas: National Land Monitoring System of Suriname, 2021. In collaboration with the Nature Division of the government of Suriname, accessed on [30/04/2021] through the link: [www.gonini.org]
Forest Concessions: Stichting Bosbeheer en Bostoezicht (SBB), 2016

Pan Amazon:

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Indigenous Territories:
- Brasil: Instituto Socioambiental (ISA), 2020. In RAISG, 2020
- Colombia: Agencia Nacional de Tierras, 2019. Mapa Digital de Resguardos Indígenas. República de Colombia
- Ecuador: EcoCiencia, 2019
- Guyana: Indigenous Affair - Guyana, 2009
- Peru: IBC-SICNA, 2019

Protected Areas:
- Brasil: Instituto Socioambiental (ISA), 2020
- Colombia: Parques Nacionales Naturales de Colombia, 2019. Mapa Digital Parques Nacionales Naturales según la categoría. Escala 1:100.000. República de Colombia.
- Ecuador: Ministerio de Ambiente y Agua del Ecuador (MAAE), 2020
- Guyana: Iwokrama International Centre for Rain Forest Conservation and Development, 2012
- Peru: Ministerio del Ambiente (MINAM)-Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP), 2019
- Suriname: National Land Monitoring System of Suriname, 2021

Forest Concessions and Authorizations:
- Brasil: Cadastro Nacional de Florestas Públicas Atualização, 2019
- Colombia: Mapa Digital Parques Nacionales Naturales según la categoría. Escala 1:100.000.República de Colombia. Parques Nacionales Naturales de Colombia 2019
- Ecuador: Ministerio de Ambiente y Agua del Ecuador (MAAE), 2020
- Guyana: Guyana Forestry Commission, 2016

Peru: Ministerio de Desarrollo Agrario y Riego (MINAGRI) - Servicio Forestal y de Fauna Silvestre (SERFOR), 2017
Suriname: Stichting Bosbeheer en Bostoezicht (SBB), 2016

Maps – Deforestation patterns

Brazil:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Brasil, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Brasil 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Ecuador:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Ecuador, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Ecuador 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Colombia:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Colombia, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Colombia 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Guyana:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Guyana, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Guyanas and Suriname 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Peru:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Peru, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Peru 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Suriname:
Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.

Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series - Guyana, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map of Guyanas and Suriname 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

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Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope.
Land Cover: RAISG, 2020. MapBiomas Amazonía Project- Collection [2.0] of the Annual Series of Maps of Land Cover and Land Use Map Series, accessed on [24/04/2021] through the link: [https://plataforma.amazonia.mapbiomas.org/map].
Deforestation: RAISG, 2020. Deforestation Map 2001 - 2018. (https://www.amazoniasocioambiental.org/en/maps/#download).

Maps – Ecoregions in Pan Amazon

Pan Amazon limit: RAISG 2020. Limits of the Panamazon scope
Ecoregions: World Wildlife Fund and Nature Conservancy Terrestrial Ecoregion layer, 2011 (http://maps.tnc.org/files/metadata/TerrEcos.xml)

Appendix 12 – References for Chapter 2.4 (Climate Risk and Vulnerability), and Climate-Risk and Vulnerability Related Information in the country profiles

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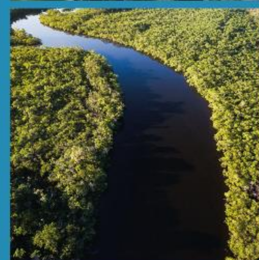

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August 2021

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