Mangroves for climate: Public, private and community partnerships for mitigation and adaptation in Ecuador

Annex 2: Feasibility Study

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Acronyms and Abbreviations

AAE	Asesoramiento Ambiental Estratégico
AGB	Aboveground biomass
ASC	Aquaculture Stewardship Council
ASOTEP	Asociación de Terminales Portuarios Privados del Ecuador (Association of Private Port Terminals of Ecuador)
AUSCEM	Acuerdos para el Uso Sostenible y Custodia del Manglar (Agreements for Sustainable Use and Custody of the Mangrove Ecosystem)
BGB	Belowground biomass
BUR	Biennial Update Report
CAF	Corporación Andina de Fomento (Andean Development Corporation)
CBD	Convention on Biological Diversity
CI	Conservation International
CI	Conservation International's Ecuador country program
CIIFEN	Centro Internacional para la Investigación del Fenómeno de El Niño (International Research Centre for El Niño Phenomenon)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLIRSEN	Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos (Center for Integrated Survey of Natural Resources by Remote Sensing)
COA	Código Orgánico del Ambiente (Organic Environmental Code)
CSS	Climate Smart Shrimp
dbh	Diameter at Breast Height
DW	Deadwood
EFU	Estuary Field Unit
ENF	Evaluación Nacional Forestal (National Forest Inventory)
ENSO	El Niño-Southern Oscillation
ERU	Emissions Reductions Unit

ESL	Extreme Sea Level
FIAS	Fondo de Inversión Ambiental Sostenible (Sustainable Environmental Investment Fund)
FPIC	Free, Prior and Informed Consent
FREL	Forest Reference Emissions Level
GAD	Gobierno Autónomo Descentralizado (Autonomous Decentralized Government)
GAP	Gender Action Plan
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
GMA	Global Mangrove Alliance
INEC	Instituto Nacional de Estadística y Censos (National Institute for Statistics and Census)
INOCAR	Instituto Oceanográfico y Antártico de la Armada (Oceanographic Institute of the Navy)
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
KPI	Key Performance Indicator
MAE	Ministerio del Ambiente del Ecuador (Ministry of Environment of Ecuador; until 2020)
MAATE	Ministerio del Ambiente, Agua y Transición del Ecuador (Ministry of Environment, Water and Transition of Ecuador; from 2020)
MTOP	Ministerio de Transporte y Obras Públicas (Ministry of Transport and Public Works)
MRV	Monitoring, Reporting and Verification
NAP	National Adaptation Plan
NCA	National Chamber of Aquaculture
NDA	Nationally Designated Authority
NDC	Nationally Determined Contributions

NRT	Near Real-Time
PA	Protected Area(s)
Project Management Unit	Project Management Unit
PAN-Manglares Ecuador	National Action Plan for the Conservation of the Mangroves of Continental Ecuador
PAR-Manglares	Regional Action Plan for the Conservation of Mangroves in the Southeast Pacific
PDOT	Plan de Desarrollo y Ordenamiento Territorial (Development and Land Use Plan)
PSB	Programa Socio Bosque (Forest Partner Incentive Program)
PSM	Propensity Score Matching
PUCESE	Pontificia Universidad Católica del Ecuador Sede Esmeraldas (Pontifical Catholic University of Ecuador Esmeraldas Extension)
RBP	Results Based Program
RCP	Representative Concentration Pathway
RE	Reserva Ecológica (Ecological Reserve)
REM	REDD Early Movers
RPF	Reserva de Producción de Flora y Fauna (Flora and Fauna Production Reserve)
RVS	Reserva de Vida Silvestre (Wildlife Refuge)
REDD+	Reducing emissions from deforestation and forest degradation, and fostering conservation, sustainable management of forests, and enhancement of forest carbon stocks
SATA	Sistema de Alerta Temprana Ambiental
SBP	Socio Bosque Program
SC	Steering Committee
SDG	Sustainable Development Goals
SGMC	Subsecretaría de Gestión Marina y Costera (Undersecretariat of Marine and Coastal Management)
SLR	Sea Level Rise

SM	Socio Manglar (Mangrove Partner)
SNGR	Servicio Nacional de Gestión de Riesgos y Emergencias (National Service for Risk Management and Emergencies)
SOC	Soil Organic Carbon
SOF	Althelia Sustainable Ocean Fund
SPA	South Pacific Anticyclone
SSP	Sustainable Shrimp Partnership
SSP	Shared Socioeconomic Pathways
SUIA	Sistema Único de Información Ambiental (Unique Environmental Information System)
TULSMA	Texto Unificado de Legislación Secundaria Ambiental (Unified Text of Secondary Enviornmental Legislation)
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UOCV	Unidades Operativas de Control y Vigilancia (Operational Units for Control and Surveillance)
VMAP	Viceministerio de Acuacultura y Pesca (Viceministry for Aquaculture and Fisheries)
WB	World Bank
WRI	World Resources Institute

1 Context: Ecuador´s Coast and Mangrove Ecosystems

1.1 Overview of Ecuador's Coast

Ecuador's complex coastal geography comprises 3,631 km of coastline (Figure 1). The coastal region of Ecuador is divided into five provinces[1] and 35 municipalities with a combined population of seven million people[2]. The coast is also the location of Ecuador's largest city and major economic hub, Guayaquil.

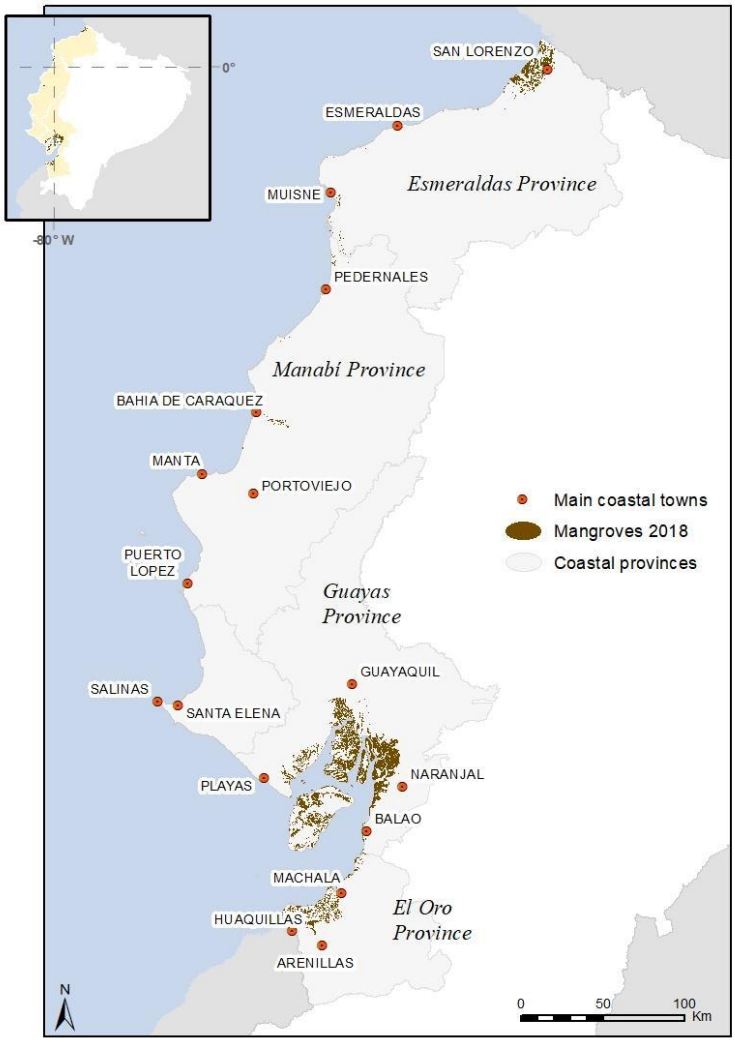


Figure 1. Ecuador's coastal region. Main urban centers and mangrove areas

[1] Esmeraldas, Manabi, Santa Elena, Guayas and El Oro

[2] Based on the 2022 census data. The population has increased from 5 million in the 2010 census

The coast concentrates a significant portion of the nation's economic output, much of which is directly dependent on coastal and marine areas, including:

1. *Shrimp:* Ecuador is the world's second largest exporter of farmed shrimp, with approximately 174,000 ha of shrimp ponds and annual exports of 1,060,000 MT worth US$6.653 billion (Cámara Nacional de Acuacultura (CNA), 2022). The volume of exports has more than doubled in the past 10 years (Piedrahita, 2018). Production is dominated by small- and medium-sized producers who constitute 97% of farms and 76% of the total area (GPS, 2020). Although farmers struggled with lower prices due to decreased service industry demand at the beginning of COVID-19, as well as China placing multiple bans on Ecuadorian shrimp, the sector quickly transitioned to service online and retail segments, especially expanding to the U.S. where shrimp consumption increased during the pandemic (Molinari, 2021). This market adaptation and diversification strategy led to a production increase of 19% between 2019 and 2020, reaching over 700,000 MT (Chase, 2021). Ecuador is recognized in the market for slightly higher quality shrimp, due in part to lower production intensities. There is still substantial room for intensification and modernization, where best management practices are adopted on farms (e.g. using auto-feeders, monitoring and managing for water quality, enhanced biosecurity, etc.) to reduce mortalities, increase profitability (through reduced production costs on a per kg basis), and improve product quality.

2. *Small scale fisheries:* The number of small-scale fishers in Ecuador is not well known, but the most detailed government census estimated there are 28,399 artisanal fishers in Ecuador, organized into 420 associations (Vice Ministry of Aquaculture and Fisheries (VMAP), 2013), with an estimated 113,596 people directly or indirectly dependent on this activity, assuming an average family size of four members. In the Gulf of Guayaquil, 74% of fishers and gatherers earn less than US$400 per month, and 37% have monthly incomes less than US$200 (Herrera *et al*., 2017).

Climate

The country is located at the Inter-Tropical Convergence Zone (ITCZ), a low-pressure belt where the two hemispheric air masses with different temperature and precipitation characteristics converge. The ITCZ is characterized by atmospheric instability, cloud cover and rain. It oscillates between the northern and southern hemispheres throughout the year, defining the rainy and dry periods in its area of influence. Between December and May, the ITCZ moves south, generating rains on the Ecuadorian coast. In June to December, the ITCZ is at its northernmost position and defines the dry season on the coast and highland regions. This is why the northernmost region of the country has higher accumulated precipitation values over the year (Pourrut, 1983; CAF, 2000). The movement of the ITCZ is related to the action of the high-pressure system located near the coast of Chilé, called the South Pacific Anticyclone (SPA). This system, with counterclockwise wind circulation, strengthens during the southern hemisphere's winter and pushes the ITCZ north, while its weakening in the southern hemisphere's summer allows the ITCZ to move south (Hernández & Zambrano, 2007).

In the oceanic region, Ecuador´s exclusive economic zone is made up of a strip of 200 miles parallel to the continental coastline. Two of the main masses of the southeast Pacific converge in this region; one is the warm current of Panama to the north and the other is the Humboldt Current with cold waters in the south (Figure 2). In the northern region, the current of Panama brings waters with low salinity and low concentrations of nutrients and is most influential in Ecuador between the months of December to

February. On the other hand, the Humboldt Current, is cooler, has low salinity, is high in nutrients and becomes more intense between the months of June and August (Majluf, 2002; Okuda *et al*., 1983).

In the continental coastal region of Ecuador, the climate is strongly influenced by the ocean since, in the rainy periods, between approximately the months of December to May, the air temperatures are slightly higher, which coincides with the warming of the sea (intensification of the Panama current). On the other hand, the dry season coincides with the intensification of the South Pacific Anticyclone, which in turn strengthens the Humboldt Current and cools the waters in the region (Gálvez & Regalado, 2007).

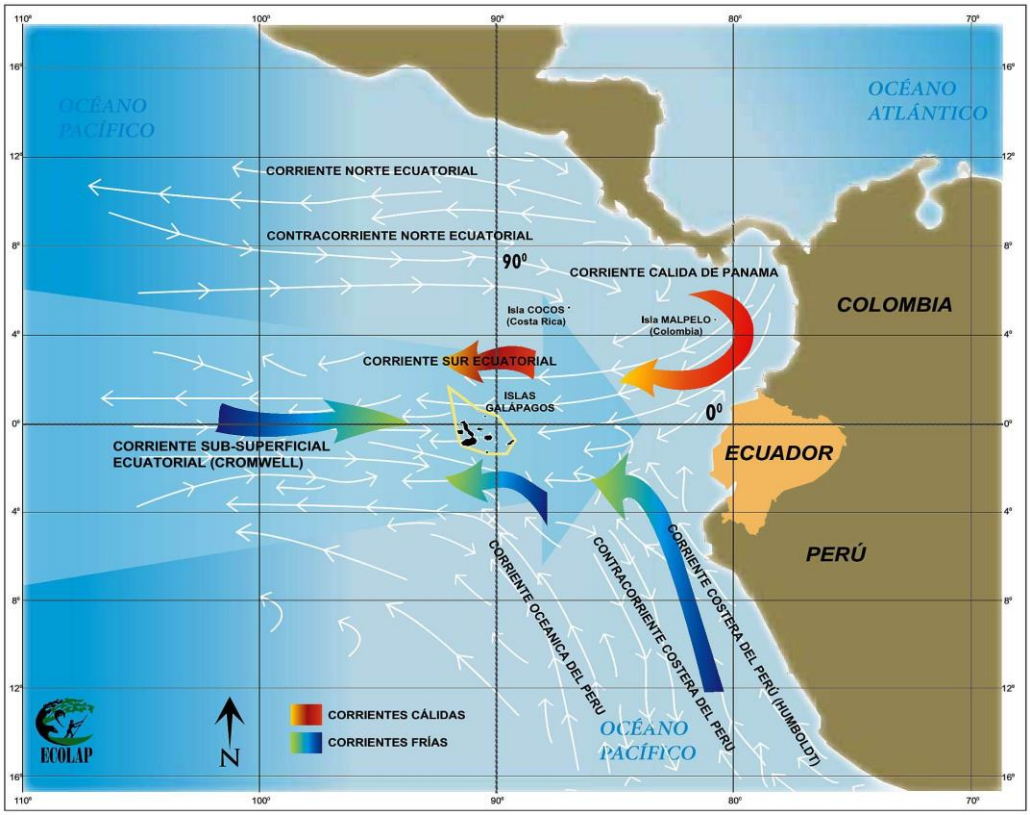


Figure 2. Location of the primary oceanic currents that influence coastal Ecuador. Source: ECOLAP & MAE (2007).

In the north-central region, rainfall exceeds 2,000 mm annually, and air temperatures are between 25°C and 39°C. Further south, the coastal zone is under the influence of the cooler Humboldt Current, so its precipitation values are between 300 and 1,000 mm per year (see Figure 3), and the average temperature values are between 24°C and 26°C (Pourrut, 1983; CAF, 1998).

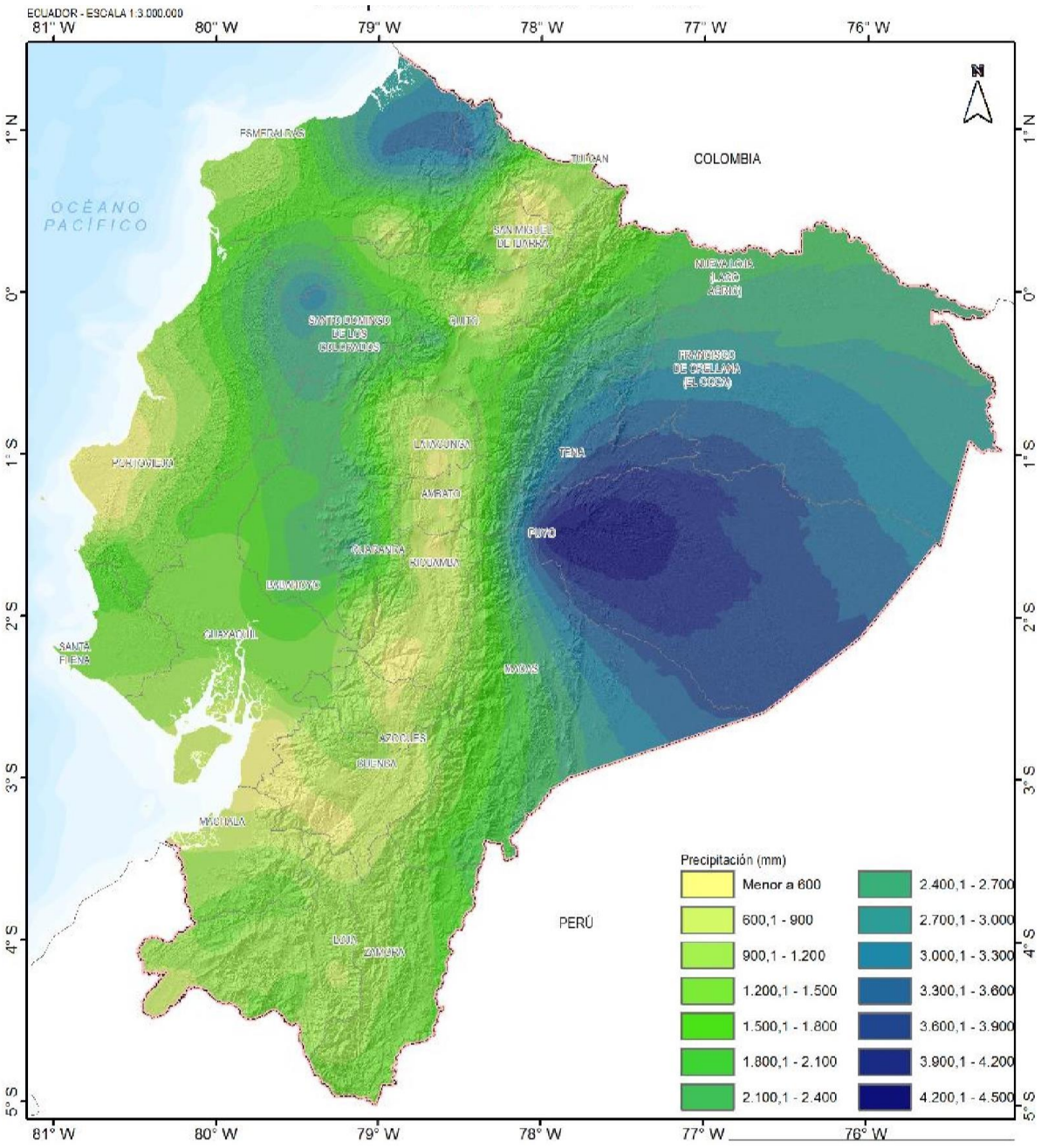


Figure 3. Annual Precipitation in Ecuador 1981-2005 based on data from 137 weather stations from the National Institute of Meteorology and Hydrology. Source: Armenta Porras et al., 2016.

1.2 Mangroves in Ecuador

1.2.1 Mangrove Ecosystem and Species

Ecuador´s mangrove ecosystem can be divided into two ecoregions (Figure 4), the Chocó humid forests and the South American Pacific zone (Cornejo, 1994). In Ecuador there are seven mangrove species from four different families (Table 1). Their associated flora is diverse and made up of more than 100 species. A great diversity of local, endemic and migratory animals depend on these mangroves. For example, there are birds that migrate the length of the American continent that use Ecuadorian mangrove sites for nesting, feeding, and resting, making them important biodiversity conservation objectives for mangrove protected areas.

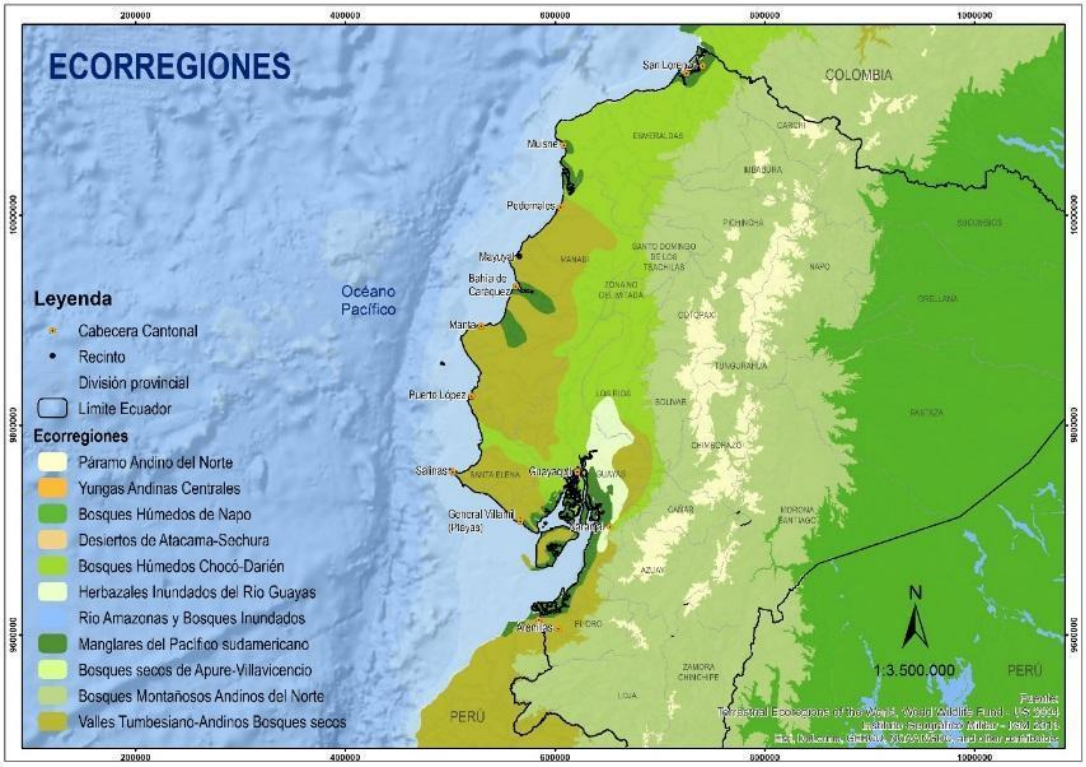


Figure 4. Ecuador ecoregions with mangroves (IGM, 2013; Olson et al., 2001)

Table 2. Mangrove Species of Ecuador

Family	Species	English common name
Rhizophoraceae	*Rhizophora mangle*	Red mangrove
	Rhizophora racemosa	
	Rhizophora harrisonii	
Acanthaceae	*Avicennia germinans*	Black mangrove
Combretaceae	*Laguncularia racemosa*	White mangrove

	Conocarpus erectus	Green buttonwood
Tetrameristaceae	*Pelliciera rhizopohorae*	Tea mangrove

Source: Cornejo, 2014

In Ecuador, mangroves provide nursery areas and habitats for several species:

- crustaceans, such as the Pacific white shrimp, *Litopenaeus vannamei*; Pacific blue shrimp *Litopenaeus stylirostris*; red crabs, *Ucides occidentalis*;
- fishes, including croakers, *Cynoscion spp*.; mullets*, Mugil spp*. (e.g., *Mugil cephalus*), and snook, *Centropomus nigrescen*s
- shellfishes, including mussels, *Mytella strigata* and *M. speciosa*;
- mangrove cockles (= ark shells), *Anadara spp*., such as *Anadara tuberculosa*, *A. similis* and *A. grandis*;
- reptiles, such as critically endangered American crocodiles, *Crocodylus acutus* and iguanas, *Iguana iguana*;
- birds, including mangrove black hawks*, Buteogallus anthracinus*; white ibises, *Eudocimus albus*; roseate spoonbills, *Ajaia ajaja*; and several species of herons, including great egrets, *Ardea alba*; snowy egrets *E. thula*; little blue herons, *E. caerulea*; tricolored herons*, E. tricolo*r; green-backed herons, *Butorides striatus*, as well as black–crowned *Nycticorax nycticorax* and yellow-crowned *Nyctanassa violacea* night herons; and,
- mammals, including crab-eating raccoons, *Procyon cancrivorus*, and neotropical otters, *Lontra longicaudis* and bottlenose dolphins (*Tursiops truncatus*) also reside around the mangrove estuarine waters (Carvajal & Alava, 2007).

Ninety-eight percent (98%) of the mangroves are concentrated along the shores of four main estuaries - Cayapas Mataje, Muisne Cojimíes, Guayas and Jambelí (Figure 5). In the north, rainfall is high, and extensive natural mangroves remain in the Cayapas Mataje riverain complex. Moving south, rainfall quickly diminishes although it remains high in El Niño years. Estuarine mangroves are found notably in the Muisne Cojimíes estuary, but these are now almost entirely limited to narrow strips fronting large areas of shrimp aquaculture. To the south of the country, the Gulf of Guayaquil still has the largest area of mangroves, notably north along the Guayas River and its adjacent channels, where they extend some 50 km upstream but also in the south in several smaller estuaries and around the Jambelí estuary. Although still abundant, these Gulf of Guayaquil mangroves represent only a fraction of their former extent with large areas converted to aquaculture ponds.

Rhizophora species are the dominate species in Ecuador, but *Avicennia germinans, Laguncularia racemosa*, and *Conocarpus erectus* are also found, while *Pelliciera rhizopohorae* is restricted to the northern forests. Forest canopies of 30 m or more are found along low-salinity riverine edges in the north, with reports of 50 m trees in some places in the Gulf of Guayaqui; however, most mangrove zones are typically 15 to 20 m high. Adjacent vegetation includes freshwater forests and high diversity rain forests in the north while a variety of saltmarsh herbs and grasses are found in adjacent high-salinity areas further south.

Ecuador has lost a lot of its mangroves, resulting in significant greenhouse gas (GHG) emissions from the trees' lost biomass and through the release of soil carbon. The most extensive losses have been linked to

the conversion of intertidal land to shrimp aquaculture, an industry that was first introduced in 1968. Although the general regulation of aquaculture in the 1970s was intended to prevent mangrove loss it was largely ineffective. More recently, recognition of the value of mangroves in protecting coastlines and in supporting healthy aquaculture and coastal fisheries has led to public calls for conservation and restoration.

1.2.2 Importance of mangroves for Ecuador's coastal populations

Mangroves extend along 36% of Ecuador's continental coastline and play a central role in sustaining both export-oriented industries and local livelihoods by providing habitat to commercial fish species and maintaining healthy coastal zones. Nearly 96% of mangroves are concentrated in eight municipalities with over 1,000 ha of mangrove each, located within three provinces[3]. These municipalities are home to over 3.4 million people, with very high rates of poverty[4] (see Table 3). Of this total population, over 2.18 million people (97% urban, 3% rural) lived within five kilometers of mangroves in 2010 (Instituto Nacional de Estadística y Censos - INEC, 2010)[5], with significant vulnerable populations living in poverty (49% of urban population, 95% of rural).

[3] See Section 5.3 Selection of Project Priority Areas.

[4] Ecuador's National Institute of Statistics and Census employs a definition of "Poverty by Unsatisfied Basic Needs "A person is poor by unsatisfied basic needs if he/she belongs to a household that presents deficiencies in the satisfaction of at least one of its basic needs represented in five components: i) quality of housing, ii) overcrowding, iii) access to basic services, iv) access to education and v) economic capacity." Poverty by Unsatisfied Basic Needs (UBN) is a multidimensional poverty measure developed in the 1980s by the Economic Commission for Latin America and the Caribbean (ECLAC).

[5] Note that at the time of writing this Feasibility Study the data from the 2022 census has not yet all been released. While some high-level population statistics (e.g. national, provincial and municipality data) have been updated in the document, finer scale analysis of the recent population census data is not yet possible. Some analyses therefore still rely on the data from the previous census in 2010.

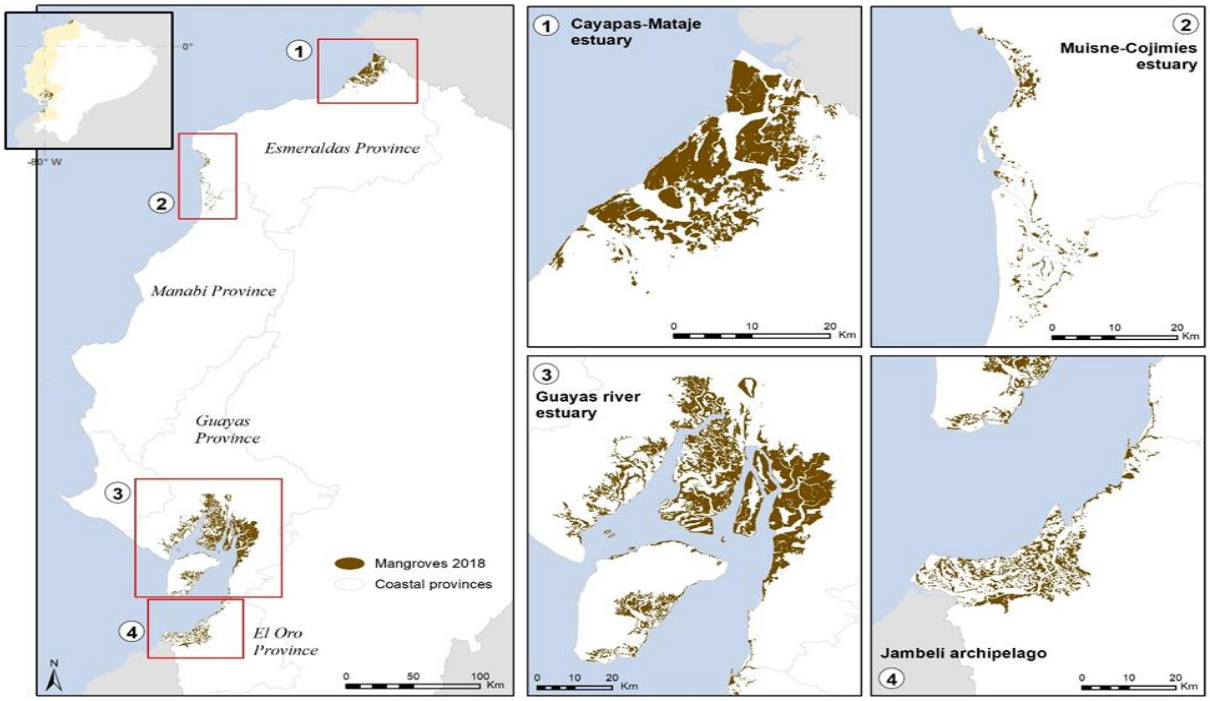


Figure 5. Principal Mangrove Areas of Ecuador

Table 3. Municipalities of Coastal Ecuador with >1,000 ha of Mangrove

Province	Municipality	Estuary	Population[1]	% Poverty[2]	Mangrove Area 2018 (ha)[3]
El Oro	El Guabo	Jambelí	59,536	74%	1,377
El Oro	Machala	Jambelí	306,309	56%	3,434
El Oro	Santa Rosa	Jambelí	80,299	56%	10,164
Esmeraldas	Eloy Alfaro	Cayapas Mataje	46,305	94%	10,454
Esmeraldas	Muisne	Muisne Cojimíes	36,426	98%	1,507
Esmeraldas	San Lorenzo	Cayapas Mataje	48,391	84%	10,296
Guayas	Guayaquil	Guayas	2,746,403	47%	90,059
Guayas	Naranjal	Guayas	83,691	74%	22,774
Total			**3,407,403**		**150,065**

Sources: [1]Instituto Nacional de Estadística y Censos - INEC. 2022; [2] Instituto Nacional de Estadística y Censos - INEC. 2010 [3]Ministerio del Ambiente del Ecuador 2020

Fifty-one percent of the population of these municipalities' lives below the poverty line (INEC, 2010), which greatly lowers their adaptive capacity. Twenty-seven percent (27%) of the total population in these municipalities is illiterate.

The mangrove ecosystem offers a wide range of ecosystem goods and services to communities, providing them with livelihoods, improving their well-being and protecting against destructive natural forces (Burgess *et al.*, 2015; Solá Defranc, 2016; UNDP, 2014; MAE, 2019; AAE-CIIFEN, 2020). In Ecuador, the National Action Plan for Mangrove Conservation (MAE, 2019) identified the following mangrove ecosystem services:

- Provisioning services, such as production of seafood (e.g., crabs, clams, mussels, oysters, fish), raw materials (e.g., wood for housing or for use in fisheries, firewood) and medicinal resources.
- Regulatory services, such as improving air quality and estuarine water quality, prevention of coastal erosion, protection of soil fertility, carbon sequestration and storage, attenuation of extreme climate events (e.g., floods, storms, tsunamis), natural wastewater treatment, pollination, biological pest control, and regulation of water flows.
- Habitat and support services for flora and fauna, including threatened and endangered species, and conservation of genetic diversity.
- Cultural services as a source of inspiration for art, tourism (e.g., nature, adventure), recreational activities, cultural identity and ancestral knowledge.

A baseline of mangrove ecosystem services was developed for the project based on secondary information and the results of workshops that were held in Esmeraldas and the Gulf of Guayaquil, the sites of the country's largest mangrove reserves.

People living near Ecuador's mangrove areas, including both urban and rural dwellers, are highly reliant on fishing and gathering of shellfish. There are an estimated 5,000 cockle (*Anadara spp.*) harvesters, the largest number of any country in the region, but the expansion of aquaculture has created tensions as cockle fishers now have to travel further and their catches are reduced (MacKinzie, 2001). The total population dependent on mangrove fisheries is approximately 42,000 people, most of whom live in the project area[6]. This number does not include the larger coastal open-water fisheries and associated economic activity which are indirectly dependent on mangroves´ ecological function as critical nurseries for a variety of economically important fish species (Sheridan & Hays 2003; Hutchison *et al*., 2014; Igulu *et al*., 2014; Lavanya & Kavi Kumar, 2017; Simpfendorfer & Milward 1993; Aburto-Oropeza *et al*., 2008). It is estimated that the national market for fish and seafood products generated by small-scale fisheries is approximately US$200 million per year (Monnier *et al.*, 2020).

The majority of fishers and shellfish gatherers dependent on mangroves live in poverty. In the Gulf of Guayaquil, 74% of the fishermen surveyed in six associations were earning less than US$400 per month,

[6] Mangrove management associations (AUSCEM), with 4,556 registered members, are almost exclusively dedicated to fisheries activities in mangrove areas (Ministerio del Ambiente del Ecuador, 2020). These management associations cover approximately 43% of Ecuador's mangroves and do not include unaffiliated 'independent' fishers who are not part of these associations, implying that the actual number of people fishing and gathering shellfish from mangroves is likely more than double the number of registered members in associations (Zambrano, N. *pers. comm.*). Total estimated beneficiary numbers are based on 4.04 family members dependent on each of these fishers (INEC 2010).

and 37% had incomes below US$200 (Herrera *et al.,* 2017). In Ecuador in 2016, the average monthly rural income was US$457, indicating that 74% of the families were below the national monthly rural average and below the benchmark 'basket' of basic family needs defined by the National Institute of Statistics and Census as US$507. Of the fisher families surveyed in the Gulf of Guayaquil, mangroves are essential for sustenance and livelihoods: 90% of income comes from these activities (Herrera et al, 2017).

Mangroves are related to offshore fisheries in numerous and complex ways. From the export of organic matter and nutrients that enter estuarine trophic chains, to the use of these ecosystems as nursery and/or breeding grounds for coastal and pelagic organisms (Sheridan & Hays 2003; Hutchison *et al*., 2014; Igulu *et al*., 2014, Lavanya & Kavi Kumar 2017). Some of the commercial species that are frequently reported as directly related to mangroves include shrimp (inshore and offshore), crabs, mangrove clams, catfish, snapper, croaker and snook. Some demersal or pelagic species that are related to mangrove ecosystems during their life history include sardines, anchovies, sharks, skates and rays (Simpfendorfer & Milward, 1993; Lavanya & Kavi Kumar, 2017).

While the links between mangrove ecosystems and inshore fisheries are clear, those with offshore commercial fisheries are much harder to quantify (Blaber, 2007). For example, several species of sharks have been reported to use mangrove habitats as nurseries, including hammerheads (Simpfendorfer & Milward, 1993; Yates *et al*., 2015). In fact, variables such as water turbidity and salinity, which can be significantly impacted by climate change (e.g., through variations in rainfall), have been shown to be key to the functioning of shark nurseries (Yates *et al*., 2015). More broadly, Igulu *et al*. (2014) reported that "…changes in seawater level and rainfall due to climate change may have important effects on how juvenile reef fish use nearshore seascapes in the future." Factors such as tidal amplitude and salinity are key to the use of mangrove habitats by fish species. Tidal changes are important in structuring fish fauna in shallow habitats and influence habitat connectivity (Igulu *et al*., 2014).

1.2.3 Historical changes to the area of mangrove land cover

In Ecuador, the use of mangrove ecosystems dates back more than 13,000 years to early coastal cultures that relied on its resources for food, through fishing and capturing and gathering various shellfish (Ayón & Zapata, 1988). In the late 1600s, mangrove wood was used for the construction of houses and boats. During the 1900s, its use was diversified for fishing gear, firewood and charcoal, for building foundations in muddy areas of Guayaquil and Machala, use of tannins from the bark and leaves of *Rhizophora* or Red Mangrove for leather, and honey was collected, produced by bees visiting flowers of *Avicennia* or Black Mangrove (Ayón & Zapata, 1988).

In the 1970s, the development of aquaculture began with rudimentary captive shrimp breeding in small ponds; the Pacific white shrimp, genus *Litopenaeus,* was selected. Subsequently, larger ponds (shrimp farms) were built in saline areas, shrubby or agricultural land adjacent to the mangroves (CLIRSEN, 2007), quickly growing to drive large scale deforestation of mangroves in the 1970s, 1980s and 1990s. This trend

has been consistent over time, and shrimp farms continue to be the prominent driver of mangrove loss, with shrimp ponds during 2008-2018 accounting for 51% of mangrove loss[7] (CIIFEN-MAE, 2020).

As part of this Feasibility Study, an analysis was conducted to assess mangrove cover, loss and regeneration for the period 2014 to 2018, thereby updating the most recent national government analyses. As of 2018, there were 154,338 ha of mangrove remaining in the four key estuaries of mainland Ecuador[8] (See Table 3). Nearly 25% of Ecuador's mangroves have been deforested since 1969 (CLIRSEN, 1999, 2007; Ministerio del Ambiente de Ecuador-Subsecretaría de Gestión Marina y Costera, 2017). Mangroves are one of the nine forest strata included in the Forest Reference Emission Level (FREL) and referenced in the Reducing Emissions from Deforestation and Forest Degradation-Plus (REDD+) Action Plan (see section 4.2.2).

Table 4. Historic areas of mangrove coverage, for four main mangrove estuaries of mainland Ecuador from CLIRSEN (2007) and CIIFEN (2020).

Year	Mangrove area (ha)
1969	203,695
1984	182,157
1987	175,155
1991	162,186
1995	146,938
1999	146,938
2000	159,505
2006	148,230
2008	151,376
2014	152,594
2016	158,462
2018	156,633

[7] Data from the more recent 2014-2018 period also allows for classification of post-deforestation land use: an additional 13% was converted to other agricultural use, 22% converted to open water (due to natural dynamics of estuarine areas), with the remainder transformed for infrastructure, scrub and other vegetation, and land without vegetation (e.g. beaches and mud flats).

[8] And 1,730 ha in fragments outside these estuaries and on coastal islands.

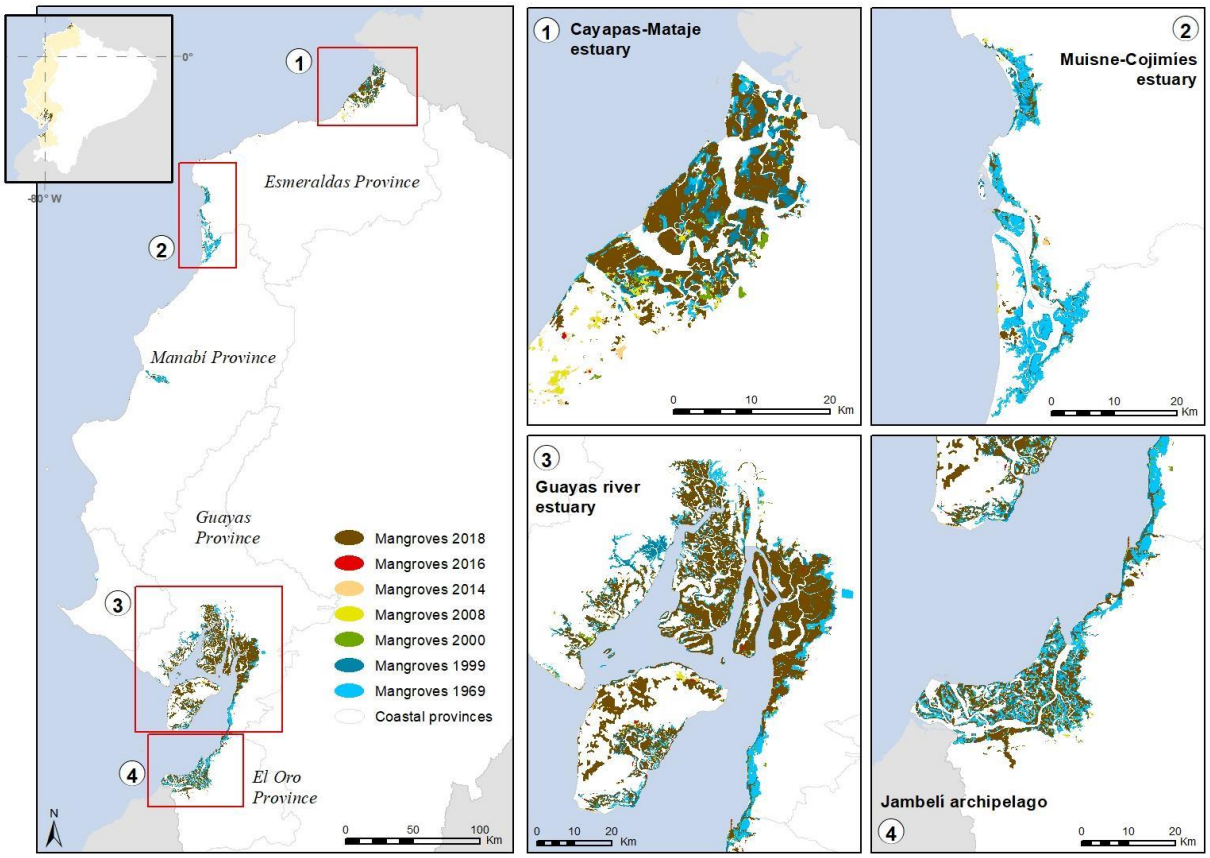


Figure 6. Historic coverage of mangroves 1969-2018.

Conversion to shrimp farms has accounted for the largest share of mangrove deforestation; accounting for 45% of lost mangroves since 1969 (CLIRSEN, 2007). Mangrove areas have historically proven vulnerable to encroachment by shrimp farms because the intertidal belt where mangroves grow has natural conditions of water flow and salinity for traditional, extensive shrimp farming. This trend has been consistent over time, and shrimp farms continue to be the prominent driver of mangrove loss, with shrimp ponds during 2008-2018 accounting for 51% of mangrove loss[9] (CIIFEN-MAE, 2020).

Recent years have seen growth in new mangrove areas replacing other land uses, with a total net gain in mangrove area of 15,161 ha from 2008-2018 (Table 5). This positive development of mangrove expansion can be attributed to implementation of new regulations (Executive Decree 1391 of 2008) requiring shrimp farms to restore mangrove areas to operate and export legally. Restoration due to these regulations accounts for at least 3,000 ha of this net gain. Abandonment of shrimp farms following disease problems associated with white spot disease during the late 1990s and early 2000s, likely also account for a portion

[9] Data from the more recent 2014-2018 period also allows for classification of post-deforestation land use: an additional 13% was converted to other agricultural use, 22% converted to open water (due to natural dynamics of estuarine areas), with the remainder transformed for infrastructure, scrub and other vegetation, and land without vegetation (e.g. beaches and mud flats).

of these gains in mangrove area, while natural coastal dynamics also contribute to mangrove formation (and loss). Insufficient data is available to distinguish and precisely attribute the contributions of these various factors nationally although recent detailed data is available for marine protected areas (MPAs) (see below).

Despite net gains in mangrove coverage there is also significant ongoing gross loss of mangroves, totaling an area of 9,903 ha lost during 2008-2018. The ongoing loss of mangroves in these areas is the result of illegal logging of mangroves (mostly for shrimp farms but also for agriculture and building), which continues to occur due to weak application of environmental regulations to sanction damages to mangroves and poor land-use planning for mangrove conservation by local governments. Natural loss of mangroves also occurs as noted below in the discussion of mangrove changes within MPAs.

Table 5. Gross and net mangrove deforestation in Ecuador, by estuary, 2008-2018.

	Gross Deforestation (ha)					
Estuary	**To Shrimp Farms**	**To Other Land Use**	**Sub-total**	**Gross Gain (ha)**	**Net Change (ha)**	**Total Mangrove Area 2018 (ha)**
Cayapas-Mataje	99	2,093	2,192	2,306	114	20,759
Muisne-Cojimíes	140	239	380	512	133	2,072
Río Guayas	2,839	2,239	5,079	8,532	3,453	114,033
Archipiélago de Jan	1,768	114	1,883	3,466	1,584	18,039
Others	187	183	370	344	-26	1,730
Total	5,035	4,868	9,903	15,161	5,258	156,633

Source: MAE, 2020

For comparison and context, deforestation of mangroves accounted for <1% of Ecuador's total deforestation (2000-2014) according to official reports to the UNFCCC (Ministerio del Ambiente, 2020).

A detailed analysis of changes in mangrove cover in MPAs between 2014 and 2018 by Castro (2020) and based on high resolution satellite imagery (see Table 6) provides important detail on the causes of mangrove loss in the protected areas (PAs) included in the project. This report confirms that most mangrove loss from anthropogenic causes is due to shrimp farms (60%) and built infrastructure (mostly associated with shrimp farms), with conversion to cropland and pasture also making a smaller contribution to mangrove loss (approximately 20% of loss due to anthropogenic causes). In addition, this analysis highlights the importance of changes that occur between natural habitat types with both mangrove loss and gain being recorded, which reflects the complex dynamics of mangrove ecosystems. This study indicates that some of the mangrove deforestation loss observed nationally will be due to natural causes. Indeed, in PAs the majority (82%) of mangrove loss was due to natural causes but natural gains meant that overall there was a net gain of 55 hectares over the 2014 to 2018 period.

Table 6. Change in mangrove cover due to anthropogenic and natural causes within Ecuador's 7 marine protected areas between 2014 and 2018

	From mangrove (ha)	To mangrove (ha)	Net change (ha to mangrove)	Percentage change
Anthropogenic causes	**67**	**99**	**32**	**18% of mangrove loss**
Shrimp farm	40	89	49	60% of anthropogenic loss
Artificial channels	2	1	-1	3% of anthropogenic loss
Crops	13	0	-13	19% of anthropogenic loss
Pasture	1	2	1	1% of anthropogenic loss
Built infrastructure (walls, roads, populated areas)	11	8	-3	16% of anthropogenic loss
Natural causes	**299**	**354**	**55**	**82% of mangrove loss**
Water	90	138	48	30% of natural loss
Shrubby vegetation	13	62	49	4% of natural loss
Herbaceous vegetation	44	35	-9	15% of natural loss
Dry forest	16	0	-16	5% of natural loss
Saline areas	50	47	-3	17% of natural loss
Humid forest	1	6	5	>1% of natural loss
Flooded forest	76	11	65	25% of natural loss
Area without vegetation cover	7	20	13	2% of natural loss
Unclassified	0	1	1	
Total change	**366**	**453**	**87**	

Source: calculated based on Castro (2020)

2 Climate risk profile

2.1 Current and projected climate change impacts in the coast of Ecuador

Climate change is projected to create significant changes in local environmental conditions along Ecuador's coast including increases in sea level, changes to El Niño-Southern Oscillation events, intensity and variability of precipitation, flooding, and increased sea surface and atmospheric temperatures, all of which will affect Ecuador's economy.

Sea Level Rise (SLR) will have significant direct impacts on Ecuador's coast and its increase is a climate-change driven phenomenon. By 2100, mean sea level is projected to rise an additional 49-64 cm on Ecuador's coast[10] depending on the Shared Socioeconomic Pathways (SSP) scenario (Table 6). Measured mean sea level increased at an average annual rate of approximately 0.8 cm (1990-2009) based on the tide gauge of La Libertad (Alavera & Nath, 2013), implying that these projections are conservative. A separate analysis (CIIFEN, 2018) reported a smaller rate of increase in historic mean sea level, based on two tide gauges from coastal Ecuador and one from Peru. From 1985 to 2015 the gauges from La Libertad (+0.13 mm) and Baltra (+0.09 mm) reported modest increases, while Callao Peru (-0.05 mm) reported a drop, perhaps due to relative movement of the continental plate (Figure 7).

[10] https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool The SLR range cited is based on projections for scenario SSP2-4.5 (lower estimate) and SSP3-7.0 (higher estimate).

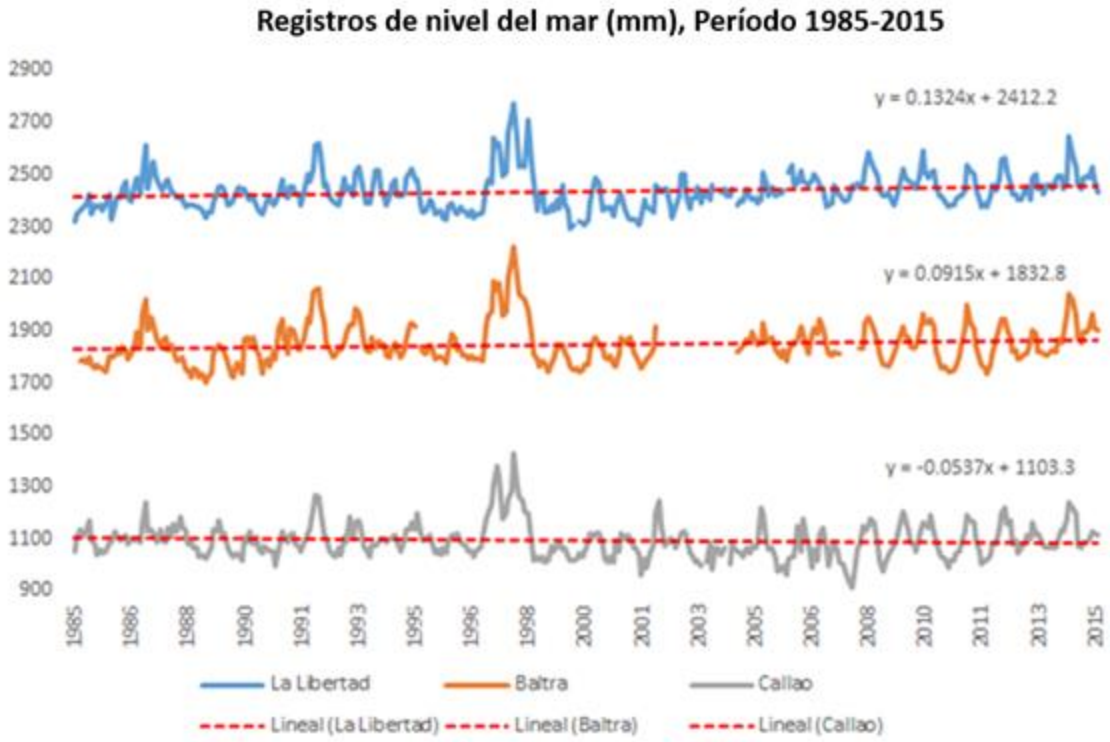


Figure 7. Trends in mean sea level 1985-2015 from three stations: La Libertad, Baltra (Ecuador) and Callao (Peru). Source: AAE-CIIFEN 2020 based on data from Instituto Oceanográfico de la Armada del Ecuador (INOCAR) and Dirección de Hidrografía y Navegación

An increase in mean sea level will also be compounded by increased frequency of extreme sea level (ESL) events (storm surge and tidal flooding), which will become common by the end of the century and occur annually by mid-century in low-lying coastal areas (IPCC, 2019). Increases in SLR and ESL are expected to increase the risks of coastal flooding and consequently impact rural and urban populations, and aquaculture in coastal areas, especially when compounded by periodic El Niño events. Celemin (2018), in an analysis of Ecuador´s northern coastal province of Esmeraldas, posited extensive damage related to a 5 m increase in mean sea level, though this extreme scenario is outside the range of most other projections.

Table 7. Projected increase in mean sea level rise under SSP 2-4.5 and SSP 3-7.05, projection to 2040 and 2100. Ranges given represent values at the 17th and 83rd percentiles. Projections are relative to a 1995-2014 baseline.

Location	Scenario	Increase in Mean Sea Level by 2040 (cm)	Increase in Mean Sea Level by 2100 (cm)
La Libertad	SSP2-4.5	11.6 (8.5-16.4)	49.4 (32.9-73.8)

	SSP3-7.0	11.9 (8.6-16.7)	63.7 (46.0-89.6)

Source: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

El Niño-Southern Oscillation (ENSO): El Niño is a large-scale, recurring climate pattern associated with above average sea surface temperatures in the eastern Pacific. El Niño events have already led to observed ocean warming and dramatic rises in sea level due to seawater expansion (Cai *et al*., 2014; Wang *et al*., 2019). During the 1997-98 season, sea surface temperatures off the coast of Ecuador increased by 5°C above normal, and sea level increased up to 42 cm (CAF, 2000). In the equatorial Pacific region, sea levels can deviate from the global mean sea level by as much as 40 cm because of El Niño (Walsh *et al*., 2012).

ENSO is a natural climatic driver, and it is very likely that rainfall variability related to ENSO will be amplified by the second half of the 21st century under the SSP 2-4.5, SSP 3-7.0 and SSP 5-8.5 scenarios (IPCC, 2021). There are indications that extreme El Niño events may increase in frequency due to climate change (McPhaden *et al.*, 2020). Regardless, the magnitude and impacts of future El Niño events affecting Ecuador even if historical patterns remain unaltered by climate change will be augmented as El Niño-driven SLR increasingly builds on top of a baseline of elevated mean sea level directly due to climate change (Reguero *et al*., 2015).

Changes in precipitation: Between 1960 and 2016 the average annual precipitation on the coast of Ecuador increased 33% (INAMHI, from Ministerio del Ambiente del Ecuador, 2017). Some models project significant increases in annual precipitation for coastal Ecuador, up 9-10% under RCP 4.5 by 2071-2100 (Armenta Porras *et al.,* 2016; Table 8). An analysis focused on the Santa Elena peninsula García-Garizábal *et al.* (2017) documented increasing temperatures (0.038°C/year) and precipitation (0.196 mm/year) for the period 1982-2011 with modeling (ECHOG A2) predicting increases in temperature (+2.7°C) and precipitation (+8,2%) by 2100. Other analyses indicate that while total annual rainfall is not expected to increase significantly, greater variability is projected, with heavier localized rains (up to 15 more days per year of extreme rainfall events) and periodic dry spells expected to increase (Ministerio del Ambiente de Ecuador, 2019; UNDP, 2013), increasing the risk of both flooding and drought (Ministerio del Ambiente del Ecuador, 2012).

Table 8. Percentage Change (%) in annual precipitation for regions of coastal Ecuador under four RCP Scenarios (from Armenta Porras et al., 2016) with respect to a baseline of 1985-2005.

2011-2040	**RCP 2.6**	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
Central Coast	0.6	1.1	1.6	4
Northern Coast	4.5	7.3	7.3	10.4

Southern Coast	2.1	3.1	1.5	4.8
2041-2070	**RCP 2.6**	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
Central Coast	3.9	6.7	4.6	10
Northern Coast	10.8	8.8	12.1	12.1
Southern Coast	3.4	7.1	6.4	10.9
2071-2100	**RCP 2.6**	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
Central Coast	2.8	10.1	6.9	13.7
Northern Coast	7.3	9.9	13.6	17.2
Southern Coast	1.8	9	11.1	17.4

Atmospheric temperature increases: From 1960-2016 average temperature for Ecuador´s coast increased 0.6°C, and an increase in atmospheric temperature of 2.2°C-2.9°C is expected by 2100 under RCP 4.5 and RCP 8.5, respectively (see Table 9, Armenta Porras *et al.,* 2016). Though outside the scope of the analysis and available data for this feasibility assessment, these temperature increases may affect livelihoods from agricultural activities and increase health risks in project areas adjacent to or outside of mangroves. This variable is included for reference purposes but is not directly expected to impact flood risks, which are the focus of this project.

Table 9. Projected mean annual temperature increase (°C) for coastal Ecuador under four RCP Scenarios (from Armenta Porras et al., 2016) with respect to a baseline of 1985-2005.

	RCP 2.6	**RCP 4.5**	**RCP 6.0**	**RCP 8.5**
2011-2040	0.78	0.91	0.73	0.87
2041-2070	1.1	1.62	1.54	1.85

2071-2100	1	2.2	2.41	2.91

Changes in ocean biochemistry: Analyses conducted for this Feasibility Study by the International Center for Research on the El Niño Phenomenon (CIIFEN) indicate that dissolved oxygen, primary production and chlorophyll will have reductions in their values under projected climate change scenarios RCP 4.5 and 8.5. The hydrogen potential off the coast of Ecuador would be reduced, showing signs of possible ocean acidification. These changes could cause impacts to fisheries and associated livelihoods, though the ecological pathways have not been modeled and are beyond the scope of current data and this feasibility analysis.

2.2 Climate-related flooding events in Ecuador

2.2.1 Historic and current flood risk and impact

Flood risks are a significant concern for Ecuador's coast. Over the last 45 years Ecuador's coastal provinces have suffered the highest degree of flooding. Guayas has been the most affected, with more than 100 floods (SNGR, 2018). Augmented sea level, coupled with the exceptionally high precipitation and El Niño-affect in coastal Ecuador, limits the discharge of river systems into the ocean, leading to inland flooding. This results in impacts to drainage throughout the coastal zone, which is not fully captured in existing coastal and river flooding models. Under current assessments, 39% of areas within five kilometers of Ecuador's coastline are already at high risk of annual flooding (SNGR, 2018).

Historical El Niño events provide a reference point for the scale of future climate-related damages for Ecuador's coast. The Dartmouth Flood Observatory registered 22 major flooding events since 1987, with over 506,000 people displaced (*DFO, 2020*). Flooding events were particularly severe during El Niño events of 1972/73, 1982/83, 1997/98, as well as in 2008 and 2012, with 184,000-222,000 ha flooded (Ocles Padilla, 2018). Flooding events registered since 1965 on the coast of Ecuador have affected over 1,822,704 people, who required immediate assistance during those events, with 68% of those occurring during El Niño years. During those flooding events, 97,031 people became homeless and 836 people were killed (Em-DAT, 2021) (see Figure 8). Those numbers, even if considered the best available, are underestimated as only events that have impacted more than 100 people, and have killed more than 10 people, are recorded.

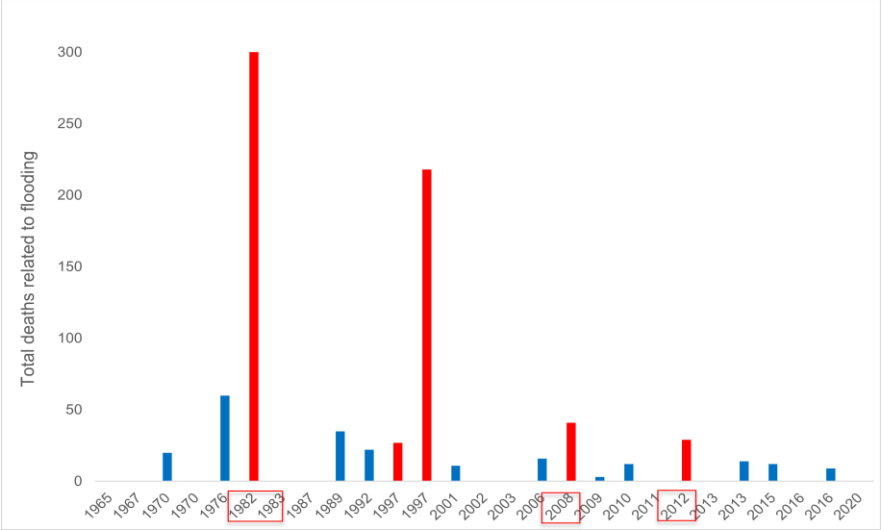


Figure 8. Number of deaths recorded in the Coast of Ecuador since 1965. Bars in red represent flooding-related deaths that happened during El Niño years. (Data from EM-DAT, 2021).

Those flooding events led to over US$ 1.5 billion in damages and economic losses, of which 96% occurred during El Niño events (EM-DAT, 2021). Furthermore, one quarter of the total coastal population was exposed to increased health risks in the form of infectious diseases such as malaria, diarrhea and cholera, which are associated with floods and damages to sanitary infrastructure caused by the 1997/98 El Niño event (Vos *et al*., 1999). The El Niño event in 2015 generated damage to infrastructure and caused losses in agricultural and aquaculture production and an economic loss estimated at US$3.5 million. This included direct and indirect damages to social sectors (housing, health, and education), the service sector (energy, water, and hydrocarbons), transport and the productive sectors. Impacts were felt for years due to the time required for rehabilitation and reconstruction (CIIFEN, 2017). Poor governmental preparation and response to previous El Niño events, in areas such as land-use planning, management, and decision making, are indicative of limited adaptive capacity in the face of climate change.

The National Secretariat for Risk Management (SNGR) has developed flood risk maps indicating that across all of coastal Ecuador approximately 198,687 people living within the coastal mangrove zone have a high likelihood of experiencing flooding during annual rainfall events, with approximately 142,000 of these people concentrated in the eight municipalities prioritized by the project. The SNGR analysis does not, however, distinguish the source of the flooding as either coastal or fluvial (river), instead the source is assumed to be a combination of both. These are flood events with probability of occurring once per year under normal conditions.

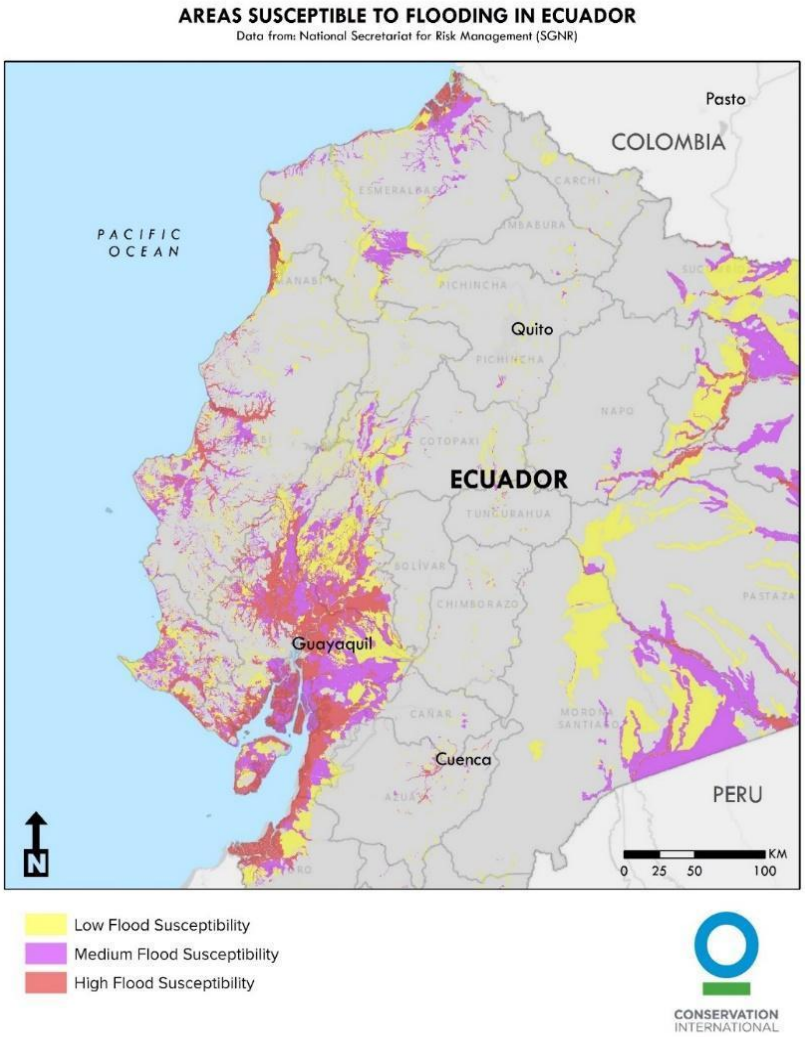


Figure 9. Areas Susceptible to Flooding in Ecuador

For the project, the coastal zone was defined as areas lying within one kilometer of the coastline (defined by mean high tide), within eight kilometers of coastline with mangroves, or mangrove forests located more than eight kilometers from the coastline. This area was further adjusted to correspond to nearest full census unit (*sectores censales*) boundaries to ensure consistency of population data, and also includes shrimp farm areas that partially overlapped these boundaries.

2.2.2 Impacts of flooding on the coastal population of Ecuador due to climate change

There are no studies that quantify the impacts of past floods on communities in Ecuador in detail, but some studies have investigated community perceptions and responses to flooding. Most of these studies have focused on inland riverine flooding (e.g. UNU-EHS, 2021) but Tauzer et al.'s (2019) study in the coastal city of Machala (population 241,000 in 2010 census) in the Guayas Estuary (in the project area) gives insight to the expected impacts from coastal flooding. In this case, community members reported both annual flooding events (with up to one meter floodwater height) and multiple severe floods over the last 30 years. Severe floods were reported to have 0.5 to 3 m floodwater height lasting from several hours to months after the flooding event. Areas of the town located near estuarine canals were affected by tidal activity with high tides and coastal flooding affecting the ability of drainage canals and sewers to discharge into the sea, which caused increased flooding. The impacts reported from the floods were wide-ranging and included damage to property and infrastructure, loss of crops, power outages, the economic costs of repairs and health impacts such as outbreaks of infectious diseases, skin infections, snakebites and injury/drowning. Government data reported thirteen deaths in Machala due to flooding during a 2022 flood.

Another study by Borbor-Cordova *et al*. (2020) assessing the causes of the coastal city of Duran's vulnerability is also highly relevant. Duran (population 235,000 in 2010 census and within the project area) is in the Guayas Estuary on the opposite bank of the river from Guayaquil and 24% of its area suffers from the effects of chronic flooding. As in Machala, flood-prone areas along the estuary edge and low-lying areas are inhabited by the poorer families of the city. Flooding events have become more frequent over the last 30 years; and are particularly acute during El Niño events in which rainfall can rise as high as 3,500 mm per year. The Borbor-Cordova *et al*. (2020) study recommends that coastal cities in Ecuador must recognize that they are part of larger scale ecosystems and that they need to integrate coastal ecosystem services from mangroves and other wetlands into urban and landscape design.

Extreme El Niño events, and related precipitation variability, at a regional scale, and increases in sea level, will likely intensify (Pachauri *et al*., 2015). When combined with the expected increase in SLR (unrelated to ENSO events), flooding of coastal areas will likely increase. Future El Niño events are likely to become more frequent and more intense (Magrin *et al*., 2007; Wang *et al*., 2019), but even an El Niño of similar magnitude to historical events, will affect larger areas and more people as its flooding impacts are compounded by SLR, as described previously.

Based on a review of local data sets and a series of models that were applied to Ecuador´s coast, the project will reduce flood risk for 89,600 people, as summarized below:

- In coastal mangrove areas, approximately 198,000 people are currently exposed annually to high flood risks from either coastal or riparian flooding (SNGR, 2018). Of those, approximately 22,400 are estimated to have an annual risk of flooding from coastal storm surges even with current mangrove cover (based on the methodology of Menéndez *et al*., 2020; see below, Appendix 6 and Annex 25 for more details).

- Without the protective functions of mangroves, an additional 86,200 people would have an annual risk of experiencing floods[11] due to a storm surge event (based on the methodology of Menéndez 2020; see Appendix 6 for more details of calculations). These 86,200 will benefit from the project since it will strengthen the protection of existing mangroves and therefore ensure that the flood protection continues into the future.
- By ensuring that current mangrove areas are conserved, deforestation due to shrimp farming reduced by 50% and restoration expanding mangrove coverage by 4,850 ha, the project will benefit 89,600 people currently exposed to annual flood risk (see **Appendix 6 and Annex 25**).

These conclusions are based on a conservative approach to estimating the number of beneficiaries that will have reduced exposure to flooding. Several other modelling approaches described below suggest that the population at future flood risk is significantly higher and that therefore the number of people likely to benefit in the future from the project is higher. However, the more conservative estimate of direct beneficiaries (89,600), has been used because: 1) it is based on a widely used and tested model of mangrove flood benefit; and 2) it is based directly on the expected changes to mangrove cover to be achieved during the 6-year project implementation period and therefore less likely to be significantly affected by population migration due to non-climate related changes. Future population changes related to migration linked to economic changes are likely to be important given the trend towards urbanization over the last several decades but are beyond the scope of this project to model.

Hallegatte *et al*. (2013) estimated the relative risk of vulnerability to flooding (economic average annual losses/city's GDP) in 136 coastal port cities, by assessing city-level flood risk and a database of urban coastal protection in 2005 and showed that the city of Guayaquil (which is protected by the mangroves included in the project) is ranked number four globally for flood risk. When future socio-economic changes are included, as well as a modest sea level rise scenario (20 cm increase), the assumption of adaptation measures by 2050, the increase in the economic average losses by 13%, put the city of Guayaquil within the top 14 of flooding-related economic losses expected between 2005 and 2050 (Hallegatte *et al*., 2013).

Modelling of current and future coastal flood risk

Three models allow for extracting data specific to Ecuador (Reguero *et al.,* 2015; Menéndez *et al.,* 2020; and Hofste 2019) to assess current and future flood risk under a variety of assumptions. Reguero et al. (2015) analyzed the impact of future SLR and climate on coastal flooding; this is described further in this section. Menendez et al. (2000) and Hofste (2019) explored the protective function of mangroves and their models are further described in section 2.4.2

Reguero *et al.* (2015) provided a regional spectrum of present and future exposures of land, population and built capital for various SLR projections, inter-annual variations (associated with El Niño events), extreme sea levels and population levels. The study evaluated climate drivers including mean sea level, ENSO, natural subsidence, and extreme sea levels that result from SLR, waves, and storm surge. These drivers were evaluated for current conditions (2011), mid-century using RCP 4.5, and end of century using RCP 4.5 and RCP 8.5 future climate scenarios. Differences between exposures using RCP 4.5 and RCP 8.5

[11] For the Menendez model, the term "people impacted by flooding" refers to people who live in areas where the water height is estimated to reach higher than 0.5m above the land height.

in 2050 were not significant to cite separately. Population estimates for this study were based upon the Global Rural-Urban Mapping Project data with 1,000 m resolution referenced to year 2000 (Center for International Earth Science Information Network-CIESIN-Columbia University *et al*., 2011) and extrapolated to 2011, 2050, and 2090 using population growth rates from the Economic Commission for Latin America and the Caribbean's 2013 Statistical Yearbook (United Nations, 2014). Coastal areas were assumed to have the same population growth as national rates. The modeling was conducted for the entire Latin American and Caribbean coastline. Populations and land areas exposed to inundation and flooding were computed by discretizing the coastlines into 5 km segments, and polygons extend 20 km inland from the shoreline.

Data specific to Ecuador was extracted to estimate exposure to coastal flooding in current and future scenarios (*Figure* 10). Due to SLR and increased populations in the coastal zone, a future 1997/98 El Niño scale event, not accounting for river flooding, would displace approximately 100,000 people in 2050 and between 145,000 (RCP 4.5) and 175,000 (RCP 8.5) in 2090, meaning that those people would be at elevations below the highest projected sea level (*Table* 10). This same model projects the number of people affected by extreme coastal flooding, with a likelihood of occurring once every 100 years (100-year event), and not including river flooding or El Niño effects. In 2010, approximately 155,000 people would likely experience negative effects from flooding (inundation and property damage) by such an extreme coastal flooding event. This number increases to 260,000 people by 2050, and between 285,000 (RCP 4.5) and 290,000 (RCP 8.5) by 2090, see *Table* 11 and *Figure* 10.

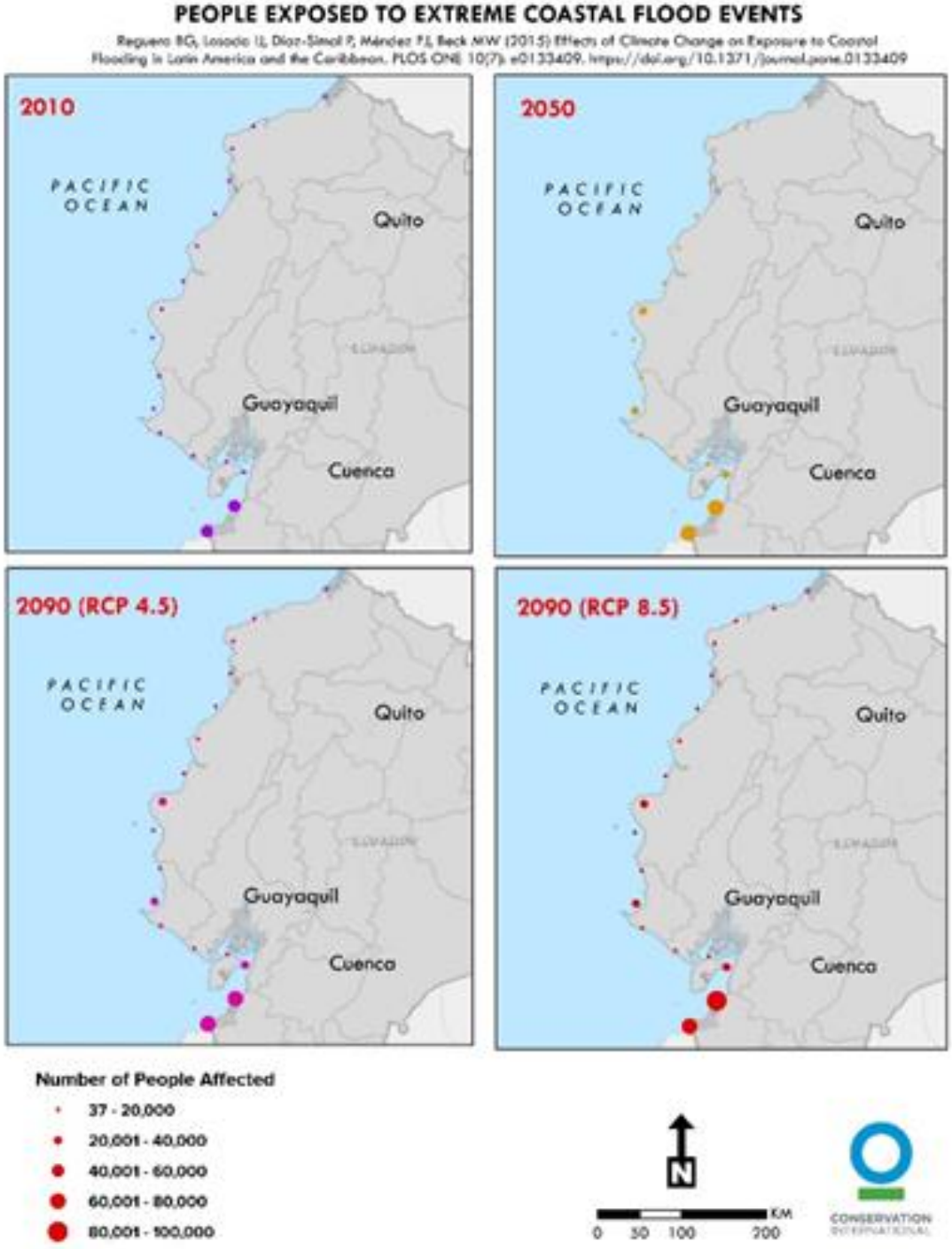


Figure 10. Number of people affected by coastal flooding events in Ecuador in current and future scenarios (Ecuador-specific data extracted from Reguero et al., 2015).

Table 10. Projected coastal impact of future El Niño (ENSO) events based upon the El Niño 1998 event and relative sea level rise projections. (Reguero, 2015)

Predicted Coastal Impact of future El Nino (ENSO) events based upon the El Nino 1998 Event* and Relative Sea Level Rise Projections (Reguero, 2015)				
	People Exposed to Coastal Flooding			
	Current (2011 population)	2050	2090	
			RCP 4.5	RCP 8.5
Guayas	20,208	65,729	94,970	115,525
Santa Elena	2,966	9,699	14,044	17,063
Manabi	5,583	18,447	26,776	32,548
Esmeraldas	1,938	6,819	10,040	12,267
Ecuador	**30,696**	**100,695**	**145,830**	**177,404**
*"sea levels can deviate as much as 40 cm because of ENSO"				

Table 11. People displaced by extreme (100-year) coastal flooding events (Reguero, 2015)

People Displaced by Extreme (100-year) Coastal Flooding Events* (Reguero, 2015)				
	2010	2050	2090	
			RCP 4.5	RCP 8.5
Guayas	104,906	178,885	198,882	205,401
Santa Elena	14,949	22,894	24,313	24,508
Manabi	24,020	36,593	38,837	39,071
Esmeraldas	12,498	19,980	21,545	22,087
Ecuador	**156,372**	**258,352**	**283,577**	**291,066**
* Extreme Sea Level (does not include tropical storms) = mean sea level + astronoical tide + storm surge + wave setup				

2.2.3 **Communities at Highest Risk from Flooding**

Background

A vulnerability and risk index was created to illustrate the relative flood risk between coastal communities in Ecuador with mangroves. The Index leverages best available data, sourced from CIIFEN (AAE-CIIFEN 2020), to provide a holistic view of community-level risk by combining multiple hazards with socioeconomic and built environment factors. Vulnerability and risk are characterized for 150 coastal

census tract areas, considering climate change projections, populations affected, and the adaptive capacity of communities. The analysis is consistent with the conceptual framework for evaluating vulnerability and climate risk, shown in *Figure* 11.

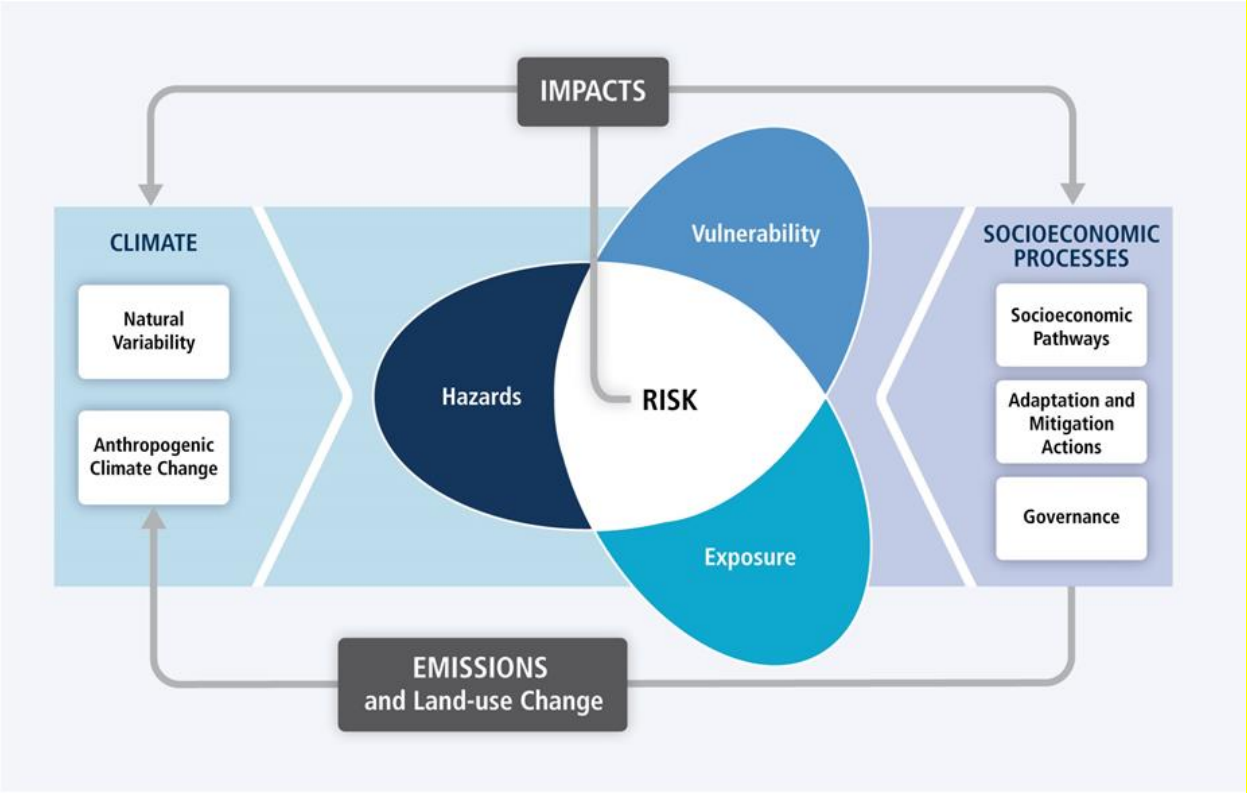


Figure 11. Conceptual framework showing the relationship between vulnerability, exposure, and hazards (threat) for evaluating risk. Source: IPCC, 2014

Risk is determined by three factors:

- Hazards: Climate-related physical events or trends, which may be of natural or anthropogenic origin, or a physical impact that may cause loss of life, injury or other negative effects on the natural (ecosystems) and human (infrastructure, livelihoods, etc.) systems.
- Exposure: the presence of people, livelihoods, species, or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and environments that could be adversely affected (IPCC, 2014).
- Vulnerability: propensity or predisposition of a natural or human system to be adversely affected. It comprises sensitivity or susceptibility to damage and lack of capacity to respond and adapt (IPCC, 2014).

Exposure and vulnerability are constituted as dynamic factors in time and space; therefore, for their evaluation, factors that condition their behavior in the face of a hazard are defined. In this sense, the IPCC states that vulnerability levels are conditioned by two factors:

- Sensitivity: corresponds to the degree to which a system or species is affected, positively or negatively, by climate variability or change.
- Adaptive capacity: refers to the capacity of systems, institutions, people and other organisms to adjust to climate change in order to moderate potential damages, take advantage of opportunities and/or withstand negative consequences.

Here Vulnerability is calculated as Sensitivity divided by Adaptive Capacity, and Risk is a product of Vulnerability multiplied by Exposure and Threat:

- *Risk = Hazard x Exposure x Vulnerability*
- *Vulnerability = Sensitivity/Adaptive Capacity*

Method

The Risk Index and its associated data are meant for planning purposes only and not as a substitute for localized risk assessment analysis. Global and nationwide datasets used as inputs are, in many cases, not as accurate as local data, when and where available.

The Risk Index does not consider the intricate economic and physical interdependencies that exist across geographic regions. Hazard impacts in surrounding counties or census tracts can cause indirect losses in a location regardless of the location's risk profile.

The Risk Index can be updated as new data becomes available and improved methodologies are identified.

Scores

All the index scores are constrained to a range of zero (lowest possible value) to five (highest possible value). To achieve this range, the values of each component are rescaled using minimum-maximum normalization, which preserves their distribution while making them easier to understand. For example, if the minimum value is 18 and the maximum is 2,500, then the minimum becomes 0, maximum becomes 5, and all values between them are transformed proportionally to fit in the 0 to 5 range.

Ratings

For every score there is a qualitative rating that describes the nature of a community's score in comparison to all other communities, ranging from "Very Low" to "Very High." Because all ratings are relative, there are no specific numeric values that determine the rating. The rating is intended to classify a community, for a specific factor, in relation to all other communities.

Maps

To assist with mapping and visualization, standard color schemes have been applied to the qualitative ratings. Risk Index ratings are represented using a diverging blue (Very Low) to red (Very High) color scheme. Ratings for Vulnerability, Sensitivity, Adaptive Capacity, Threat, and Exposure are represented

using sequential color schemes (single color at various intensities). Higher Vulnerability, Sensitivity, Threat, and Exposure, and/or lower Adaptive Capacity increase overall risk. Darker shading in the map layers represents a higher contribution to overall risk.

Sensitivity

Four factors were included in the estimation of sensitivity:

1. Deforestation of Mangroves (percent loss between 2014 and 2018) (MAE, 2019)
2. Urban Expansion over Mangrove Areas (from 2014 to 2018) (MAE, 2019)
3. Presence of Aquaculture Ponds (in 2018) (Ministerio de Acuacultura y Pesca, 2019.
4. Illiteracy Rates (from 2010 census information, INEC 2010)

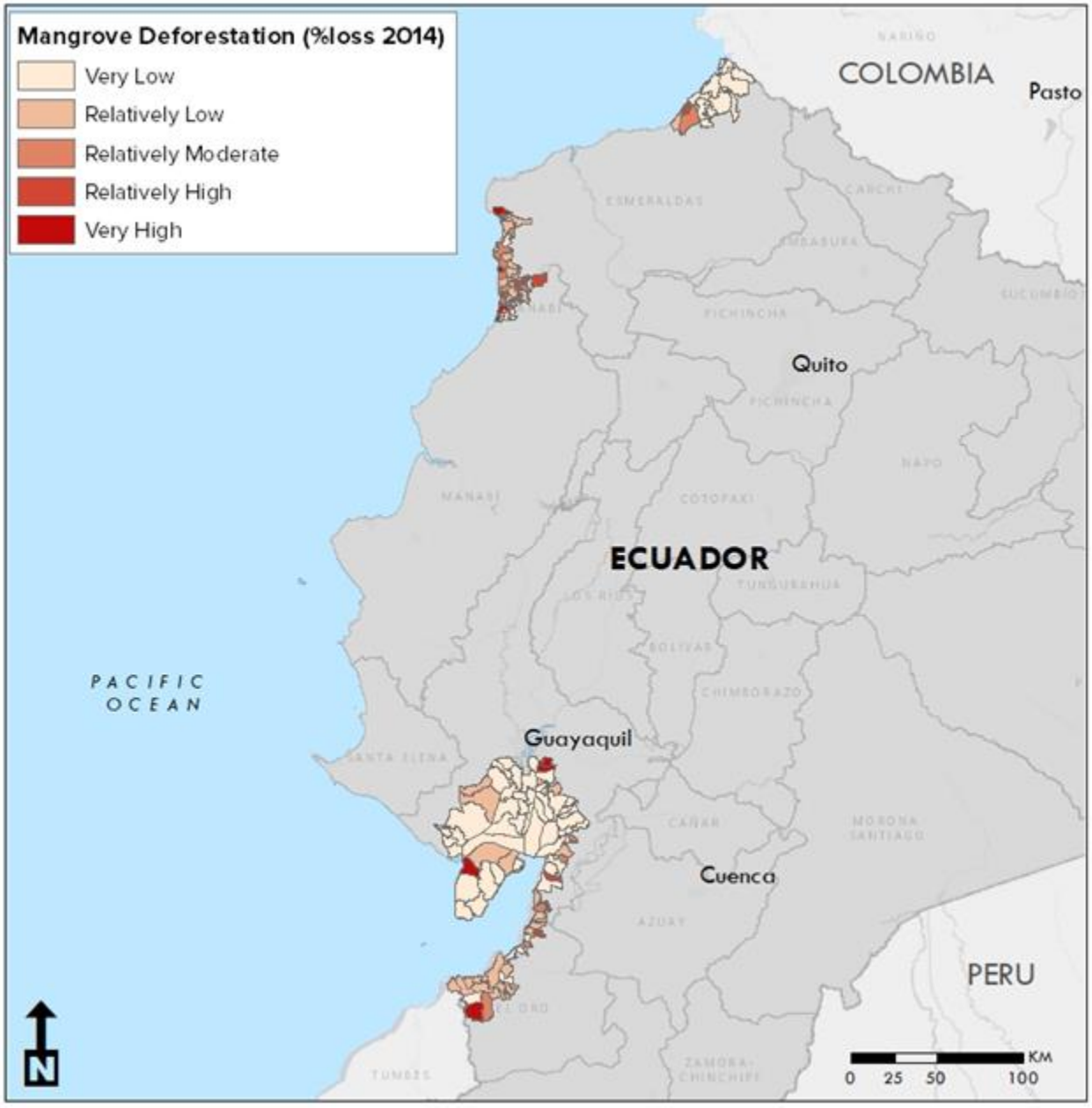


Figure 12. Sensitivity 1, Mangrove Deforestation (% loss 2014-2018)) in the project area

Figure 12 shows the spatial variation in mangrove deforestation patterns across the 150 census districts of the project area. Mangrove loss varies widely between the districts but there is no strong spatial pattern. Rates of loss in the Jambeli archipelago in the south and in the Muisne-Cojimies estuary in the north-west appear to be slightly higher than in the two other project estuary areas.

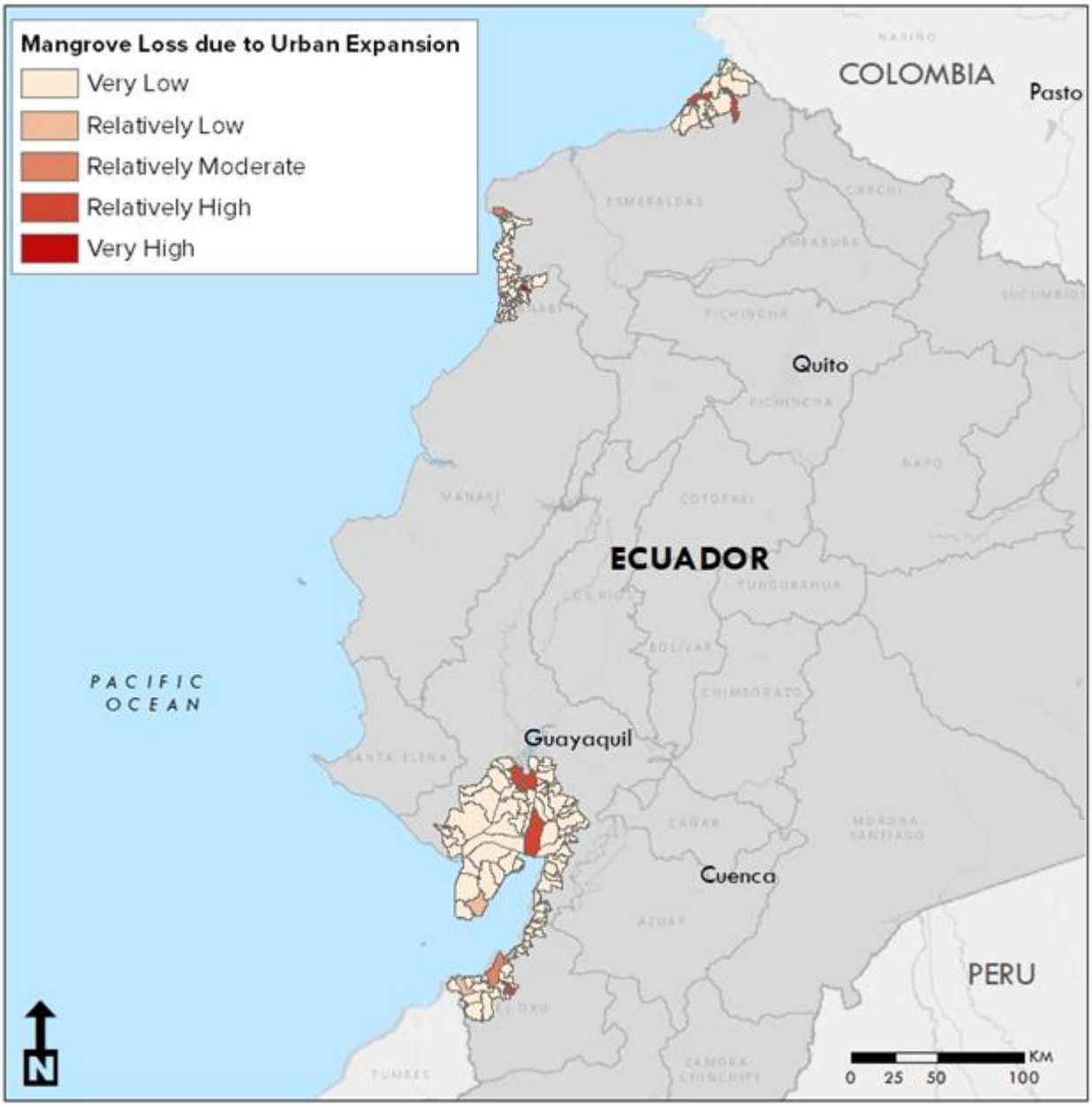


Figure 13. Sensitivity 2, Mangrove Loss to Urban Expansion

Figure 13 shows that urban expansion is a cause of mangrove loss in localized districts across the project area but there's no large-scale pattern to the loss.

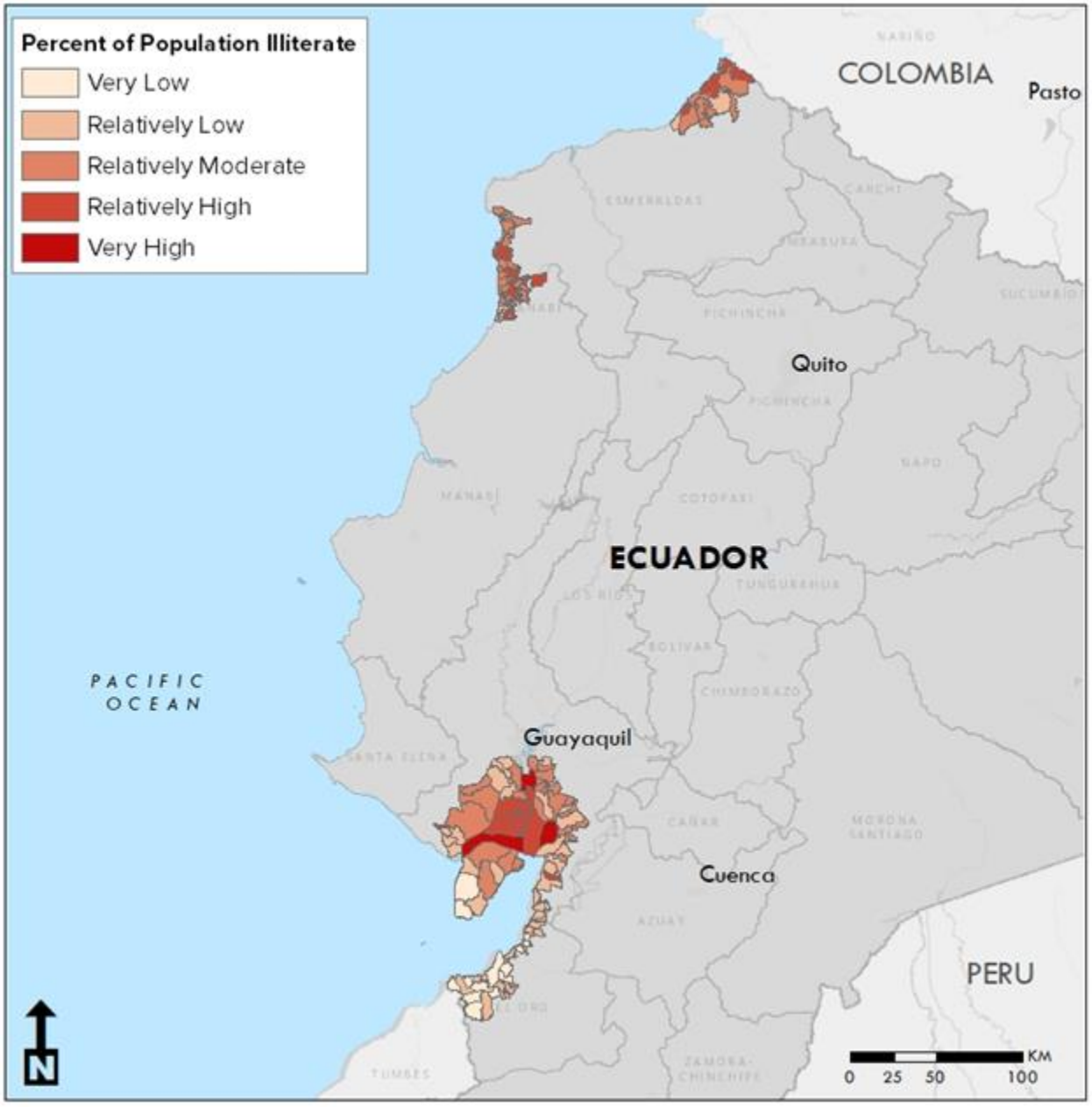


Figure 14. Sensitivity 3, Percentage Population Illiterate

Figure 14 shows high concentrations of illiteracy in the northern part of the Guayas estuary and the two northern estuaries of the project area.

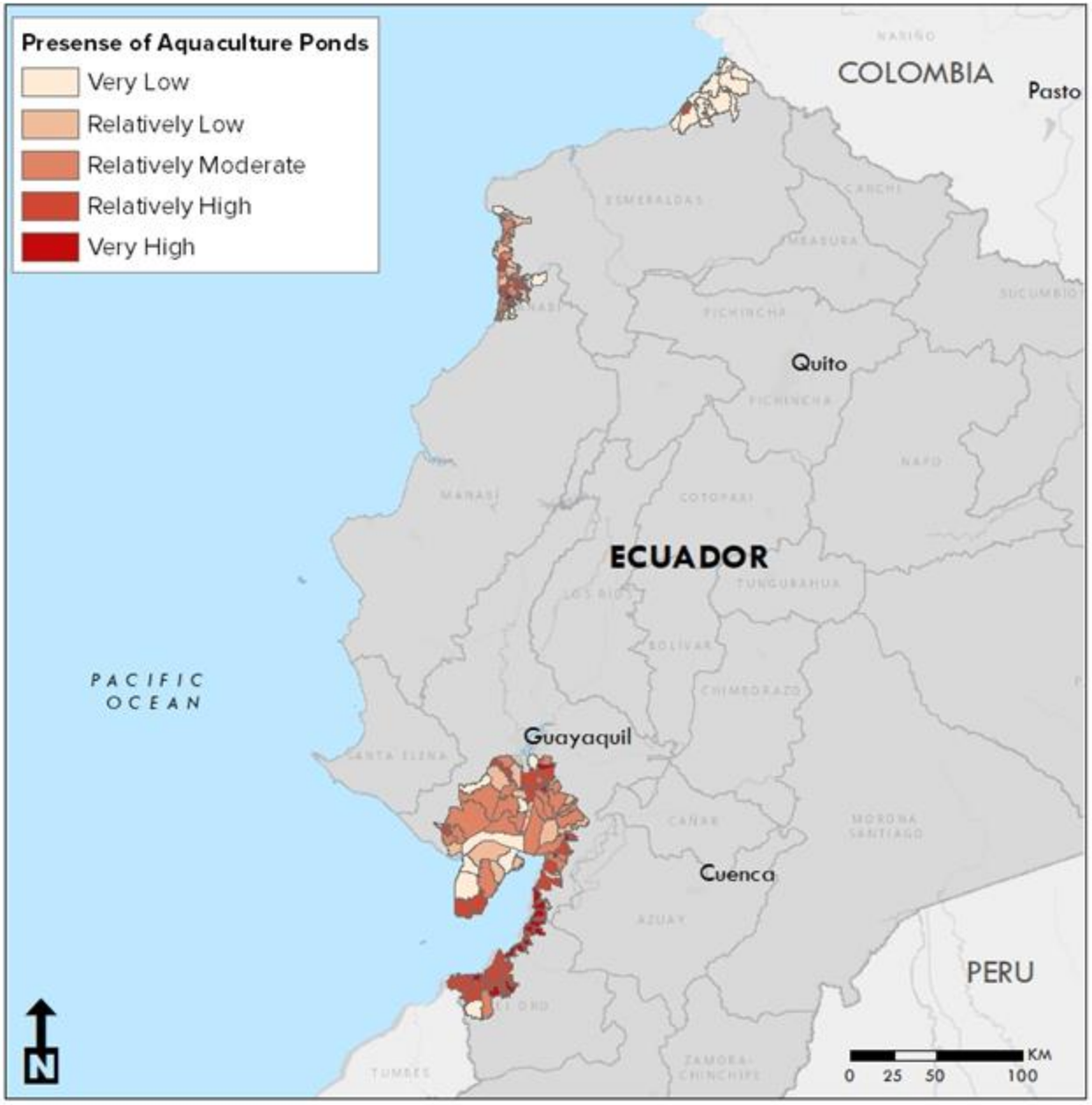


Figure 15. Sensitivity 4, Presence of Aquaculture Ponds

Figure 15 shows the high concentration of aquaculture ponds in all except the northern Cayapas-Mataje estuary. Particularly high concentrations of aquaculture ponds are present in the southern-most Jambeli archipelago. The combined, relative sensitivity of each of the 150 census districts is also shown in Figure 15.

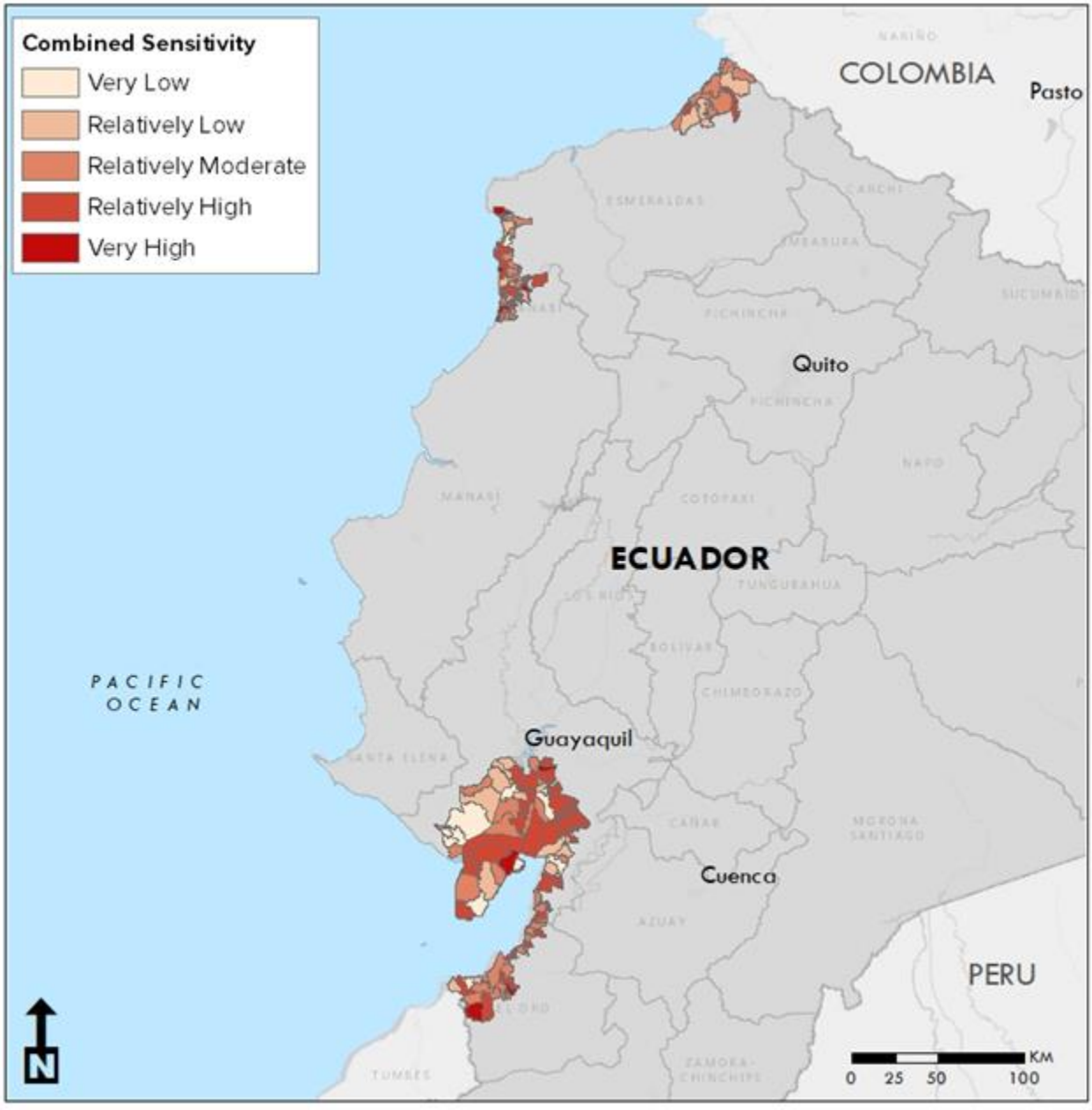


Figure 16. Combined Sensitivity

Figure 16 shows the map combined for the four sensitivity factors and highlights that all areas are likely to be sensitive to the impacts of climate change, although for different underlying reasons as illustrated in Figures 12-15.

Adaptive Capacity

Two factors were included in the estimation of adaptive capacity:

1. Existence and validity of management plans for AUSCEMs (Agreements for Sustainable Use and Custody of the Mangrove Ecosystem).
2. Mangroves managed through the Socio Bosque program.

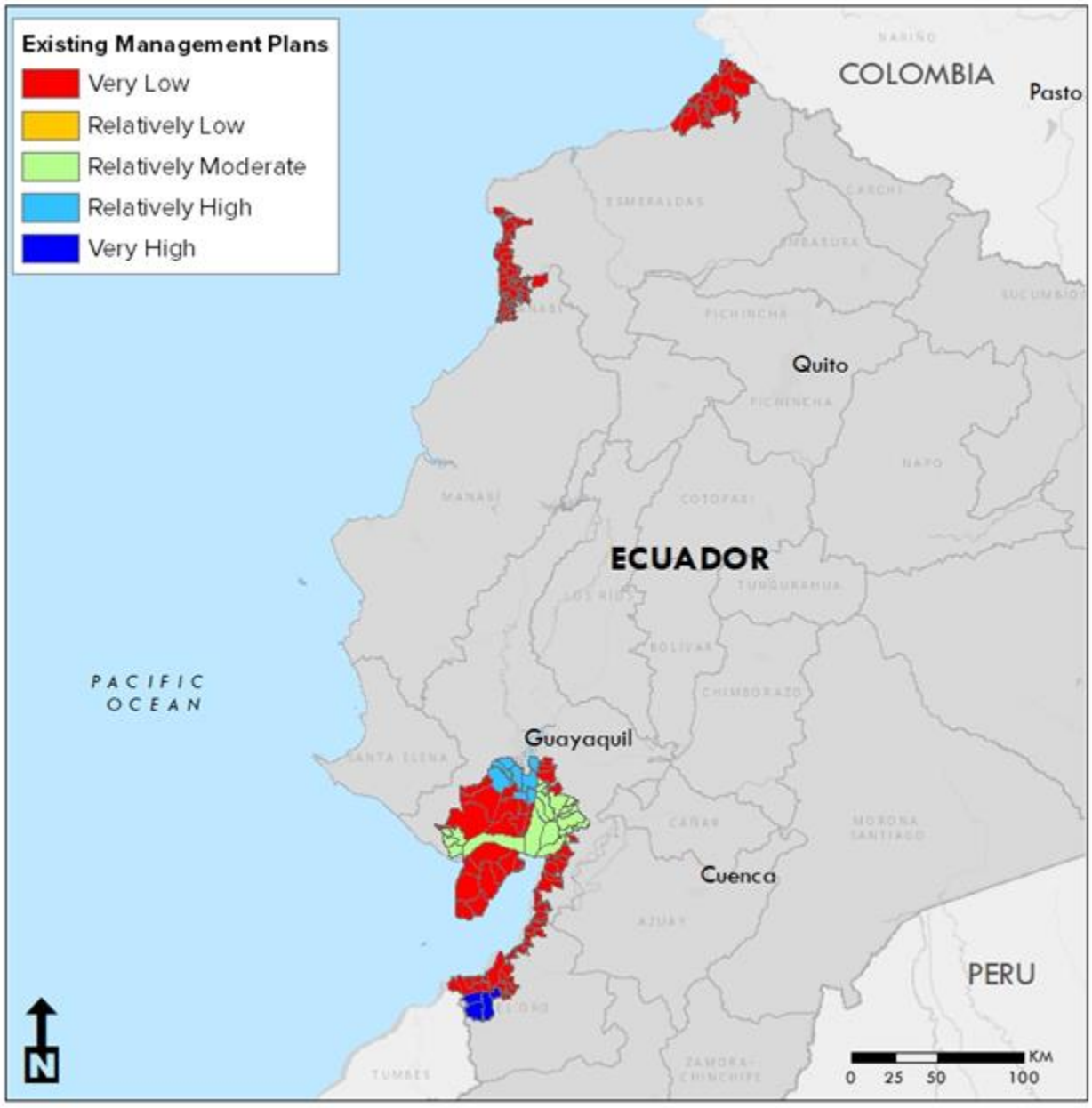


Figure 17. Adaptive capacity 1, Existing management plans

Figure 17 shows that most active AUSCEMs with management plans are in the Guayas estuary suggesting that this area will have greater adaptive capacity to effectively manage mangroves as part of a climate change adaptation strategy.

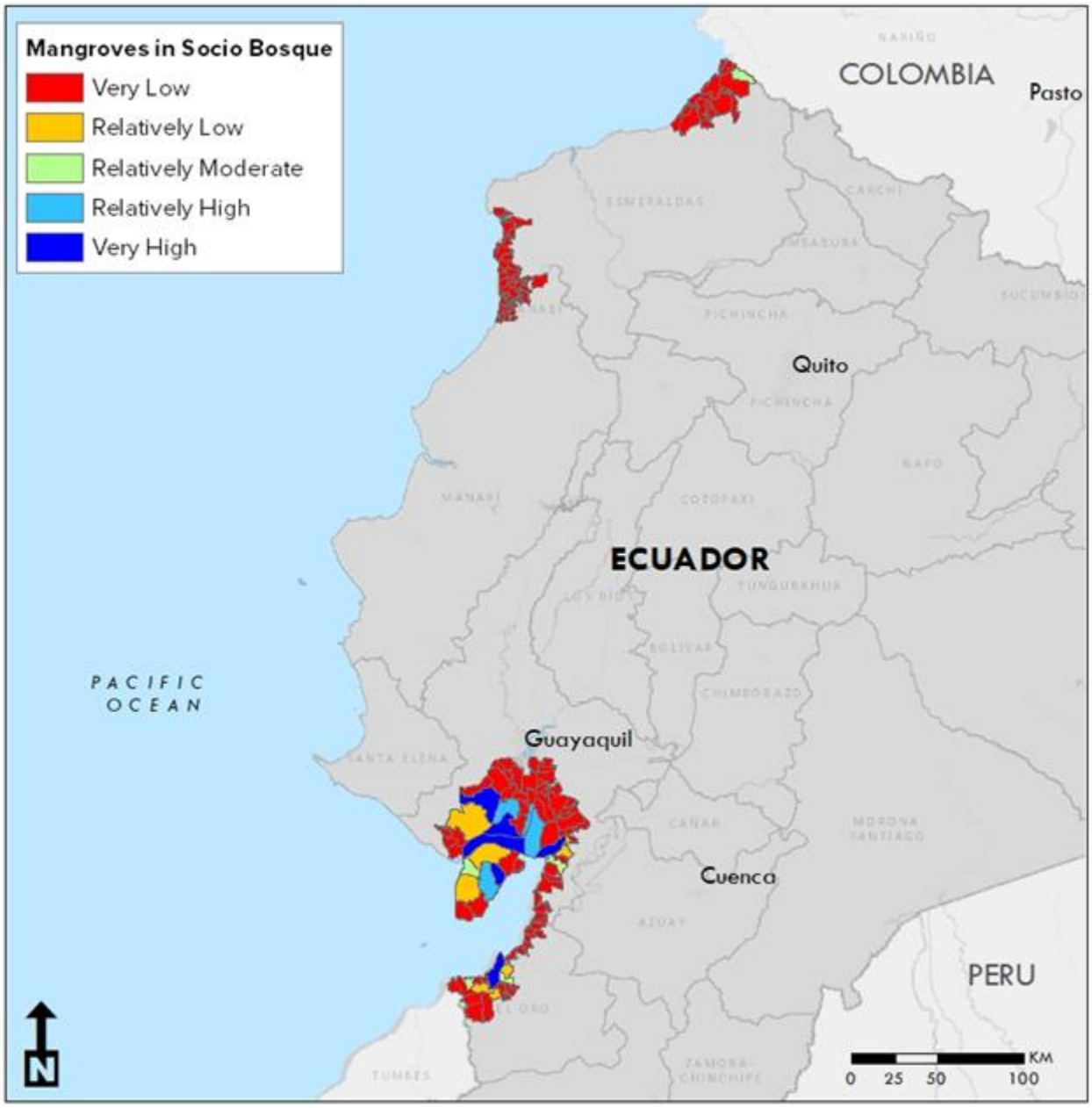


Figure 18. Adaptive Capacity 2, Mangroves in Socio Bosque

Similar to *Figure 17* above, Figure 18 illustrates that most support to communities through the Socio Manglar incentives program (which the part of the Socio Bosque program focused on mangroves) is concentrated in the two southern estuaries: Guayas and the Jambeli archipelago.

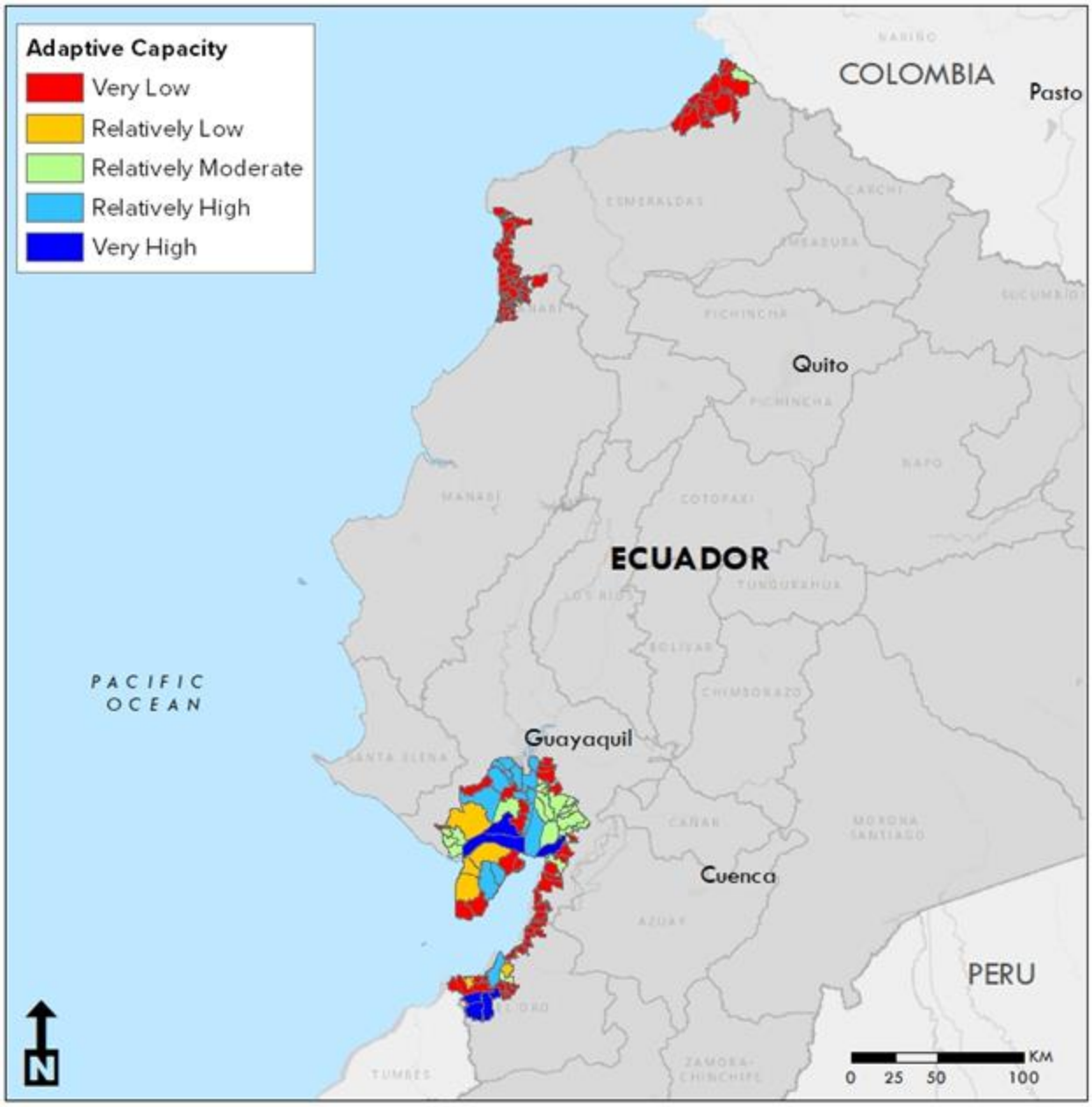


Figure 19. Combined Relative Adaptive Capacity

The combined, relative adaptive capacity of each of the 150 census districts is shown in Figure 19. Current adaptive capacity for communities to manage mangroves effectively is considered very low.

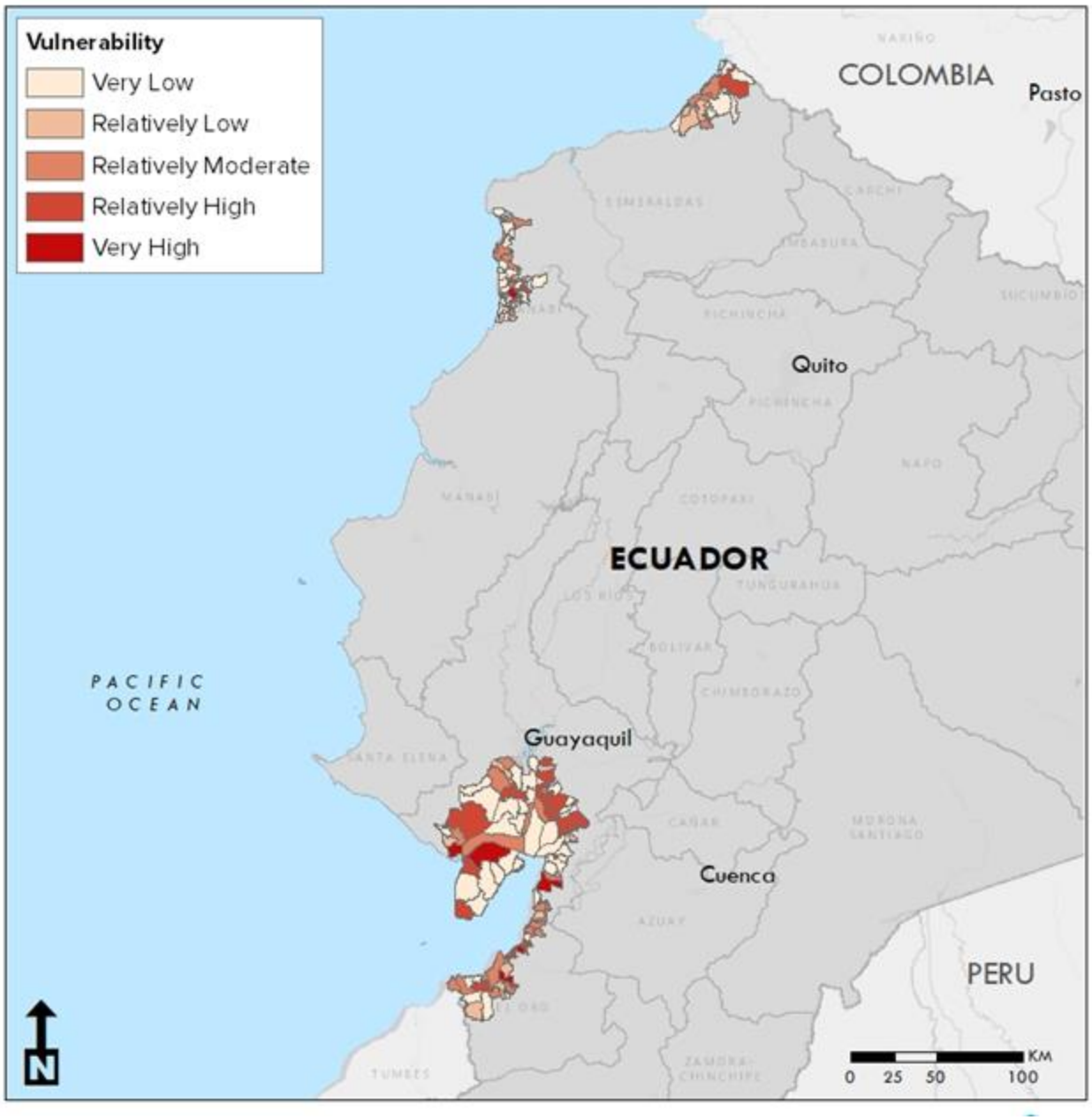


Figure 20. Relative vulnerability (sensitivity divided by adaptive capacity)

The relative vulnerability (sensitivity divided by adaptive capacity) of each of the 150 census districts is shown in Figure 20. This figure illustrates that there is no particular widespread pattern to vulnerability. While some districts are considered to have very high vulnerability, their neighboring ones can have varied vulnerability. Overall, there seems to be a mixed picture with high sensitivity in many areas of the southern estuaries due to the high density of shrimp farms being offset by higher capacity among AUSCEMs to manage mangroves sustainably.

Exposure

Relative exposure was defined by total population per census units. Mangroves of mainland Ecuador are concentrated in the provinces of Guayas, Esmeraldas, El Oro and Manabí, with 14 Cantons (municipalities), 37 parishes (*parroquias*) and 150 census sectors[12].

Table 12. Census Sectors with Mangroves. Source: INEC 2010.

Estuary	Canton (*Cantón*)	Parish (*Parroquia*)	Number of census sectors
Estuario del río Guayas	Balao	Balao	3
	Durán	Eloy Alfaro (Durán)	6
	El Guabo	Tendales (Cab. En Puerto Tendales)	1
	Guayaquil	Guayaquil	20
	Guayaquil	Morro	4
	Guayaquil	Posorja	1
	Guayaquil	Puna	10
	Guayaquil	Tenguel	4
	Naranjal	Naranjal	5
	Naranjal	Santa Rosa De Flandes	3
	Naranjal	Taura	10
Archipiélago de Jambelí	Arenillas	Arenillas	2
	Arenillas	Chacras	1
	El Guabo	Barbones (Sucre)	2
	El Guabo	El Guabo	2
	El Guabo	Tendales (Cab. En Puerto Tendales)	2
	Huaquillas	Huaquillas	1
	Machala	El Retiro	3
	Machala	Machala	2
	Santa Rosa	Jambelí	7
	Santa Rosa	Santa Rosa	2
Estuario Muisne - Cojimíes	Muisne	Bolívar	2
	Muisne	Daule	3
	Muisne	Muisne	5
	Muisne	Salima	3
	Muisne	San Francisco	1
	Muisne	San Gregorio	2
	Muisne	San José De Chamanga	2
	Pedernales	Cojimíes	20
	Pedernales	Pedernales	3
Estuario Cayapas - Mataje	Eloy Alfaro	La Tola	5
	Eloy Alfaro	Pampanal De Bolívar	2
	Eloy Alfaro	Valdez (Limones)	3
	S. Lorenzo	Ancón (Pichangal) (Cab. En Palma Real)	2

[12] These are the smallest units for which census data is collected and reported by Ecuador's National Institute of Statistics and Census (INEC)

	S.Lorenzo	Mataje (Cab. En Santander)	1
	S. Lorenzo	San Lorenzo	2
	S. Lorenzo	Tambillo	3

Figure 21. Relative Exposure, total population (INEC, 2010)

The relative exposure, as expressed by the total population living in the 150 census districts is shown in *Figure 21*. This shows high variability in population density ranging from very low density in rural areas to very high in urban areas.

Threat

Three types of data were included in the estimation of flooding threats:

1. Sea Level Rise (for current (2010) conditions and future (2040) RCP 4.5 and RCP 8.5 climate scenarios from AAE-CIIEFEN 2020)
2. Precipitation Increases (for current (2010) conditions and future (2040) RCP 4.5 and RCP 8.5 climate scenarios, from AAE-CIIEFEN 2020)
3. Flooding Risk (from the National Secretariat for Risk Management flood risk maps (SNGR 2018))

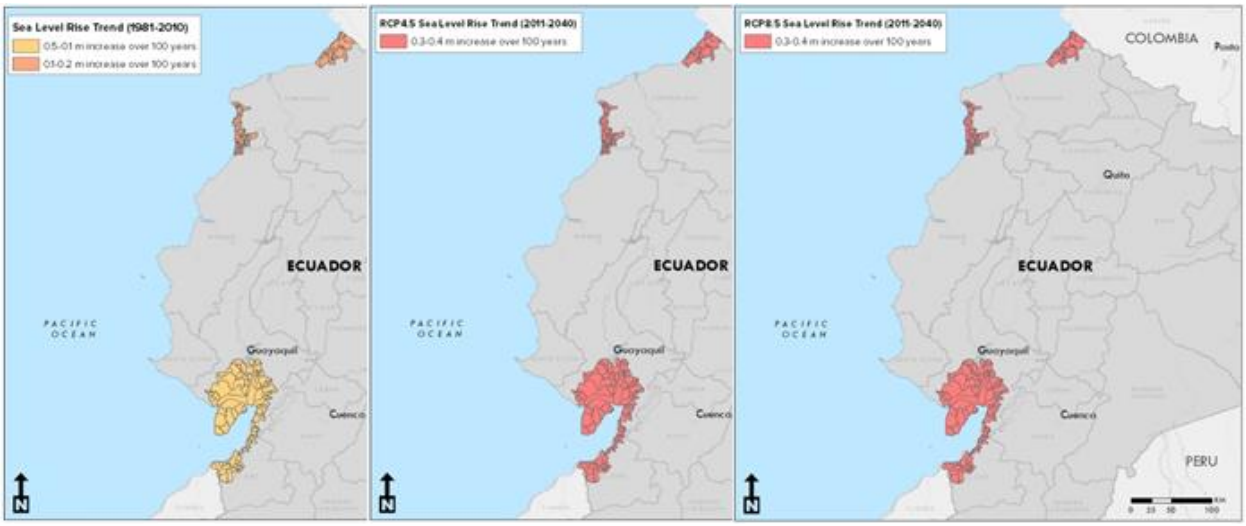


Figure 22. Threat 1, Sea Level Rise (for both current (2010) conditions and future (2040) RCP 4.5 and RCP 8.5 climate scenarios

Figure 22 shows that all project areas are threatened by SLR under both RCP 4.5 and RCP 8.5 climate scenarios. There is little difference up to 2040 for the RCP 4.5 or RCP 8.5 scenarios.

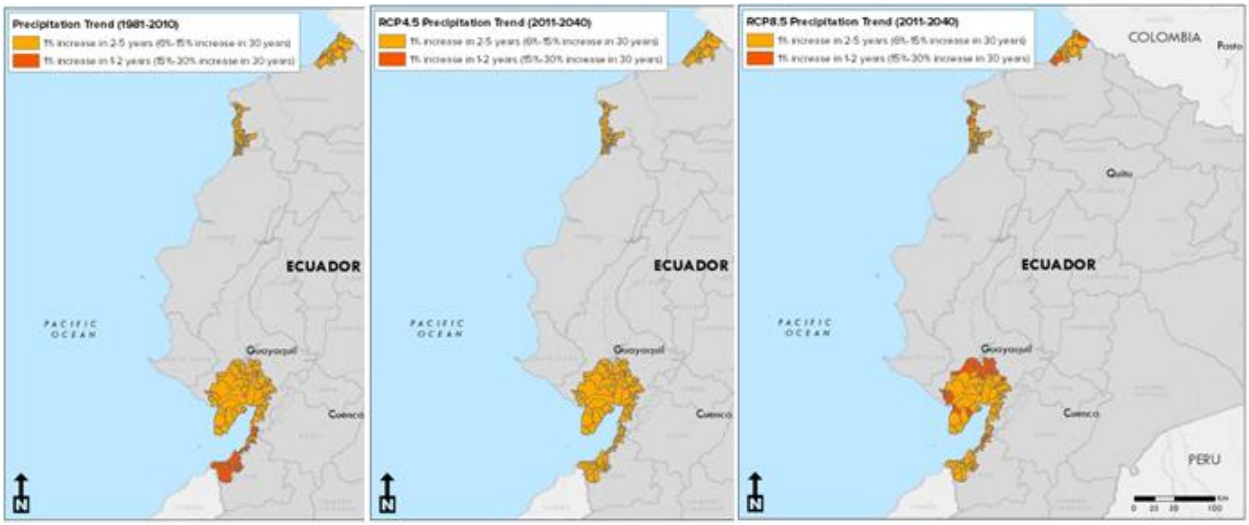


Figure 23. Threat 2, Precipitation Increases (for both current (2010) conditions and future (2040) RCP 4.5 and RCP 8.5 climate scenarios

Figure 23 shows that projected increases in precipitation will be similar across the whole project area in both the RCP 4.5 and RCP 8.5 scenarios.

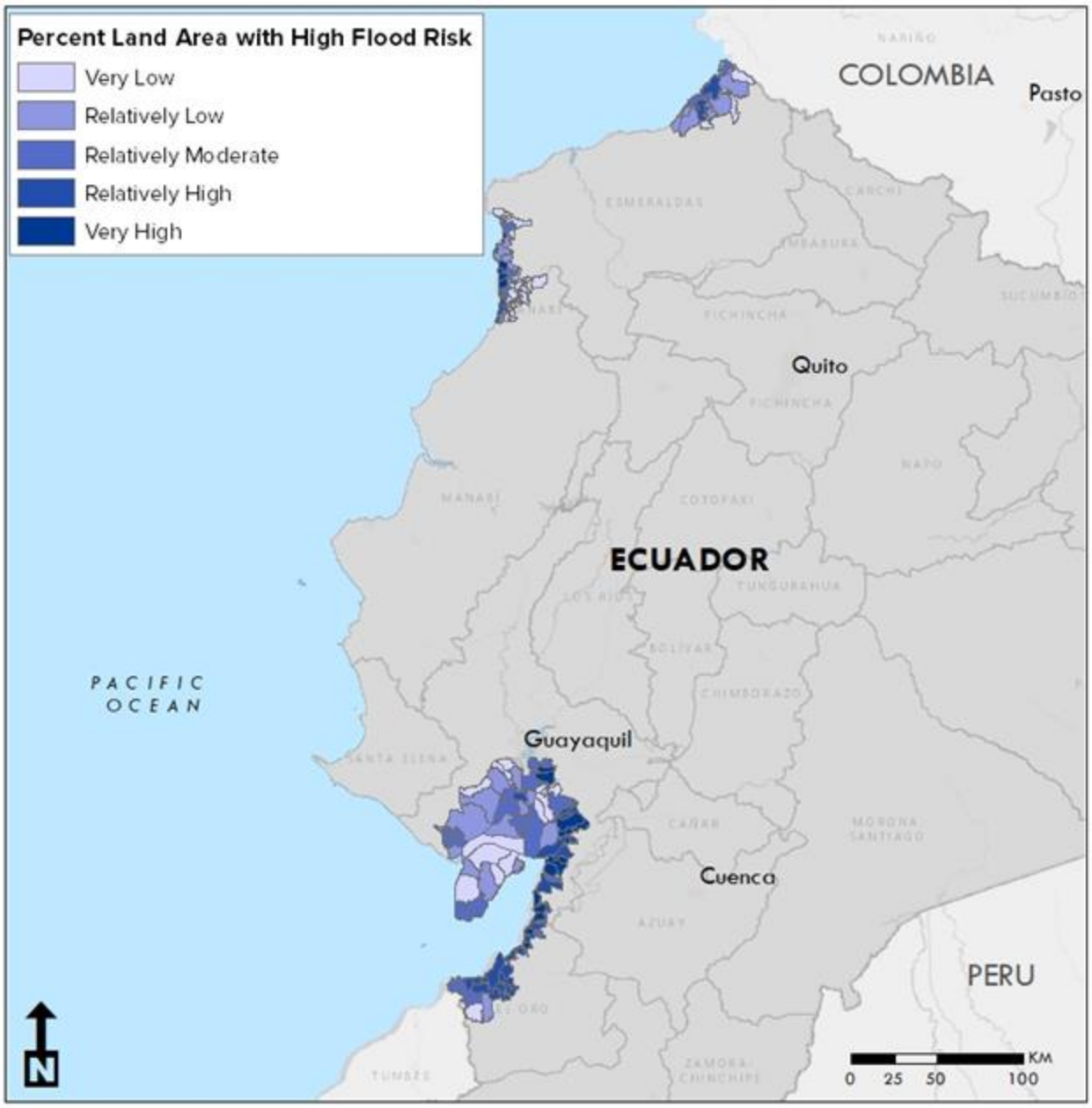


Figure 24. Threat 3, Percent land area with high flood risk.

Figure 24 shows the flood risks for the 150 census districts. Flood risk is particularly elevated in coastal districts of the Jambeli Archipelago and of the two northern estuaries. The districts to the northwest of Guayaquil have the lowest flood risk according to these maps. However, these flood maps include both coastal and riverine flooding. More refined analysis of the flood risk from coastal surges, which are the type of flooding that mangroves can protect against is provided in the following sections.

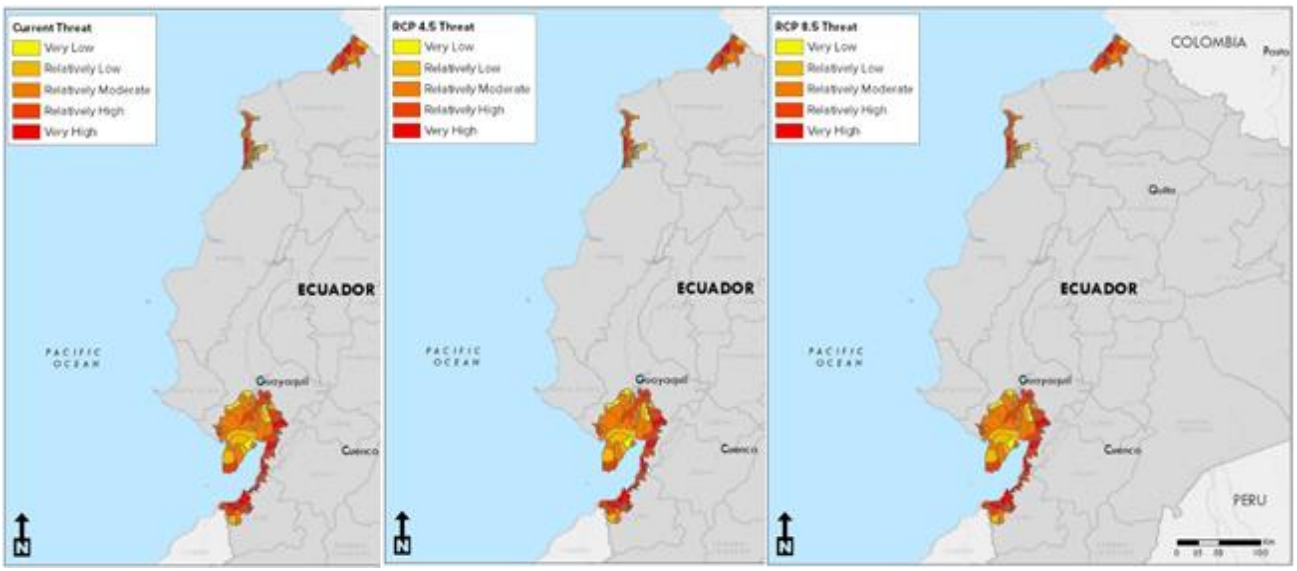


Figure 25. Combined relative threat

Figure 25 shows the combined relative threat across the 150 districts under current, RCP 4.5 and RCP 8.5 scenarios. The map shows that although threat varies across the districts, the pattern remains similar irrespective of the scenario.

Risk Index

The relative risk (defined as *Hazard x Exposure x Vulnerability*) of each of the 150 census districts is shown in Figure 26 and summarized in *Table* 13, in relation to the priority municipalities identified for the proposed project activities. The analysis indicates that there are areas of localized high risk across the project area. However, since the model doesn't differentiate between coastal and riverine flooding and because it will be highly sensitive to the weights given to the different factors considered, further analysis of risks using other approaches were also used and are described in section 2.4.2. These approaches focus on the threat from coastal flooding.

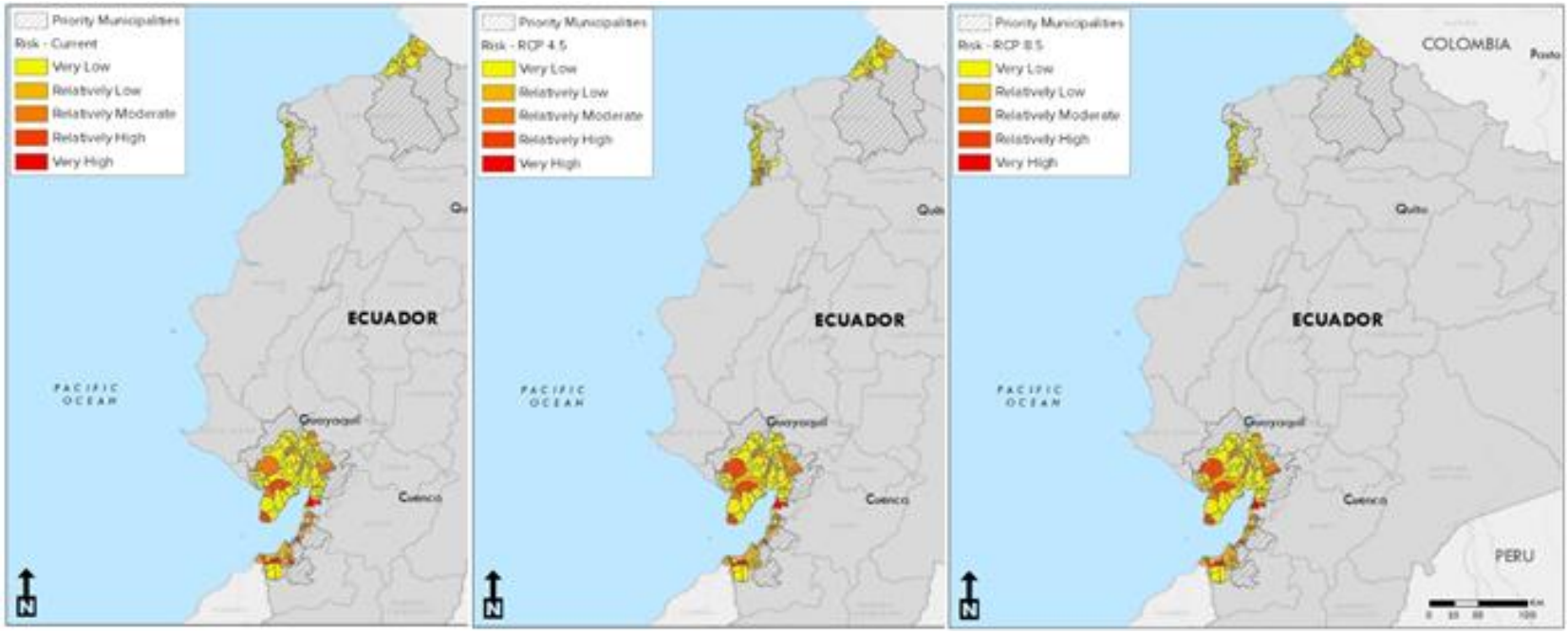


Figure 26. Relative Risk Index under Current (2010), RCP 4.5 and RCP 8.5 Scenarios

Table 13. Summary of Risk Index for Census Units of Ecuador's Coast

Scenario	Risk Index	Number of Census Units	Population of Census Units	Area (ha)	Area in mangrove (ha, 2018)	Area at high flood risk (ha, SNGR)
Current	Very High	4	842	18,768	2,396	13,806
	Relatively High	8	1,354	43,853	6,064	15,977
	Relatively Moderate	16	4,284	82,740	18,846	46,589
	Relatively Low	18	4,525	81,085	20,556	51,089
	Very Low	104	25,458	503,521	104,973	186,649
RCP 4.5	Very High	3	642	16,026	1,936	11,754
	Relatively High	9	1,607	78,909	11,060	29,849
	Relatively Moderate	14	4,911	57,580	18,444	33,899
	Relatively Low	13	2,323	79,503	18,000	38,321
	Very Low	111	26,980	497,950	103,395	200,287
RCP 8.5	Very High	3	642	16,026	1,936	11,754
	Relatively High	9	1,847	84,561	12,668	36,236
	Relatively Moderate	16	5,034	58,310	17,977	32,170
	Relatively Low	18	3,430	92,828	18,895	46,302
	Very Low	104	25,510	478,243	101,360	187,648

2.3 The impacts of flooding events on key economic sectors

Ecuador's shrimp production has been highlighted as having the highest vulnerability to climate change of the world´s brackish aquaculture producers in a global assessment, based on exposure (temperature, water balance, population density, precipitation change, flood risk, drought risk and cyclone risk), adaptive capacity and sensitivity (Handisyde *et al*., 2017). Eighty-two percent of shrimp farms along Ecuador's coast are sited in areas classified as high flood risk under current conditions (Ministerio de Acuacultura y Pesca, 2018; Secretaría Nacional de Gestión de Riesgos, 2018), risks which will increase with increased sea level and intensified precipitation projected due to climate change. During the 1997-98 El Niño, flooding, disruption of supply chains and damage to transport infrastructure affected the shrimp aquaculture sector and around 4,500 ha of ponds were severely damaged[13] (CAF, 2000). Heavy rains and flooding can also affect the harvest cycle, causing shrimp to molt early, resulting in up to a 20% drop in yield per pond (Sackton, 2016). These damages have direct consequences for the more than 60,000 people employed (approximately 0.45 jobs/ha of shrimp farm) in shrimp aquaculture farming and processing (Yahira Piedrahita, 2018) [14]. Direct consequences include loss of income from lower production or when severe weather events cause partial or total loss of harvest.

2.4 Importance of mangroves for coastal flood protection and climate change

2.4.1 Overview

While mangroves provide a diversity of ecosystem services, their value for coastal protection and the reduction of flood risks is particularly well documented and relevant for Ecuador's coast. The use of "green infrastructure" in the form of natural ecosystems to reduce the effects of climate change hazards, for example to dissipate wave energy and reduce the intensity of storm surges, has been well documented. Mangrove species have dense roots that reduce wave energy and height, such as depicted in Figure 27 and Figure 28. Almost 0.4 kilometers of mangroves (*Kandelia spp*.) is needed to reduce wave height by 50% and 1 km is required to reduce wave heights by 90% (Barbier *et al*., 2008). Other studies estimate a decrease in wave height between 13-66 % for every 100 meters of mangrove (McIvor *et al*., 2012a; Spalding*, et al*., 2014).

Storm surges can raise water levels on the coast for periods of hours or days. By comparison, waves that come from normal winds or tides last for shorter times (seconds or minutes). So, greater widths of mangrove are required to reduce storm surges. Empirical studies and numerical modeling efforts have estimated a reduction of four to 48 cm of storm surge per kilometer of mangrove width (Krauss *et al*., 2009; Zhang *et al*., 2012). Zhang *et al*. (2012) found that the highest attenuation rate in the storm surge occurred at the edge of the mangroves towards the sea, with a decrease in efficiency towards the interior. Figure 29 demonstrates the decrease in storm surges with the width of mangroves.

[13] Clark Labs data estimates the presence of 1,571,298 km^2 of aquaculture ponds in Ecuador in 1999 (source: http://www.aquaculture.earth/coastal/index.html)

[14] Other estimates for the shrimp industry reference 100,000 - 220,000 directly or indirectly employed.

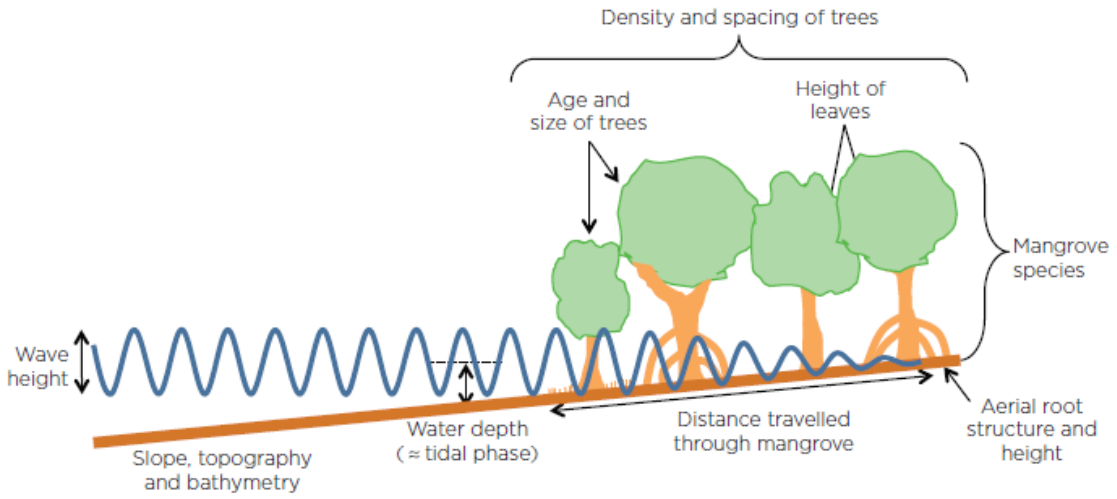


Figure 27. Key factors contributing to wave attenuation. Source: McIvor et al., 2012b

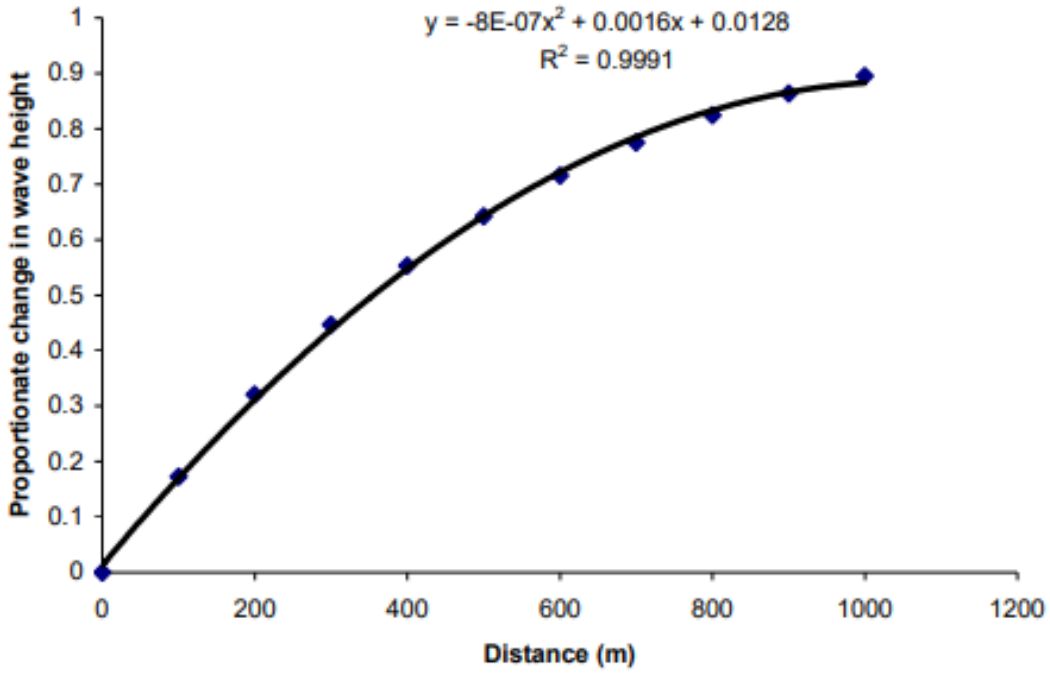


Figure 28. Reduction of wave height by mangroves (Kandelia spp.) at mid-tide where distance is measured from open water towards shore. Source: Barbier 2008

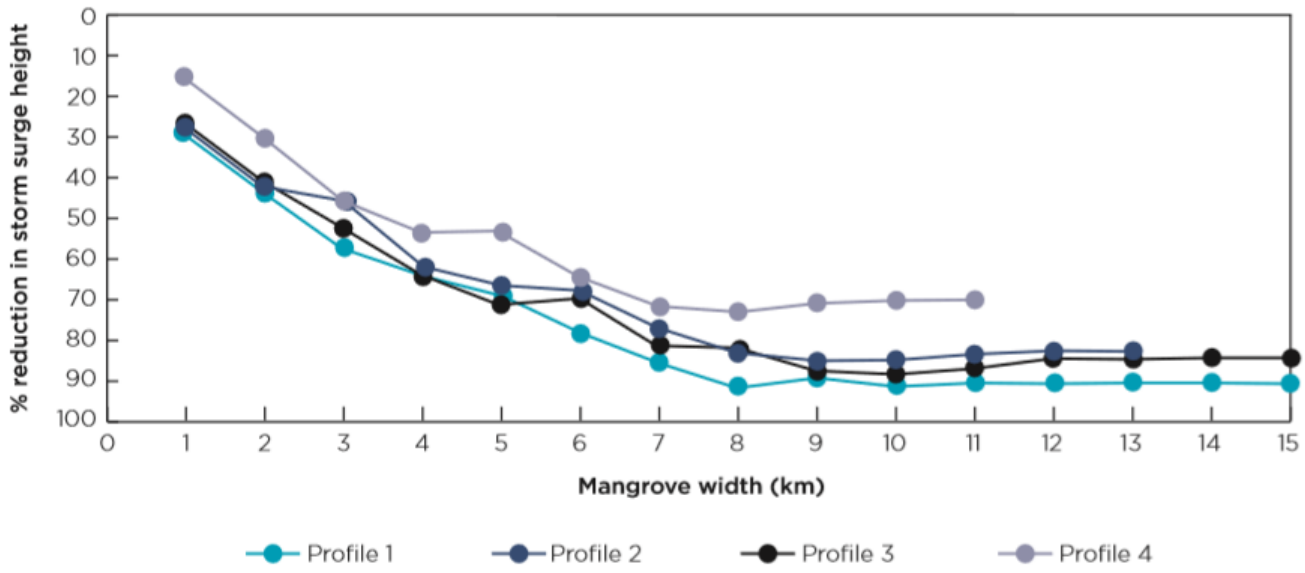


Figure 29. Reduction of storm surge height by mangroves (Gulf Coast - United States)

Mangroves serve as natural structural barriers reducing coastal erosion (Spalding, *et al*., 2014; Thampanya *et al*., 2006). They also provide important flood-control functions, by dissipating wave energy and storm surges through bottom friction and structural barriers formed by roots, trunks and canopy (McIvor *et al*., 2012a, 2016; Menéndez *et al*., 2020; Thampanya *et al*., 2006). The destruction of mangroves and replacement by other land uses that have a lower capacity for infiltration and storage of storm waters increases coastal flooding risks.

2.4.2 **Flood Protection Benefits of Mangroves in Ecuador**

An extensively validated model developed by the Coastal Resilience Lab (CRL) at the University of California, Santa Cruz (Menéndez, 2020) was used to estimate the flood protection benefits of mangroves by providing high resolution estimates of economic value using 20 km long coastal segments, and predicting land area flooded, people affected, and property loss with and without mangroves. This CRL global model was adapted to use locally specific data for Ecuador as described in Appendix 6. The model does not evaluate future climate scenarios, nor does it estimate benefits of adding mangroves, only the resulting damages if existing mangroves are removed. The coastal flooding that occurs based on the model is for both typhoon and "regular" weather based on a historical data set from 1979-2010. The modeling was conducted for all areas around the world with mangroves, and Ecuador-specific data was extracted to estimate the flood protection benefit of mangroves (see Appendix 6 of this document).

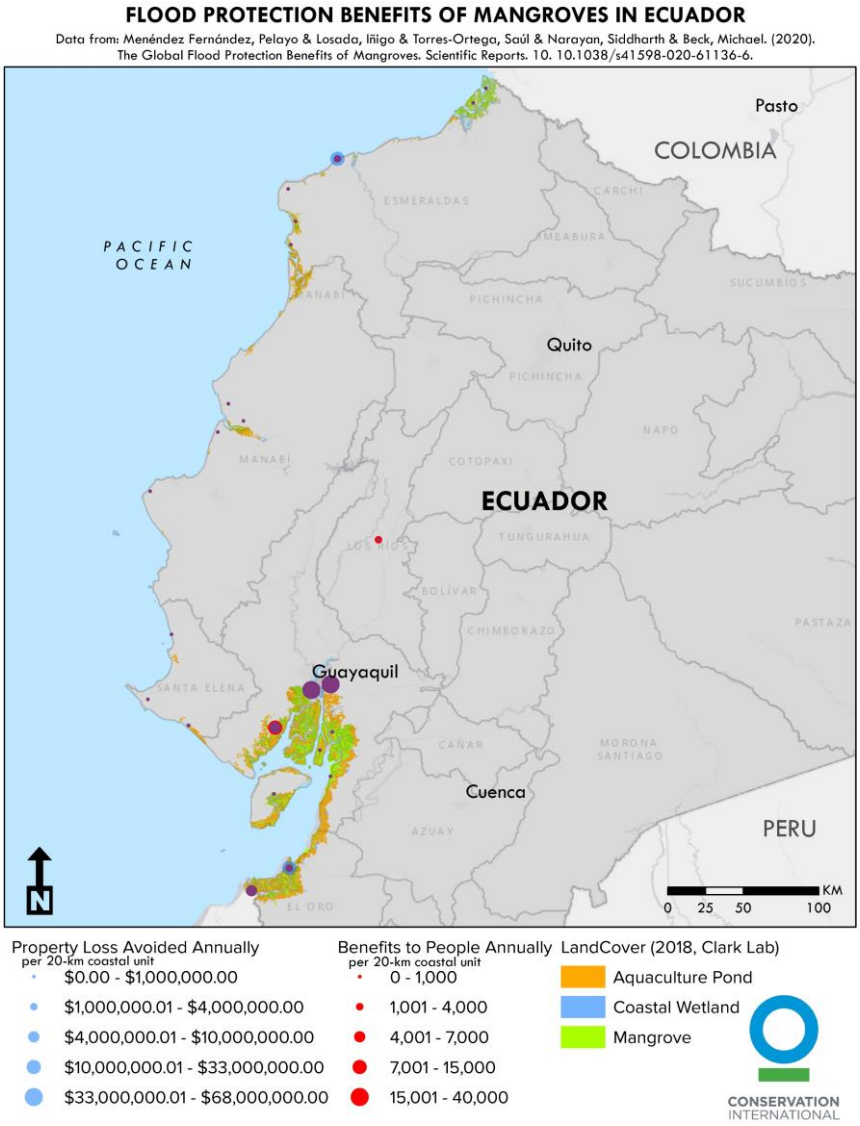


Figure 30. Flood protection benefits of mangroves in Ecuador

On Ecuador's coast, mangroves reduce floodwater levels of areas within 5 km of their edges by 63% or 1.10 m over a 10-year period and by up to 1.20 m over a 100-year period (*Table* 14)[15].

[15] Based on analysis of data described in Appendix 6 using the methods of Menéndez *et al*, 2020. Total Water Level (Mean Sea Level + Astronomical Tide + Storm Surge) data for "tropical cyclone" events for points on Ecuador's coast, including scenarios with and without mangrove cover. Data averaged for coastal region, and calculated over 10-, 25-, 50- and 100-year time horizons.

Table 14. Storm flooding scenarios with and without mangrove cover for Ecuador's coast (based on Menéndez 2020)

		Average water level (m)			
		10 years	**25 years**	**50 years**	**100 years**
All coast	With-mangrove scenario	0.58	0.59	0.59	0.59
	Without-mangrove scenario	1.71	1.73	1.74	1.81
	Difference between scenarios (m)	1.14	1.14	1.15	1.22
	Difference between scenarios (%)	66.38	66.10	65.92	67.45
Areas with current (2018) mangrove	With-mangrove scenario	0.64	0.65	0.66	0.64
	Without-mangrove scenario	1.72	1.74	1.75	1.90
	Difference between scenarios (m)	1.08	1.09	1.09	1.25
	Difference between scenarios (%)	62.74	62.50	62.26	66.16
Areas with mangrove influence (mangroves 2018 + 5km buffer)	With-mangrove scenario	0.63	0.64	0.64	0.64
	Without-mangrove scenario	1.72	1.74	1.75	1.84
	Difference between scenarios (m)	1.10	1.11	1.11	1.20
	Difference between scenarios (%)	63.66	63.43	63.26	65.40

The analysis concludes that based on current conditions, 22,400 people have an annual expected risk of coastal flooding caused by storm surge (16,900 in urban areas and 5,500 in rural areas). Under these current climate conditions, but without the protections that mangroves provide, approximately 89,600 more people would be at annual risk of coastal flooding in the project area. The analysis also shows that the mangroves prevent approximately US$250 million of property loss from flooding annually. Based upon mangrove coverage in Ecuador from 2018 (approximately 156,633 ha), every hectare of mangrove prevents approximately US$ 1,600 of property loss from coastal flooding every year in Ecuador. Property loss in this case includes both industrial and residential stock where damage and property loss values increase with increasing flood depth. Similarly, based on these figures, approximately one person has reduced annual expected flood risk for each hectare of mangrove in Ecuador[16]. As above, urban areas

[16] Or, more precisely 1 ha of mangrove provides protection for 0.55 people on average.

currently account for most of the people at risk and therefore concentrating mangrove protection and restoration efforts between the sea and urban areas will have the most impact. This is particularly the case in the Gulf of Guayaquil, where most urban inhabitants reside.

An alternative modelling approach was also investigated in the preparation of this Feasibility Study to compare consistency of estimates for people affected by flooding and to model future climate impacts on flooding. The Aqueduct Floods model (Hofste *et al*., 2019) integrates data on climate change. This model projects that coastal flooding in Ecuador, independent of riverine flooding and El Niño, affected 4,300 people every year in 2010.[17] This increases to 22,000 people being affected annually by 2030, 100,000 by 2050 and 220,000 by 2080 (RCP 8.5). In a business-as-usual climate scenario (RCP 8.5), the Aqueduct model projects annual damage caused by coastal flooding in Ecuador will increase from US$110 million in 2010 to US$35 billion by 2080. Guayas represents an increase from 0.1% of the urban asset value as a percentage of GDP in 2010 to 4.1% by 2080. Data from the WRI Aqueduct Floods model is summarized in Table 15. The Aqueduct model coincides with Menéndez *et al.* model in projecting that the majority of people and property impacted by annual coastal floods in Ecuador live in Guayas. This alternative modelling approach also estimates that a similar number of people are currently affected by coastal flooding (Aqueduct model estimates 4,300 people in 2010 and 22,000 in 2030; Menendez model estimates 22,400 for 2015).

Table 15. Coastal flooding impacts in Ecuador (based on WRI Aqueduct Floods Model, accessed 2020)

Coastal[1] Flooding Impacts in Ecuador (WRI Aqueduct Floods Model, accessed 2020)								
	People Affected (#)		Annual Damages (US$)		% Annual Expected Urban Damage		Urban Asset Value (% of GDP)	
	GUAYAS[2]	ECUADOR	GUAYAS[2]	ECUADOR	GUAYAS[2]	ECUADOR	GUAYAS[2]	ECUADOR
2010	4,000	4,300	$98,000,000	$110,000,000	0.4%	0.1%	0.2%	0.0%
2030	20,000	22,000	$960,000,000	$1,110,000,000	19%	0.5%	0.5%	0.1%
2050	94,000	100,000	$7,700,000,000	$8,500,000,000	7.9%	2.1%	2.0%	0.5%
2080	200,000	220,000	$30,000,000,000	$35,000,000,000	13.8%	3.9%	4.1%	11%

[1] Does not include impacts from riverine flooding

[2] Guayas is a subset of the data from all of Ecuador (not additional)

The Aqueduct model demonstrates that the number of people affected by coastal flooding will increase significantly under climate change. The relative importance of natural flood defenses is therefore also

[17] The predicted number of people affected by flooding by Aqueduct (4,300) is less than Menendez (15,000) for three reasons: (1) they are different models with different variables and starting assumptions, (2) Aqueduct is based on 2010 population estimates whereas Menendez is based on a larger 2015 population (with more people susceptible to flooding than in 2010), (3) Menendez includes both regular climate and extreme (tropical) storm induced coastal flooding, whereas Aqueduct is regular storms. The Aqueduct model includes future sea level rise due to climate change.

likely to increase. Note that none of the models integrate population growth. Migration patterns in the coastal region are likely to be significant given recent trends and this limits the usefulness of modelling to predict the numbers of people who may be affected by coastal flooding in the future.

The conclusions to be drawn from the Menendez *et al*. and Aqueduct models are that mangroves are already important in reducing coastal flooding, climate change induced coastal flooding is likely to be significant in the future (approximately five times more people will likely experiencing flooding by 2050 if there was no migration due to other factors), and therefore, natural protection from mangroves will remain important or even become more important than it is currently.

2.4.3 **Vulnerability of Mangroves to Climate Change**

Mangrove ecosystems help shield human populations from climate change impacts, but climate change may also have a significant impact on mangrove ecosystems, due to SLR, changes in precipitation, and increases in air and sea temperature. These impacts are due to the sensitivity of mangroves, especially to flooding and variations in salinity levels, which can exceed the physiological tolerances of the constituent mangrove species. It is therefore important to consider whether mangroves in the region are likely to survive future climate change impacts so that they can continue to provide their coastal protection function.

On the atmospheric side, air temperature has also been shown to be an important influencing factor, as it affects phenology, productivity and latitudinal distribution range. These can affect mangroves negatively whether their values increase or decrease. Some authors have shown that sea surface temperature can also be a limiting factor for the distribution range of some species (Gilman *et al*., 2008; Kodikara *et al*., 2018; Ward *et al*., 2016; Wilson, 2017; Ximenes *et al*., 2018).

A conceptual relationship of the main climate change factors that impact mangroves is described in Figure 31. Some relationships are dependent on others, for example the increase in air temperature is, in part, responsible for increases in extreme precipitation events, which in turn can generate other problems such as erosion or decreased plant productivity.

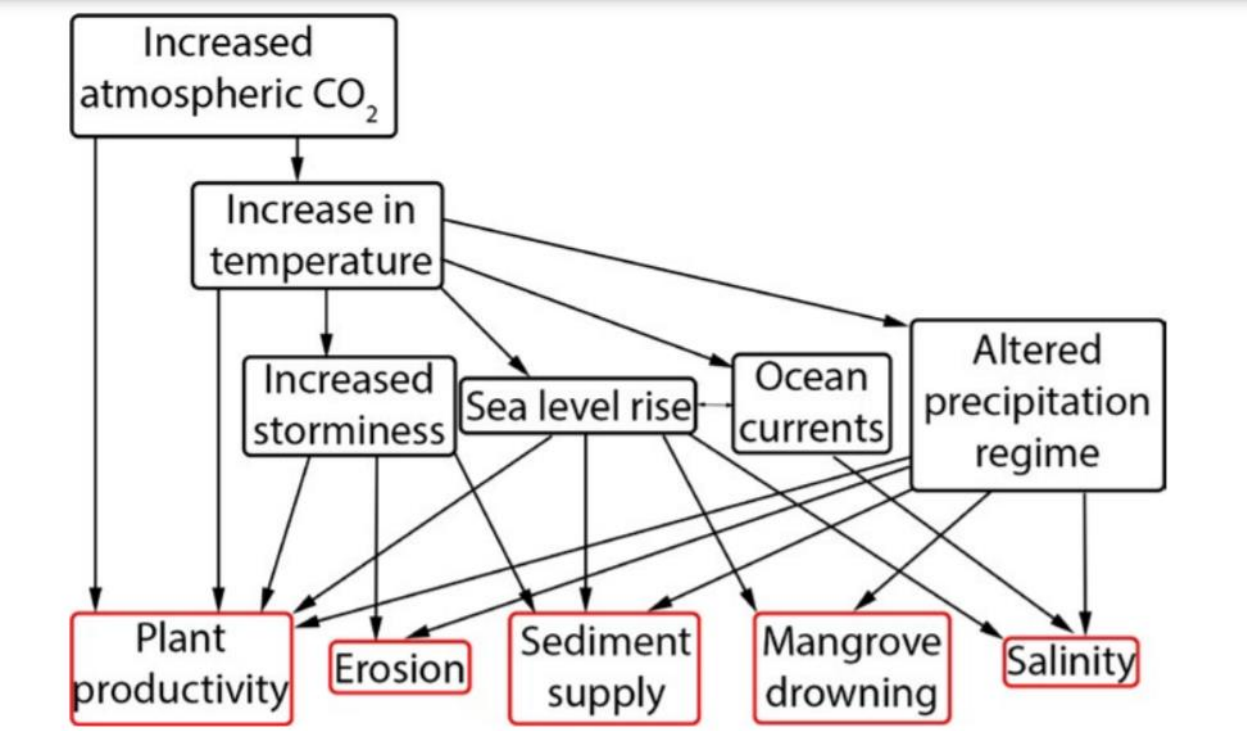


Figure 31. Conceptual framework principal impacting factors of climate change and how they are likely to negatively influence mangrove communities. Source: Figure 1, Ward et al. (2016: 2)

Mangroves grow in the nearshore, intertidal zone and as such are highly exposed to the effects of sea level rise (Lovelock *et al*., 2015); when the rate of sea level increase is faster than the capacity of the ecosystem to adjust, the ecosystem may drown. The threshold relative SLR for mangrove ecosystems is 6-7 mm/year, above which these systems cannot typically survive (Lovelock, 2020; Saintilan *et al*., 2020; Sasmito *et al*., 2016). Mangroves can accommodate SLR by accreting and landward retreat resulting in amongst the highest rates of carbon burial of all ecosystems (Donato *et al*., 2011; Rogers *et al*., 2019). Global SLR will likely stabilize at ~5 mm/year by the year 2100 if moderate-emissions scenarios are achieved. Given the expected rates of SLR for Ecuador's coast under RCP 8.5 (3.3 mm/y), mangroves, if allowed to remain intact, are likely to be able to keep pace by building up shorelines through vertical accumulation of sediments and inland movement, if not impeded by built infrastructure, thus maintaining flood plains and current tidal ranges (Krauss *et al*., 2014; McKee, 2011; McKee *et al*., 2007).

Even with reduction in CO_2 emissions limiting SLR, management of river water and sediment flows, conservation and restoration of mangrove areas, and conservation and planning for landward migration, are necessary for mangroves to maintain the capacity for vertical accretion so they can be maintained into the future.

2.5 Carbon stocks and flows in mangroves

2.5.1 Overview of mangrove carbon dynamics

Mangroves are one of the most productive ecosystems per unit area in the world (Alongi, 2012; Donato *et al*., 2011). As mangrove trees grow, they remove carbon from the atmosphere and water column, as well as trap organic debris in their root structures. Organic carbon is then stored in their woody biomass (tree trunks, branches and roots) and accumulates in mangrove soils. The saline nature of their environment inhibits breakdown of organic material, meaning that the carbon – known as "blue carbon" – can be locked away for millennia. Thus, their protection and restoration are essential components of any climate change mitigation strategy involving the coast (Del Vecchia *et al*., 2014).

Carbon stock in mangroves is highly variable globally and even within the same site, and this is true for South American sites. According to Donato *et al.* (2011) above-ground biomass accounted for 15.5% of the carbon stock in mangroves while Siikamaki *et al*. (2012) found that biomass made up 31% of mangrove carbon and that the global average of above-ground mangrove carbon was 466.5 MgC ha^{-1}. In Brazil, above-ground mangrove carbon was estimated to average 61.3 MgC ha^{-1} using field measurements and allometric equations. In French Guiana, values were estimated to be 31 tC ha^{-1} in regenerating mangroves and 315 tC ha^{-1} in mature mangroves (Fromard *et al*., 1998). In Venezuela and Colombia, above-ground carbon values for mangroves were estimated to be between 75-100 Mg ha^{-1} (Simard *et al*., 2019). This wide range of values makes estimating carbon benefits difficult without conducting site level sampling, however, global averages can be used in conjunction with the proper caveats.

The following section provides a summary of the current state of knowledge regarding carbon stocks and flows from studies conducted in Ecuadorian mangroves.

2.5.2 Research on carbon stocks and flows in Ecuador's mangrove forests

Carbon stock has been estimated in three types of mangrove ecosystems in Muisne, located in the province of Esmeraldas: natural, restored, and afforested (Del Vecchia *et al*., 2014). Natural ecosystems were those that had not been disturbed for at least three decades. Restored sites had been mangrove forests until 1980 when they were converted to shrimp farms with restoration beginning in 2003 through manual planting of red mangrove. The afforested sites were areas previously dominated by halophytic ferns that were converted to mangrove forests in 1993. The different mangrove sites were chosen based on unpublished maps and land use information (Jatun Sacha Foundation), interviews with residents and property owners, and official maps from Ecuador's Military Geographic Institute.

Based on data collected for the three site types, carbon stocks were estimated in mangrove forests in Muisne. For above-ground biomass, in accordance with globally accepted methods, field measurements (tree height and diameter at breast height [dbh, 1.3 m]) were used in allometric equations generated by Komiyama *et al*. (2008) for three mangrove species: *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia germinans*. For sediment carbon values, in accordance with globally accepted methods, soil samples were made to a depth of one meter and their carbon stock was measured in a lab using either CHN analysis (where carbon, nitrogen, and hydrogen are separated and quantified) or loss on ignition (soil samples are dried and burned to determine the soil organic carbon content). In natural forests, carbon

values for above-ground biomass were between 39 and 193 Mg ha^{-1} and showed no statistical difference with above-ground carbon values from the afforested site (93.3 Mg ha^{-1}) that had been regenerating for 20 years. The lowest above-ground carbon values were found in restored forests (24 to 46 Mg ha^{-1}), suggesting that those mangrove sites were still regenerating after 10 years (Table 16). The fact that mangrove carbon stock (specifically soil carbon) once lost cannot be recovered in a climate change relevant timeline means that mangroves are what is known as an irrecoverable carbon system (Goldstein *et al*., 2020)[18].

Table 16. Mean (+/- standard error) carbon stock in above-ground biomass and soils (to depth of 1 m) of mangroves in Muisne and the Gulf of Guayaquil, Ecuador

Region	Sampling site	Carbon stock (Mg ha^{-1})	
		Above-ground biomass	Soils
Muisne	Natural mangrove forest A	70 ± 18	397 ± 175
	Natural mangrove forest B	193 ± 57	356 ± 63
	Natural mangrove forest C	39 ± 11	374 ± 177
	Restored mangrove A	24 ± 5	427 ± 54
	Restored mangrove B	46 ± 10	395 ± 22
	Afforested mangrove	93 ± 1	399 ± 22
Gulf of Guayaquil	Medium mangrove	--	221 ± 23
	Large mangrove	--	168 ± 21

Sources: Del Vecchia *et al*., 2014; Mereci *et al*., 2017

Hamilton *et al*. (2017) estimated carbon storage in mangrove forests in four estuaries in northern Ecuador: (a) Cayapas-Mataje and (b) Muisne; and (c) Cojimíes and (d) Chone (both in the province of Manabí). Allometric equations were applied to estimate above-ground biomass for *Rhizophora mangle*; *Laguncularia racemose* and *Avicennia germinans*. Additionally, biomass of aerial roots was estimated using a 1:0.52 tree to root ratio. *Rhizophora mangle* trees at Cayapas-Mataje were large, with an average dbh[19] of 21.47 cm and average height of 40.13 m. On the Chone estuary, the average dbh of *R. mangle* was 27.17 cm and height 21.80 m. In Muisne, average dbh was 10.54 cm, average height 17.67 m, and in Cojimíes, average dbh was 15.67 cm and average height 20.61 m (Table 17).

A total of 7,743,000 MgC in above-ground carbon (trunk, branches, leaves and aerial roots) was estimated at the four sites (Table 17). The mangroves of the Cayapas-Mataje Ecological Reserve stored the most

[18] Irrecoverable carbon is defined as carbon stores that are vulnerable to loss by human activities and, if lost, could not be restored by 2050.
[19] Diameter at breast height (1.3m from the ground level)

carbon (6,961,915 Mg), by far, of the four estuary sites. On the Cayapas-Mataje estuary, estimated mangrove carbon was 199 MgC ha^{-1}; in Chone, 125 MgC ha^{-1}; Cojimíes, 35 MgC ha^{-1}; and Muisne 34 MgC ha^{-1} (Hamilton *et al*., 2017). The different values of mangrove carbon on these estuaries were due to differing degrees of intervention and degradation of the sites. Carbon storage on the Cayapas-Mataje Estuary was particularly noteworthy as that area has been protected by its inhabitants as well as by the government since 1995 when it became part of the National System of Protected Areas.

Table 17. Tree sizes (dbh and height) and estimates of above-ground carbon in mangrove forests dominated by Rhizophora mangle in northern Ecuador (Esmeraldas and Manabí)

Province	Estuary	*Rhizophora mangle*		Above-ground carbon in mangroves		
		Average dbh (cm)	Average hgt (m)	MgC ha^{-1}	Ha per location	Total MgC at location
Esmeraldas	Cayapas-Mataje	21.47	40.13	199	34,984	6,961,915
	Muisne	10.54	17.67	34	3,638	123,684
Manabí	Cojimíes	15.67	20.61	35	7,810	273,349
	Chone	27.17	21.80	125	3,072	384,051
					Total	7,742,999

Source: Hamilton *et al*., 2017

Carbon stocks were also estimated in mangrove forests and soils in the Gulf of Guayaquil (Merecí Guamán, 2017) where three land cover types were evaluated: mangrove forests (classified as intermediate and large), and shrimp farms as the predominant anthropogenic land use. Data were collected on 24 transects (intermediate mangrove n=17, large mangrove n=7, shrimp farm n=5) and allometric equations were used to determine biomass and carbon stock. Additionally, biomass data were collected for other above-ground components: fallen wood, undergrowth and regeneration. To determine carbon in soil, samples were taken to a depth of 1.7 to 2 m (Table 18).

Table 18. Carbon stock (MgC ha-1) by ecosystem component in mangroves and shrimp farms in the Gulf of Guayaquil

Ecosystem component	Land use/land cover		
	Intermediate mangrove[1] (*n*=17)	**Large mangrove**[2] (*n*=7)	**Shrimp farm** (*n*=5)
Trees	67.88 ± 8.39	186 ± 26.76	
Regeneration	0.38 ± 0.20	0.06 ± 0.03	
Fallen wood	5.36 ± 1.00	6.05 ± 3.61	
Total above-ground C	73.62 ± 8.39 (a)[3]	192.20 ± 29.90 (b)	
Roots	26.76 ± 2.88	59.06 ± 6.16	
Soil to 1 m	220.57 ± 22.98	168.19 ± 21.30	81.91 ± 13.69
Soil to 2 m	352.51 ± 31.49	286.39 ± 38.27	126.98 ± 16.33
Total below-ground C (1m)	247.33 ± 21.81 (a)	227.25 ± 26.57 (a)	81.91 ± 13.69 (b)
Total below-ground C (2m)	379.26 ± 30.35 (a)	345.46 ± 43.57 (a)	126.98 ± 16.33 (b)
Total C ecosystem (1m)	**320.95 ± 20.88 (a)**	**419.45 ± 55.66 (a)**	**81.91 ± 13.69 (b)**
Total C ecosystem (2m)	**452.13 ± 28.32 (a)**	**537.65 ± 66.70 (a)**	**126.98 ± 16.33 (b)**

[1] Intermediate-sized mangrove: basal area 15.46 m^2 ha^{-1}
[2] Large mangrove: basal area 30.84 m^2 ha^{-1}
[3] Distinct letters refer to statistical differences between average values, i.e., when letters are different there is statistical significance between the observed values.
Source: Merecí, 2017

Additionally, Ecuador's National Forest Inventory carried out in 2013, reported 86.6 MgC ha^{-1} stored in the above-ground component (trees and roots) of the country's mangroves (MAE 2015).

Estimates of above-ground carbon stored in mangrove forests, from seven different studies in Ecuador (Del Vecchia *et al*., 2014; Hamilton *et al*., 2017; Hamilton & Lovette, 2015; Merecí Guamán, 2017; Ministerio del Ambiente, 2015; Twilley *et al*., 1992), are summarized and compared in Table 19.

Table 19. Comparison of mangrove above-ground carbon estimates (MgC ha^{-1}) from Ecuador (six publications) and global mangroves at equatorial and temperate latitudes (one publication); methods used differed among sources and included: remotely-sensed images (Landsat)

Study area	Publications						
	Hamilton *et al.*, 2017	**Hamilton & Lovette 2015**	**IPCC 2000**	**Del Vecchia *et al.*, 2014**	**Merecí *et al.*, 2017**	**MAE 2015**	**Twilley *et al.*, 1992**
Cayapas-Mataje	199	140 - 242	193				
Muisne	34			39-193			
Cojimíes	35						
Chone	125						
El Oro							
Isla Puná							
Gulf of Guayaquil					Intermediate mangrove: 100 Large mangrove: 251		
Ecuador						87	
Mangroves at latitude 0°-10°							455
Mangroves at latitude 30°-40°							200

For estimates of emissions reductions and sequestration benefits (Section 6.2) a value of 91.2 tC/ha in aboveground biomass was used. This value is the default value used by the Government of Ecuador in its Forest Reference Emissions Level (FREL) and communications with the UNFCCC (MAE 2020). The use of this value is consistent with data from other studies reviewed, as well as allowing for comparison and coherence of project results with national emissions accounting. Soil carbon values are not currently included in Ecuador's FREL but are reported in the Project's estimates of emissions reductions and sequestration. A value of 386 tC/ha, for the top meter of soil, is used, based on the recommended value defined by the IPCC (Hiraishi *et al.,* 2014). This value is consistent with site-specific analyses for Ecuador (Del Vecchia *et al*., 2014; Mereci *et al*., 2017).

2.5.3 **Carbon sequestration by mangrove forests**

Determining the sequestration rate for mangroves at a local level can be challenging. There are few empirical measurements across environmental gradients thus the context dependency of this process combined with geographically limited field sampling has made it difficult to generalize regional mangrove carbon sequestration rates. This has in turn hampered the inclusion of sequestration by mangroves in carbon cycle models. However, looking across the existing studies globally, mangroves display some of the highest rates of carbon burial and storage among vegetated habitats, sequestering 2.26 ± 0.39 Mg C ha^{-1} yr^{-1} on average (Donato *et al.,* 2011; McLeod *et al.,* 2011). This rate is influenced by patterns of vegetation and forest height in relation to sea level, as well as by the mangrove root system, particularly the pneumatophores that play an important role in capturing sediment particles by slowing their movement (Sanders *et al*., 2010).

Globally, mangrove ecosystems are highly productive, with similar rates of net primary production (NPP) as humid tropical forests. The rates of NPP and biomass accumulation depend on a combination of global factors, such as latitude, and local factors, such as hydrology. Mangrove ecosystems contribute between 1% to 3% (13.5 Gt/year) of the total carbon sequestered by tropical forests; and as marine habitats, contribute 14% of total carbon sequestered by the ocean (Alongi, 2009, 2012).

Sedimentation rates within mangroves were reported to be between 0.085-1.02 cm/year (H. Mahmood *et al*., 2005). This rate was influenced by patterns of vegetation and forest height in relation to sea level, as well as by the mangrove root system, particularly the pneumatophores that play an important role in capturing sediment particles by slowing their movement (Sanders *et al*., 2010). In the Churute Mangrove Ecological Reserve in Ecuador, sedimentation rates were estimated as 4,074-5,151 g m^2/year, of which more than 75% of total accumulation was inorganic sediments (Twilley *et al*., 1997).

Rates of carbon accumulation in mangrove soils are influenced by the interaction of biological, biogeochemical and physical factors, as well as natural and anthropogenic factors that affect the mass of carbon produced and its potential to become the leaf litter that forms part of the organic carbon in the soil (Macreadie *et al*., 2019). Globally, mangroves can accumulate an average of 160 gC^-/m^2/year in sediments (Breithaupt *et al*., 2012; Pérez *et al*., 2018).

To date, mangrove sequestration estimates in South America, and especially along its Pacific Coast, have been rare. The measurements that do exist suffer from methodological discrepancies that are difficult to interpret. For projections of project emissions reductions, Ecuador´s emissions factor for mangrove biomass was used, as described in the previous section, assuming a 20-year linear accumulation to full carbon stocks. If needed, sequestration rates within the project sites can be measured directly to ensure accuracy of estimates.

2.5.4 **Greenhouse gas emissions attributed to mangrove loss**

Mangrove forests occupy 2% of the world's coastal ocean area but are responsible for 30% of carbon burial across all subtropical and tropical coastlines (Alongi and Mukhopadhyay, 2015). Global estimates of GHG emissions from a single hectare of mangrove converted to shrimp farm range from 112-392 MgC

ha^{-1}, equivalent to emissions from conversion of five hectares of humid tropical forest or 11.5 ha of dry tropical forest (Donato *et al*., 2011).

Carbon in the mangrove ecosystem comes from two main sources: (a) autochthonous material that originates at the site and includes the NPP of vegetation, phytoplankton, benthic fauna, and chemotrophic organisms; and (b) allochthonous material that originates from outside the site and includes marine material brought in by tides and river sediments (Kristensen *et al*., 2008). The amount of each type of carbon stored depends on several factors, such as distance to other aquatic ecosystems, tidal height, location of the mangrove within the marine landscape, and patterns of organic carbon consumption by microbial consumers and fauna in general (Bouillon *et al*., 2008).

It has been estimated that on average, carbon enters the mangrove ecosystem at a rate of 1.74 MgC y^{-1}, that the global accumulation of carbon in mangrove biomass is 4.02 PgC, and that 70% of this carbon occurs on coastal margins between 0°-10° latitude (Alongi 2009; Alongi 2014). Carbon sequestration in above- and below-ground biomass has been measured at 0.16-1.5 PgC y^{-1}, while the accumulation rate of soil carbon is 0.02 PgC y^{-1} (Twilley *et al*., 1992).

At the equator (0°-10° lat), mangrove carbon stored in above-ground biomass was measured at 130.45 Mg ha^{-1} and in below-ground biomass (roots) was 78.66 Mg ha^{-1} (total of 209.11 Mg ha^{-1}); whereas between 30° and 40° latitude, mangrove above-ground carbon was estimated at 47.9 Mg ha^{-1} while carbon stored in below-ground biomass was 44.16 Mg ha^{-1} (total of 92.06 Mg ha^{-1}) (Twilley *et al*., 1992). The global average of carbon stored in mangroves is 146.3 MgC ha^{-1} (Tang *et al*., 2018).

Mangrove ecosystems store more carbon in their soil than in their above-ground biomass. Worldwide, it was estimated that 5 PgC is stored in mangrove soils, which represents 70-80% of the carbon within the ecosystem (Donato *et al*., 2011; Jardine & Siikamäki, 2014). Another study (Sanderman *et al*., 2018) determined that globally, mangrove ecosystems stored 6.4 PgC in the first meter of soil, generating values of 86-729 MgC ha^{-1}. Extrapolation of these carbon values for the area of mangrove lost worldwide between 2000 and 2015, yield an estimated loss of 30-122 TgC.

Worldwide, GHG emissions caused by mangrove deforestation vary between 0.02-0.12 PgC y^{-1}, equivalent to 12% of emissions caused by deforestation of tropical ecosystems (Baccini *et al*., 2012; Donato *et al*., 2011). Alongi (2014) estimated potential carbon losses due to mangrove deforestation to be between 90-970 TgC y^{-1}. Globally, carbon sinks in mangrove forests decreased by 86,375 Mg between 2000 and 2012, resulting in emissions of between 79,249 and 316,996 Mg CO_2 into the atmosphere. Kauffman *et al*., (2017) estimated that the conversion of mangroves to aquaculture and pastures released 554±230 MgC ha^{-1}, which translates to emissions between 1,894 and 2,599 Mg CO_2e.

In Ecuador, Hamilton and Lovette (2015) evaluated land use/land cover change of Ecuador's mangroves from the following estuaries: (i) Cayapas-Mataje, near the city of San Lorenzo, Esmeraldas Province (ii) Muisne, near the city of Esmeraldas, (iii) Cojimíes, near the city of Pedernales and at the provincial limits of Esmeraldas and Manabí, (iv) Chon, near the city of Bahía de Caráque, Manabí Province; (v) Isla Puná, located within the Gulf of Guayaquil, and (vi) coastal areas of El Oro Province near the city of Machala. They estimated carbon loss due to mangrove deforestation, most of which occurred in two of the six estuaries studies, (El Oro Province (loss of 3,586 MgC) and Cojimíes, in Manabí Province (loss of 2,218 MgC)) represent losses of 76 to 80% of the carbon previously stored in these mangrove ecosystems.

Mangrove deforestation in the Cayapas-Mataje Ecological Reserve – a Ramsar wetland site – resulted in the loss of 22% of its previous carbon storage. Interestingly, a multi-temporal study (Merecí Guamán 2017) determined that, between 1985 and 2003, mangrove loss resulted in 24,728,821 Mg CO_2e emitted into the atmosphere, but between 2003 and 2017, 3,066,059 Mg CO_2e were recovered through mangrove conservation and as a result of their expansion through both passive and active restoration. However, when looking across all six estuaries studied, about 80% of their original area (7,014.51 MgC in biomass alone) was lost due to the expansion of shrimp farming.

These estuary sites were dominated by three mangrove species: *Rhizophora mangle, Laguncularia racemosa* and *Avicennia germinans*. The distribution of species within each mangrove ecosystem was determined based on the ecological requirements for each species, such as the entry of fresh water into the mangrove which affected salinity, distance from the water that determined impact of flooding by tides, and distance from the ocean that was related to tolerance to wave action.

Table 20. Carbon stocks and flows in mangrove ecosystems

	Component	Site	Estimated value	Source
Carbon flows	NPP	Global	29.25Mg ha^{-1} y^{-1}	(Hutchison *et al*., 2014)
	Leaf litter accumulation	Churute	6.47-10.64 Mg ha^{-1} y^{-1}	(Twilley *et al*. 1997)
	C accumulation in soil	Global	2.04 Mg ha^{-1} y^{-1}	(Hutchison *et al*. 2014)

Source: Merecí Guamán, 2017

3 Policy and Legal Framework for Mangrove Conservation

3.1 International agreements

Ecuador is a signatory to the UNFCCC and numerous international agreements linked to mangrove conservation (Table 21), all of which are cited in the National Action Plan for Mangrove Conservation in Ecuador.

Table 21. International agreements related to mangrove conservation of which Ecuador is a signatory

Name of international agreement	Date signed by Ecuador
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	11 Feb 1975
Ramsar Convention on Wetlands of International Importance	7 Jan 1991
Convention on Biological Diversity (CBD)	23 Feb 1993
United Nations Framework Convention on Climate Change (UNFCCC)	Sep 1994 (in force)
United Nations Convention to Combat Desertification (UNCCD)	6 Sep 1995
International Union for the Protection of New Varieties of Plants (UPOV)	8 Aug 1997
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	6 Jan 2004
Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the CBD	1 Apr 2011
United Nations Convention on the Law of the Sea (UNCLOS/CONVEMAR)	15 Jul 2012

3.2 National legal framework for protection and use of mangroves

Ecuador's Constitution (2008), its highest law, defines actions to respond to global problems, such that Ecuador adopts mitigation and adaptation measures to climate change, and develops actions and mechanisms that reduce deforestation and limit emissions of GHG and air pollution. Natural water sources, forests, paramos, mangroves and animal life are the principal natural resources affected by climate change. Mangroves and other natural resources are considered state assets and are not susceptible to commercialization or any means of appropriation, meaning that their purpose is for conservation or controlled use and management of their resources and ecosystem services (Ministerio del Ambiente del Ecuador, 2019). Furthermore, Ecuadorian legislation prohibits the exploitation and logging of mangroves, but allows traditional communities to request concessions of mangrove areas for their conservation and subsistence use of crustaceans, mollusks, and fish. Actions to conserve the mangrove ecosystem are considered within the strategy for the Conservation and Sustainable Use of

Natural Patrimony within the Socio Manglar incentive program (Ministerio del Ambiente del Ecuador, 2019).

3.2.1 National Development Plan for a Lifetime

The National Development Plan for a Lifetime (*Plan Nacional de Desarrollo Toda Una Vida*) 2017-2021, promotes good practices that contribute to reduced pollution, improved conservation, mitigation of and adaptation to the effects of climate change, and promotes them on a global scale. Updates to this Plan included a series of guidelines for the protection of mangroves. In 2015, language was inserted to include local stakeholders and decentralized production through sustainable management of forests and other fragile ecosystems such as paramos, mangroves and wetlands. This Plan now includes the conservation and management of mangroves among its objectives to guarantee the rights of nature for current and future generations. Goals for 2021 under this plan are to:

- Ensure that the gap between the country's Ecological Footprint and its Biocapacity remains below 0.35 global hectares per capita[20];
- Maintain 16% of national territory under conservation or environmental management;
- Increase non-hazardous solid waste with adequate disposal from 70.3% to 80%;
- Reduce gross deforestation to 15% with respect to the forest reference emissions level;
- Increase the recycled solid waste from 17% to 35% in relation to total waste generated;
- Reduce and remediate pollution sources in the hydrocarbon sector with the endorsement of the environmental authority;
- Reduce expansion of the urban and agricultural frontier;
- Reduce and remediate pollution of water sources;
- Increase the percentage of treated sewage;
- Increase the number of municipalities that treat sewage before discharging into the environment;
- Reduce the Vulnerability Index of the population, livelihoods, and ecosystems facing climate change from high to medium; and
- Increase the productive lifetime of machinery, equipment and technologies considering criteria of programmatic obsolescence.

3.2.2 National climate change Strategy and policies

The **National Climate Change Strategy** (ENCC) was published in July 2012, and cites loss of mangrove areas as impacting food sovereignty due to the decrease in estuarine species and the change in land use caused by construction or expansion of shrimp farms (Ministerio del Ambiente del Ecuador, 2012).

The ENCC established three chronological goals (2013, 2017, 2025) relevant to mangroves and climate change adaptation:

[20] One global hectare is the world's annual amount of biological production for human use and human waste assimilation, per hectare of biologically productive land and fisheries (Borucke *et al*., 2013)

2013
Increase the area of the continental marine-coastal area under some form of conservation or environmental management to strengthen the capacity of marine-coastal ecosystems against the impacts of climate change. Increase the area of terrestrial ecosystems under some form of conservation or environmental management to strengthen the capacity of terrestrial ecosystems and their biodiversity against the impacts of climate change.
2017
Promote the conservation of terrestrial and marine-coastal biological diversity through actions aimed at maintaining areas under management or conservation and study the need to expand said areas, based on the analysis of the dynamics of ecosystems and the potential distribution of species according to possible climate change scenarios.
2025
Consolidate and enhance the implementation of measures that increase the response capacity of species and ecosystems against the impacts of climate change. Guarantee that the patrimony of natural areas of Ecuador contributes to increasing the response capacity of species and ecosystems against the impacts of climate change.

Goals set for 2013 and 2017 have been achieved, with the creation of three new national PAs on the coast, totaling 155,367 ha since 2012, and 52 AUSCEMs totaling 53,880 ha signed since the ENCC was released or renewed in 2012 (MAAE 2019).

The first **Nationally Determined Contribution** (NDC) for climate action under the Paris Agreement within the UNFCCC was submitted in 2019 and made national policy for the period 2020-2025 following its formulation through a participatory process with public, private and civil society, and approval by the Interinstitutional Committee on Climate Change. By comparison to the Intended Nationally Determined Contributions submitted in 2015, the updated/first NDC has strengthened targets for the Land Use, Land-Use Change and Forestry (LULUCF) sector with a 4% unconditional and 16% conditional reduction in GHG emissions from LULUCF (i.e., potentially up to 20% reduction) in comparison to the reference level for the year 2025. Conservation of marine and coastal biodiversity is identified as both mitigation and adaptation measures with specific mention of updating protected area management plans to better incorporate response to climate change impacts and protection and monitoring of marine and coastal ecosystems.

Ecuador has also established a national **REDD+ Action Plan** formally adopted in 2016 under Acuerdo Ministerial 116. The REDD+ Action Plan has four main objectives:

- Integrate climate change actions in favor of forests into national policies and territorial development plans;
- Support the transition to sustainable and deforestation-free production;

- Improve sustainable forest management and the use of non-timber products; and
- Contribute to the sustainability of forest conservation and regeneration initiatives.

Ecuador, through the MAE, has developed a methodology for Forest Reference Emissions Level (FREL), in accordance with Decision 12/CP.17, paragraph 10. Ecuador has presented a FREL to the UNFCCC with a national scope, focused on gross deforestation, which is expected to incorporate other activities in the future such as degradation, conservation, sustainable forest management and increase in carbon stocks (Ministerio del Ambiente del Ecuador, 2020). Average forest carbon stocks to determine emissions factors for the nine types of natural forests in Ecuador were obtained from the National Forest Inventory. The FREL uses the period 2001-2014 as its historical reference period to project emissions.

Mangroves are one of the nine forest strata included in the FREL and referenced in the REDD+ Action Plan.

3.2.3 **National Environmental Code**

Ecuador's Environmental Code (*Código Orgánico del Ambiente*-COA) came into effect in April 2017. In its "Chapter IV. Natural vegetation, paramos, palm swamps, mangroves and forests," there are various articles that refer to the conservation of mangroves as part of the country's natural patrimony (Art. 99-108); three articles (99, 103, 104) refer to mangroves specifically (Table 22). Prior to the development and approval of the National Environmental Code, the protection and specific allowed uses of mangroves by ancestral communities were dictated by agreements and decrees under the Ministry of the Environment's Unified Text of Secondary Legislation (TULSMA). In 2004, this law was strengthened to give greater importance to mangroves and declare them government property such that they could only be exploited through authorized concessions. This law was replaced by the National Environmental Code.

Table 22. Summary of Articles in the National Environmental Code (2017) that refer to mangroves

Article no.	Summary
99	Conservation of paramos, palm swamps and mangroves: The conservation, protection and restoration of these ecosystems is of public interest. It is prohibited to log them, convert them to another land use, or otherwise affect them. The communities, towns and ancestral populations may request custody and sustainable use of the mangrove, to be granted for their subsistence, exclusive use and commercialization of fish, mollusks and crustaceans, among other species, that develop in this habitat. The organization of associations of the popular economy will be promoted and prioritized. The activities of use, and other technical considerations related to the area, will be defined by the National Environmental Authority.
103	Provisions on the mangrove ecosystem: The mangrove ecosystem is property of the State, such that trade, possession or any other means of appropriation is not permitted; it cannot acquire domain and it can only be exploited sustainably through a concession granted or renewed by the governing Aquaculture and Fishing Ministry.

104	Activities allowed in the mangrove ecosystem: 1. Phytosanitary control as established in the management plan or other instruments used for its conservation and management; 2. Promotion of wildlife; 3. Tourism and non-destructive recreation activities; 4. Traditional non-destructive mangrove activities, such as management and use of non-timber products; 5. Easement for transit; 6. Other non-traditional, scientific, artisanal, non-destructive mangrove activities; and 7. Other productive activities or public infrastructure that have the express authorization of the National Environmental Authority and that offer reforestation programs.

3.2.4 **National Action Plan for Mangrove Conservation**

The Regional Action Plan for the Conservation of Mangroves in the Southeast Pacific (PAR -Manglares) was created with the aim of strengthening policies and programs for the protection, recovery and sustainable use of mangroves in the countries of the region. It also has the intention to contribute to improving the quality of life of the communities that depend on the natural resources of this ecosystem.

The focal point for Ecuador is the Undersecretariat of Marine and Coastal Management (SGMC) of the Ministry of the Environment. In 2017-2018 Ecuador developed a National Action Plan (PAN) for the Conservation of the Mangroves of Continental Ecuador (PAN-Manglares Ecuador).

The vision of PAN-Manglares Ecuador (2019-2030) is to: “Promote the protection, recovery and sustainable use of the mangroves of Ecuador”, and its general objective is: “To strengthen policies and programs for the protection, recovery and sustainable use of mangroves in Ecuador, as well as to contribute to improving the quality of life of ancestral and traditional users who depend directly on the natural resources of this ecosystem". PAN-Manglares establishes six components linked to seven specific objectives aimed at solving the main threats to the mangrove ecosystem:

- Increase in illegal logging of mangroves.
- Weak application of environmental regulations to sanction damage to mangroves.
- Decrease in fishing resources in the mangrove area, due to over-exploitation and use of illegal fishing gear.
- Impact on the mangrove and its fishing resources due to contamination of solid and liquid waste of urban origin and productive activities.
- Sedimentation of estuaries due to deforestation of their hydrographic basins and those caused by dams.
- Vulnerability to climate change.
- Weakness in the territorial planning schemes of the Decentralized Autonomous Governments for the conservation of the mangrove swamp.

The PAN-Manglares Ecuador specific objectives include:

- Promote the review and/or formulation of national policies and programs for the conservation of mangroves.
- Promote the generation of knowledge, the dialogue of knowledge and the exchange of good practices between the countries of the region, to guide the actions of planning and integral management of the ecosystem.
- Strengthen the capacities of different actors, especially administrators and local communities, to ensure the conservation of mangroves in the region.
- Promote the monitoring of mangroves in the region.

3.2.5 **Mangrove Custody and Sustainable Use Agreements (AUSCEM)**

While coastal mangroves are legally public lands, "Agreements for Sustainable Use and Custody of the Mangrove Ecosystem" (AUSCEM), first established in 2000, grants traditional community users formal rights linked to conservation commitments, allowing them to benefit from improved livelihoods activities and living conditions.

Mangrove conservation has been promoted through the Coastal Resources Management Program[21] since 1999[22] including AUSCEMs that are granted to communities and ancestral user groups through Ministerial agreements. These agreements grant use rights and stewardship responsibilities to organized groups of traditional mangrove users to restrict open access and overuse, reduce deforestation and illegal extraction, and increase the ability of local users to realize economic benefits from conservation actions.

Since March 2009, the Undersecretary of Marine and Coastal Management (SGMC) has been responsible for issuing and assigning the AUSCEMs to traditional communities and users through procedures that were simplified in August 2011[23].

The legal framework for AUSCEMs is comprised primarily of:

- *Decreto Ejecutivo* 1102 [RO No. 243, 28 July 1999] that grants the Ministry of Environment authority to establish AUSCEMs.
- *Acuerdo Ministerial* 172 [2010] creates guidance for granting AUSCEMs and establishes permitted uses and requisites.
- *Acuerdo Ministerial* 129 [11 August 2010] further elaborates on eight principle requirements for AUSCEM and A.M. 144 [9 August 2011] reforms A.M. 129 and clarifies additional requirements for management plans, control, harvest and monitoring and evaluation.

[21] The Coastal Resources Management Program was a US$ 16.5 million project of the Interamerican Development Bank from 1993. This Project was focused on the development and sustainable use of coastal resources; with the control of environmental degradation, improve local capacity and improve livelihoods of coastal population. (http://oa.upm.es/14340/2/Documentacion/1_Memoria/BID/ManejoCostero_I.pdf)

[22] Executive Decree No. 1102, Official Registry No. 243 of July 28, 1999

[23] Ministerial Agreement No. 144

- *Acuerdo Ministerial* 198 [9 July 2014] repeals provisions of AMD 129, allowing AUSCEM to also be signed with users of mangroves within PAs.

Further discussion of the implementation and effectiveness of AUSCEMs, and recommendations for action, are provided in section 4.2.3.

3.2.6 Mangrove Partner Initiative (Socio Manglar)

The Socio Manglar program ("Mangrove Partner") builds on AUSCEM agreements. Socio Manglar was established by Ministerial Decree No. 198 on 9 July 2014, by the Ministry of the Environment of Ecuador, as part of the Socio Bosque Program of conservation incentives. The Socio Manglar program is designed to provide direct economic payments to beneficiary AUSCEM groups to support the conservation of mangroves and supplement income.

The objective of this program is to complement and consolidate the results achieved through the AUSCEMs granted to communities and ancestral groups of users, so as to guarantee the conservation of mangroves while improving the living conditions of the population dependent on fisheries resources.

The Socio Manglar incentive should be cost effective, structured to maximize the number of hectares entering the Program and equity and aimed at minimizing transaction costs. The amount of the incentive is established according to two factors reflecting fixed and variable compensation according to the area of mangrove under the Socio Manglar agreement:

A. An annual fixed incentive payment amount as per the following schedule

Category	Size (Ha)	Annual Fixed Incentive Agreement
1	100 to 500	US$ 7,000
2	501 to 1,000	US$ 10,000
3	More than 1,000 ha	US$ 15,000

In cases where the SGMC approves a concession for an area of less than 100 ha, these concessions may also participate in Socio Manglar, and in these cases they will receive an incentive equal to that of category 1.

B. A variable amount depending on the number of hectares within the concession. This variable amount has been set at US$3/ha/year. This value corresponds to approximately 50% of the variable operating cost observed per hectare of current AUSCEMs, with the remaining 50% equivalent to a contribution from the beneficiaries.

Further discussion of the implementation and effectiveness of the Socio Manglar incentive is provided in section 4.2.3.

3.2.7 **Legal Requirements for Mangrove Restoration**

The single most significant driver of the increase in mangrove cover in recent years is a regulation established in 2008, which required shrimp farms that had been illegally established in public coastal areas, to restore significant areas of mangrove on or adjacent to their farms. Executive Decree 1391 (*Decreto Ejecutivo* 1391, R.O. 454, 27X2008) mandates that shrimp farms established in coastal areas after 1999 that did not have legal concession rights granted under an inter-ministerial agreement authorizing their construction and operations were mandated to enter into a process of legalization, that involved developing a reforestation plan, restoring mangrove areas and having the final outcome evaluated and ratified by the Ministry of Environment. The total area of shrimp farms requiring legalization totaled 44,642 ha at the time of the issuance of Executive Decree 1391. Depending on the mangrove area destroyed during construction of shrimp farms, these were required to reforest 10% up to 10 ha, 20% for areas of 11-50 ha and 30% for areas totaling 51-250 ha.

Under this mechanism 4,282 ha of reforestation and restoration were proposed (under 988 reforestation plans) with a total of 3,110 ha successfully implemented and ratified by the MAE through 2018. Farms that did not comply with this pathway for legalization were evicted, with the property reverting to the Government. Farms within PAs (2,280 ha) were excluded from this legalization process and were evicted and restored, at the expense of the illegal farm.

In addition, projects that cannot avoid deforestation of mangroves (certain ports, canals or roads) are required to reforest six times the area of mangrove destroyed. While an important factor in planning and development decisions, the overall impact of this on mangrove cover is relatively small at the national scale, having resulted in a total of 82 ha of reforestation (Pesantes, J, pers. comm. 2020).

Executive Decree 1391 resulted in a surge in mangrove restoration immediately following its issue. An initial three-year period resulted in the registration and commencement of reforestation activities required for legalization. However, no new areas are currently being added under this mechanism. Sustaining or increasing the rate of mangrove recovery now depends on other regulatory instruments and on voluntary actions, which are the principal focus of this project. Under the current situation, regulatory frameworks and enforcement are inadequate for the protection and restoration of mangroves. Project outcome 3 is designed to address these issues and create the enabling conditions for communities, the public sector and the private sector to take sustained action to conserve and restore mangroves.

4 Relevant Projects and Initiatives

Ecuador has a variety of related projects and initiatives underway, including government programs and policies, private sector initiatives, and projects funded by international donors and entities. The project will work in close alignment and build from the actions, tools, successes and lessons learned of relevant initiatives.

4.1 Research and Monitoring

4.1.1 Monitoring and deforestation tracking

Through Ministerial Agreement 116 (2016), the Ministry of the Environment established the National Forest Monitoring System, to provide information about the current state of forests, other natural ecosystems and their associated biodiversity, also considering other types of land use in coordination with other information platforms. It constitutes a harmonized set of components, processes, methodologies, procedures and structures that includes the collection, analysis, reporting and dissemination of biophysical and socioeconomic information related to forests, other natural ecosystems and their associated biodiversity, at regular intervals and that allows monitoring of changes over time.

Currently, the information is published in the Unique Environmental Information System (SUIA)[24]. Periodic and systematic maps of land use and land cover and the sites affected by deforestation is available through a web-based interactive map[25]. Activities to generate data on forest cover and carbon stocks are coordinated with the SUIA and the MAAE system for monitoring and reporting system for the UNFCCC under Activity 3.1.1.2.

4.1.2 Oceanographic and climate monitoring

Monitoring and data collection on oceanographic and coastal variables relating to climate change has been conducted by the Oceanographic Institute of the Navy (INOCAR), in coordination with other institutions such as the Escuela Política del Litoral (ESPOL), Instituto Nacional de Pesca (INP) and CIIFEN. These institutions have strong technical capacities but there is a need to broaden focus to address more recent climate changes and to ensure adequate integration and near real time data availability (Cedeño 2011).

INOCAR's current roles and capabilities include:

- Dissemination of technical and scientific publications and programs of the Institute;
- Presentation of prevention programs for natural threats of marine origin;
- Dissemination of reports in technical meetings to national and international organizations;
- Development of programs for training and capacity improvement according to the standards established by the International Hydrographic Organization IMO;

[24] http://suia.ambiente.gob.ec/

[25] http://ide.ambiente.gob.ec/mapainteractivo/

- Technical representation in national and international organizations related to hydrographic and oceanographic management, maritime delimitation, natural resources management, marine and navigation aids;
- Monitoring of the fulfillment of commitments assumed through technical cooperation agreements with entities and areas for the purpose of institutional management;
- Tsunami reports (warning, alert, monitoring and cancellation);
- Operation of research platforms; and
- Research vessels: Orion, Sirius and other small vessels:
    - Oceanographic stations for 24/7 monitoring report of oceanographic conditions;
    - Wave buoys in Manta and Jambelí; and
    - Remote Sensors, Autonomous and Reanalysis Equipment, Global Atmospheric Ocean Data with repository accessible to remote locations.

CIIFEN is an institution established by the Government of Ecuador, with the support of the World Meteorological Organization, in 2003. CIIFEN has executed over 45 projects and manages regional data sets and capacity for analysis of El Niño and other regional climate phenomena.

In order to analyze oceanographic and climatic conditions relevant to the coastal region of Ecuador, better data and analysis is needed. Currently, Ecuador draws data from only two tide gauges along the Ecuadorian coast and one in Peru for information on sea level during the period 1985-2015. Other variables such as sea surface temperature, salinity, pH, chlorophyll and dissolved oxygen are also limited in spatial resolution and time series, making it difficult to monitor, project and plan for climate change impacts along Ecuador's coast. According to an international conference on ENSO organized by CIIFEN in 2014 “there is urgency for actions addressed to the maintenance and strengthening of the Tropical Pacific Ocean observation system, and for its enhancement in poorly covered areas such as the Eastern Pacific. This is a sine qua non condition for improving the knowledge and prediction tools, as well for strengthening warning systems on ENSO.” (Pabón and Martínez 2016). During project development, consideration was given to including activities to improve capacity for data collection, analysis and dissemination, but ultimately these activities were not included because they are so different from the core of the project activities and do not fit well with the project’s theory of change.

4.2 Protected Areas and community-based management of mangroves

4.2.1 Community-based management

Strengthening community management of mangroves has been an important pillar of Ecuador’s approach to mangrove conservation for twenty years as described in the preceding section. Strengthening the capacity of local mangrove users as a strategy for climate change adaptation has been highlighted by local studies in Ecuador (Iñiguez-Gallardo and Jurrius, 2019). AUSCEM agreements currently cover 60,217 ha of mangroves (Figure 32). However, a significant area of current mangrove areas and their traditional users are not covered by active AUSCEM, leaving them at risk of encroachment and uncontrolled resource exploitation (see Table 23).

Table 23. Area and deforestation rates of mangroves by land-tenure and use category

Category	Total Mangrove Area (2008)	Total Mangrove Area 2018 (ha)	% National total mangrove area (2018)	Gross Loss (ha)	Gross Gain (ha)	Net Change (ha)	Net Change (%)
Protected Areas (PAs)[1]	62,339	64,916	41%	1,733	4,309	2,577	4.13%
AUSCEM, active June 2020[2]	56,522	60,217	38%	1,389	5,084	3,695	6.54%
No Protection[3]	36,956	36,186	23%	6,868	6,099	-770	-2.08%
Overlap AUSCEM and PAs	-4,441	-4,686	-3%				
Total	151,376	156,633	100%			5,502	

[1] Includes 4,441 ha (2008) and 4,686 ha (2018) of mangrove in AUSCEM overlapping with Protected Areas. 2018 data includes 10,589 ha of mangrove in AUSCEM, inactive/pending renewal as of June 2020.

[2] Includes 4,441 ha (2008) and 4,686 ha (2018) of mangrove in AUSCEM overlapping with Protected Areas.

[3] Includes 3,307 ha (2008) and 3,640 ha (2018) of mangrove in AUSCEM, inactive/pending renewal as of June 2020.

Of existing AUSCEMs, many are vulnerable because income from sustainable resource use still does not meet basic needs, even for those benefiting from Socio Manglar agreements and incentive payments. In 2020, Socio Manglar payments to users totaled US$379,563. But currently only 33,467 ha of mangroves under 25 AUSCEM are benefiting from Socio Manglar incentive payment agreements, leaving significant scope for expansion within remaining active AUSCEM (26,750 ha) as well as in potential new AUSCEM areas (Figure 32). Expanding the coverage of AUSCEMs, Socio Manglar incentives and enhancing the economic viability of sustainable community enterprises would contribute to further reducing deforestation and strengthening stewardship, and is a key area addressed under Project Outcome 1.

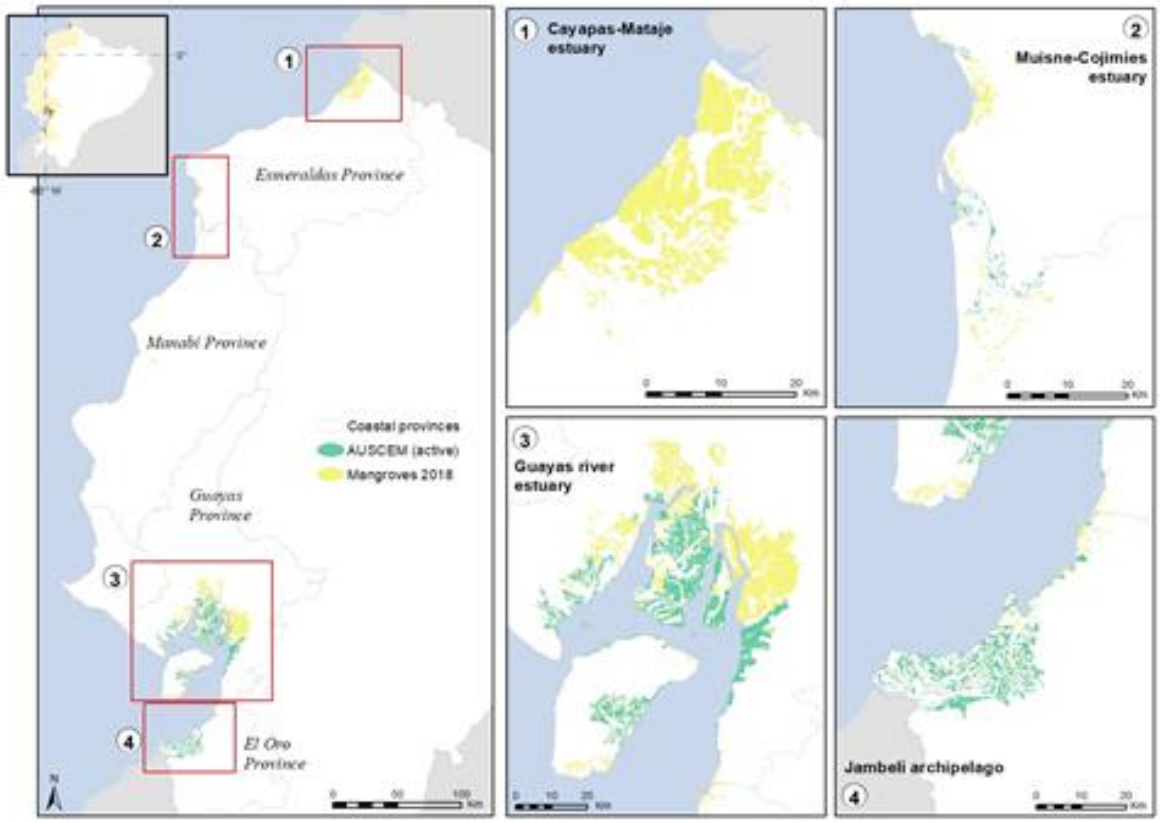


Figure 32. Coverage of current AUSCEMs and Mangroves in Ecuador, indicating significant scope for expansion to mangrove areas currently outside active AUSCEMs (Source of data: CIIFEN-MAE, 2020)

Gross deforestation rates under AUSCEMs and PAs are 86% lower than areas without these protections. Mangrove areas without community stewardship or protected area status total 36,186 ha (23% of total mangrove area), but account for 69% of all recent mangrove deforestation. Approximately one quarter of the areas under AUSCEM have currently lapsed due to lack of support and technical assistance for legal proceedings and management activities, leaving mangrove areas without effective protection. Even many current AUSCEMs are constrained by limited management capacities and lack of economic alternatives that reinforce mangrove conservation and management. Most mangrove residents, despite being highly dependent on natural resources and ecosystems, have limited awareness of climate change scenarios (Cobos Cando, 2017), though their psychological and social resources may give them a strong basis for adaptation (Iñiguez-Gallardo and Jurris, 2019). Training, participatory planning and strengthening of livelihoods alternatives can therefore contribute to enhancing climate change resilience (Cobos Cando, 2017).

4.2.2 **National Protected Areas**

Forty-one percent of all mangroves of mainland Ecuador lie within the boundaries of PAs, making these an important strategy for mangrove management and conservation.

Ecuador's National PAs are classified by IUCN guidelines. Nine PAs with mangroves are found in three types: Ecological Reserves (*Reserva Ecológica* – RE), Flora and Fauna Production Reserves (*Reserva de Producción de Flora y Fauna* – RPF) and Wildlife Refuges (*Reserva de Vida Silvestre* – RVS)

Table 24. Ecuador's Protected Areas. Mangrove cover and deforestation rates 2008-2018.

Protected Area	Area of the PA (ha)	Mangrove area of AP (ha, 2018)	Mangrove as % of PA	Gross loss (ha)	Gross Gain (ha)	Net Change (ha)	% Net Change 2008-2018
A.N.R. ISLA SANTAY	2,215	162	7%	-	0.5	0.5	0%
R.E. ARENILLAS	13,170	1,445	11%	18.6	178.4	159.8	12%
R.E. MANGLARES CAYAPAS MATAJE	56,420	20,012	35%	1,028.7	2,070.2	1,041.5	5%
R.E. MANGLARES CHURUTE	50,070	28,467	57%	331.5	1,114.6	783.0	3%
R.P.F. MANGLARES EL SALADO	15,536	11,659	75%	232.5	388.1	155.7	1%
R.V.S. ISLAS CORAZON Y LAS ISLAS FRAGATAS	2,812	614	22%	5.2	95.9	90.7	17%
R.V.S. MANGLARES EL MORRO	11,807	1,133	10%	40.3	47.3	7.0	1%
R.V.S. MANGLARES ESTUARIO DEL RIO ESMERALDAS	243	128	53%	0.9	45.4	44.5	54%
R.V.S. MANGLARES ESTUARIO DEL RIO MUISNE	92,246	1,295	1%	74.4	368.2	293.8	29%
Total	244,518	64,913	27%	1,732.1	4,308.7	2,576.6	4.1%

Four PAs, prioritized by the project contain 94.6% of mangroves in PAs:

- Reserva Ecológica Manglares Cayapas Mataje (includes 20,012 ha of mangrove)
- Reserva Ecológica Manglares Churute (includes 28,467 ha of mangrove)
- Reserva de Producción de Flora y Fauna Manglares El Salado (includes 11,659 ha of mangrove)
- Reserva de Vida Silvestre Manglares Estuario del Rio Muisne (includes 1,295 ha of mangrove)

These four PAs also encompass most of the mangrove deforestation: 96.3% of total mangrove loss in PAs 2008-2018 (1,732 ha) and 95.6% of total mangrove loss 2014-2018 (765 ha).

Ecuador has signed the Ramsar Convention for wetlands protection and incorporated 20 sites declared as wetlands of global importance under the convention. Within these sites, seven are in the marine and coastal regions and four are relevant because they have approximately 65,000 ha of mangrove coverage:

- Reserva Ecológica Cayapas-Mataje; Ramsar site No. 1292, with 44,847 ha, which overlaps with Cayapas Mataje Ecological Reserve.
- Manglares Churute, Ramsar site No. 502, with 35,042 ha, which overlaps with Manglares Churute Ecological Reserve.
- Isla Santay; Ramsar site No. 1041, with 40,705 ha, which overlaps with the Recreational Area Isla Santay.
- Manglares del Estuario Interior del Golfo de Guayaquil Don Goyo; Ramsar site No. 2098, with 15,338 ha, which overlaps with a section of the AUSCEM Cerrito de los Morreños.

4.2.3 **Effectiveness of community-based management and PAs**

Community-based management of mangrove areas, under AUSCEM, and national PAs have proven to be very effective at slowing rates of mangrove deforestation.

All PAs showed net increases in mangrove cover from 2008-2018, though a total of over 1,700 ha were still deforested during this period (Table 24). Areas under AUSCEMs performed slightly better, with overall lower rates of gross deforestation (2.46% versus 2.78% for PAs) and higher rates of mangrove gain (9% versus 7%). Both PAs and active AUSCEM areas (totaling 125,133 ha in 2018) were more effective at conserving and regenerating mangrove areas than areas outside of these protected categories. Areas outside PAs and without active or recent AUSCEM agreements (totaling 36,186 ha in 2018) suffered 18.6% gross mangrove deforestation and a net mangrove loss of 2.1% for the period 2008-2018 (Table 23). Deploying mechanisms to strengthen management of existing AUSCEMs, expand coverage of these agreements, and to bolster PAs are central elements to this project, under Project Outcome 1.

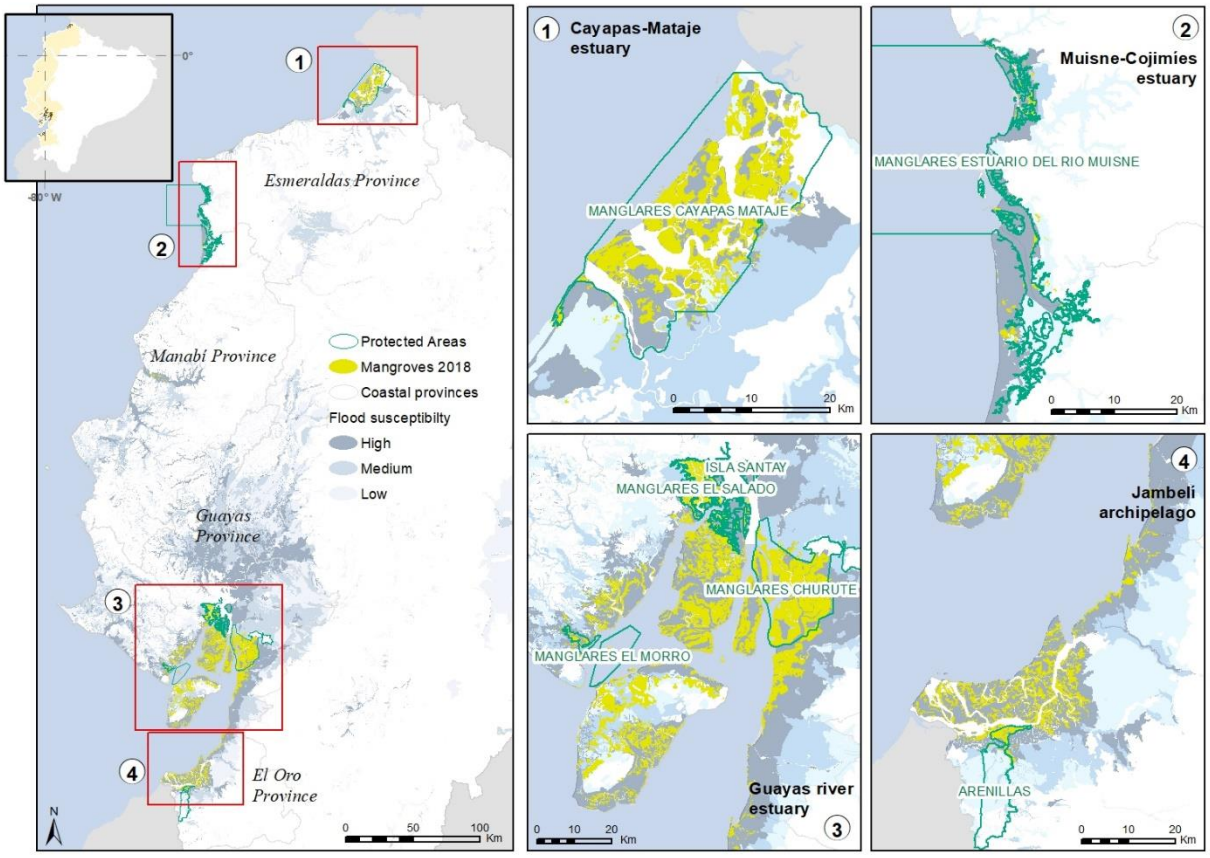


Figure 33. Protected areas of Ecuador´s coast.

4.3 Reforestation and restoration

Ecuador has established and executed successful mangrove reforestation efforts. Techniques for mangrove reforestation are well-proven in Ecuador and other sites around the world (Fundación Calisur, 2014; Global Nature Fund, 2015; Thivakaran, 2017). Approximately 3,000 ha have been reforested by shrimp farms in compliance with legal requirements since 2008. Smaller additional areas have been reforested under compensation mechanisms established by Ecuadorian law, including approximately 74 ha from port operations (DPWorld, ASOTEP) (Briones, A. Ministry of Environment and Water, Pers. Comm. 5 November 2020).

CI identified over 10,000 ha of land in the four estuaries appropriate for reforestation based on criteria including size, form, connection with remaining mangroves, vulnerability of populations and proximity to ports (Figure 34 and Appendix 3).

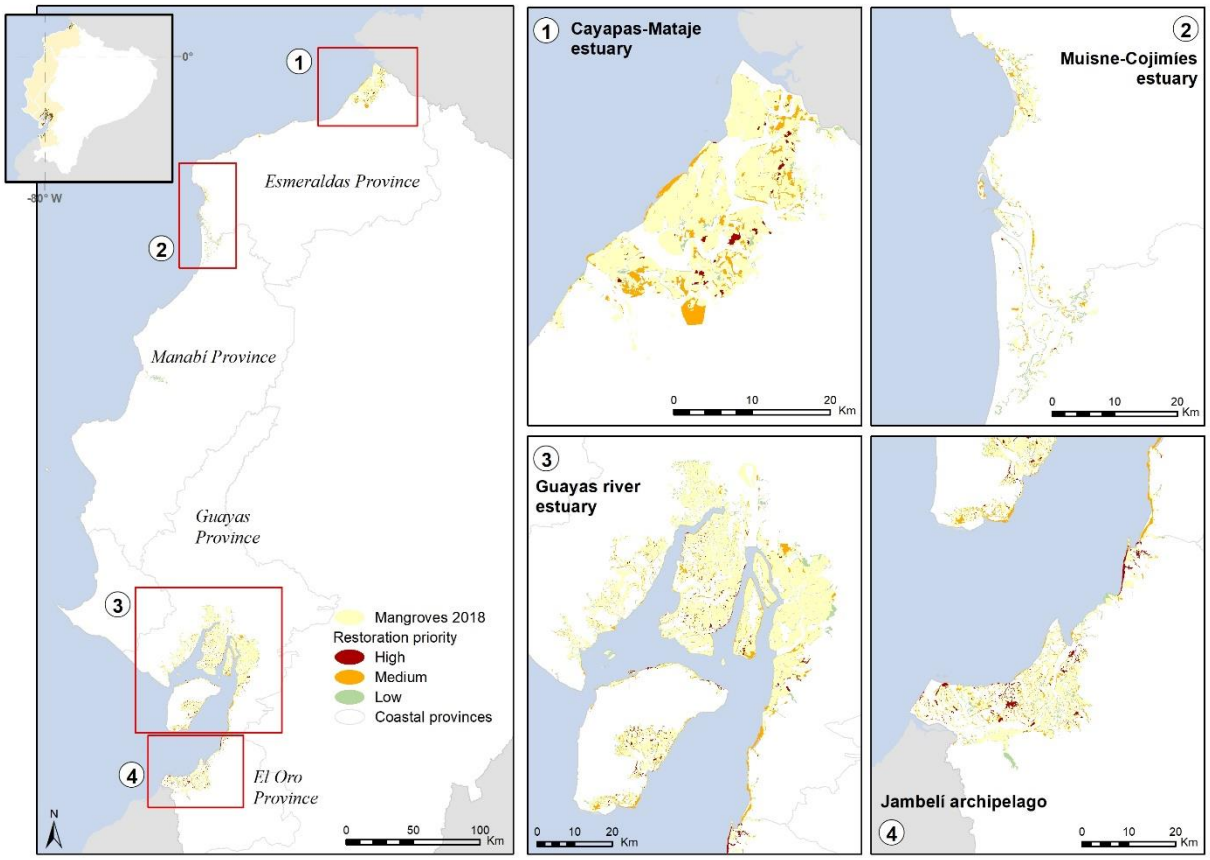


Figure 34. Mangrove reforestation priority areas for Ecuador´s mainland coast

4.4 Regulation and enforcement

4.4.1 Planning and zoning

Local governments are known as Decentralized Autonomous Governments (GADs) in Ecuador and include subnational entities at the provincial, municipal (or cantonal) and parish levels with a degree of administrative and regulatory autonomy. These decentralized government entities play an important role in climate governance in Ecuador (Wilson Lechón Sánchez, 2023).

A fundamental instrument for planning and investment of the GADs is the Development and Land Use Plans (Planes de Desarrollo y Ordenamiento Territorial - PDOT). PDOTs, according to the Organic Code of General Public Planning and Finance Code (COPFP, National Assembly, 2010a), "... are the instruments of development planning that aim to order, to make compatible and harmonize strategic development decisions regarding human settlements, economic-productive activities and the management of natural resources based on territorial qualities, through the definition of guidelines for the materialization of the long-term territorial model, established by the respective level of government".

GADs at multiple levels, in coordination with the national government, need to collaborate in integrated coastal management, based on PDOTs integrating a strong marine and coastal spatial planning approach in the mangrove zone of the coastal region of Ecuador. These PDOTs can be also complemented, under Ecuadorian law (Organic Code for the Environment – CODA), by Management Plans for Beaches and the Coastal Strip addressing the specific needs and characteristics within and across multiple GADs. Three municipalities have established such plans.

Mangrove areas and climate change vulnerabilities are generally not adequately addressed in PDOTs. The provincial government of Guayas developed a provincial climate change strategy 10 years ago, which identified four areas of concern: 1) sustained increase in air temperature; 2) more frequent extreme El Niño events; 3) possible increase in other extreme weather events, and 4) possible increase in periodic short-term drought. Mangroves were not explicitly incorporated, but the plan highlights the importance of better planning and zoning to avoid increasing pressures on natural ecosystems (Prefectura de Guayas, 2021). Seven municipalities have established ordinances relating to integrated coastal management, with four of these including mangroves, but these do not clearly address climate change mitigation and adaptation.

4.4.2 **Enforcement**

Legal enforcement has faced a series of setbacks when trying to enforce mangrove conservation measures with shrimp farm owners who expanded the shrimp farms without prior authorization from the National Environmental Authority.

Regulatory frameworks and enforcement are inadequate for protection and restoration of mangroves by public, private and community-based actors. Detection of mangrove deforestation often lags far behind the occurrence of events and usually depends primarily on ground-based observation from government agents and complaints filed by citizens. Ministry of Environment and Water field staff are limited and there is poor coordination amongst overlapping government agencies (Ministry of Environment and Water, Ministry of Fisheries and Aquaculture, municipal governments, the Navy, etc.), which means that relatively few deforestation events are identified and sanctioned. Despite the high rates of ongoing clearing of mangroves, only 13 judicial and administrative proceedings were processed for deforestation in 2011-2016, and of these, only three had been resolved by 2017. The lack of effective enforcement and sanction has been emphasized by community stakeholders during the Free, Prior and Informed Consent (FPIC) process of this project.

Operational Control and Surveillance Units (UOCVs - *Unidades Operativas de Control y Vigilancia*) for detection and law enforcement for illegal activities affecting mangroves were piloted and previously active on Ecuador´s coast, as part of the Program for the Management of Coastal Resources project. A joint effort between the Army, MAAE, VMAP, NGOs and the National Chamber of Aquaculture, the UOCVs' main goal is to avoid and control the clear-cutting of mangrove forest areas through the cooperation of public, private and NGO entities involved on this environmental issue.

Application of sanctions for environmental crimes under the Organic Code for Criminal Processes (*Código Orgánico Procesal Penal*) is also limited by gaps in regulations, including lack of clarity around administrative procedures and fines. When environmental crimes and sanctions are taken up by the

courts, there is frequently a lack of knowledge on the part of prosecutors and judges regarding marine and coastal laws and regulations, and a lack of coordination and collaboration between prosecutors and the MAAE.

4.5 Results-based payments

4.5.1 National REDD+ program

Ecuador was the second country to receive results-based payments (RBP) from the GCF for emissions reductions achieved nationally during the year 2014 (4,831,679 tCO_2eq), as compared to Ecuador's first forest reference emissions level (FREL, 2000-2008). A second FREL for the period 2001-2014 has been submitted to the UNFCCC (January 2020) and is currently under technical assessment. This second FREL is expected to serve as the basis for calculating emissions reductions from the 2015-2018 period.

In addition, in June 2018, the Government of Ecuador signed an agreement with the Governments of Norway and Germany's REDD Early Movers Program (REM), committing compensation for verifiable emissions reductions achieved for the years 2015-2018.

Both REM and the GCF RBPs are based on national-level emissions and reference levels, incorporating mangroves as one of nine forest types monitored. GCF funds are implemented through the ProAmazonia project, focused on the Ecuadorian Amazon region, while REM funding also covers areas on Ecuador's coast, including mangroves.

Neither of these results-based payment mechanisms currently covers the expected period of project implementation. However, the systems in place allow for consistent accounting at the national level, reporting to the UNFCCC through Biennial Update Report (BUR) Technical Annexes, and incorporating commitments, retired reductions and compensation under these or other future RBP agreements. It is expected that emissions reductions (ERs) generated by this project will not be eligible for results-based payments from GCF, REM or other initiatives.

4.5.2 Carbon Zero program

The Carbon Neutral Scheme (Carbon Zero Program - PECC) was created by the Ministry of the Environment of Ecuador in 2014 and its objective is to motivate companies to reduce and offset their emissions, thus contributing to the country's effort to mitigate the impacts of climate change. The scheme is voluntary and all companies that meet the eligibility criteria can apply.

This scheme provides the opportunity for companies and organizations to build and implement a strategy with a focus on mitigation and compensation of emissions.

The general principles and guidelines on which the mechanism is based are detailed below:

- Preventive: The application of preventive measures within productive activities is promoted, avoiding negative environmental impacts, and increasing efficiency in the use of environmental goods and services.
- Relevance: Ensure that the GHG inventory reflects GHG emission sources, sinks and reservoirs that serve for objective decision making, both for internal and external users.

- Integrity: Quantify and report all significant emission and removal sources, and activities considering inventory limits. Justify any exclusions.
- Consistency: Use of consistent methodologies that allow meaningful comparisons of emissions and removals over time. Document changes in information, limits, methods or other aspects transparently.
- Additionality: The offset project and the emission reduction because of that project would not happen in its absence.
- Transparency: Report all relevant aspects and guarantee that these aspects are traceable. Report any assumption and information that allows the replicability of the results. All omissions must be clearly identified, reported and justified. In addition, they must ensure accountability that allows interested parties to have access to information.
- Accuracy: The calculation of GHG emissions should not exaggerate or minimize the true amount of GHG emissions or removals. The inventory needs to allow users to make decisions with reasonable confidence. Uncertainties in the quantification process should be kept to a minimum.
- Measurement, reporting and verification: quantified emissions and removals follow an information gathering and quantification process, which are reported and verified by an independent third party.

This scheme allows companies to choose the level at which they want to apply, and depending on compliance with the requirements, they will be able to obtain a Green Initiative Distinction - Carbon Footprint Quantification or a Certification (reduction or carbon neutrality):

- Carbon Footprint: awarded to legal entities that have measured and reported their carbon footprint or emissions inventory. This recognition is valid for one year and is granted only once.
- Carbon Reduction Certification: awarded to legal entities that apply mitigation and/or compensation actions and reported reductions in their GHG emissions. This level of recognition is valid for two years.
- Carbon Neutrality Certification: awarded to legal entities that measure their carbon footprint and carry out mitigation and compensation actions and measures until reaching a “zero” balance between emissions generated and offset according to their carbon footprint or emissions inventory. In this way its production system can be considered as "carbon neutral". This level of recognition is valid for three years.

The design, development, GHG inventory management, organizational level reporting and the validation process must be carried out based on internationally recognized methodologies, including Ecuadorian Technical Standards[26], Corporate Accounting and Reporting Standard[27].

For the compensation activities, carbon must be audited by an independent auditor under ISO 14064-2. For the quantification of Emissions Reductions Units (ERUs), the proponent must identify and use the criteria and procedures considered as good practices at present, for example Gold standard, Voluntary Carbon Standard, or MDL. If criteria and procedures do not exist, criteria and procedures that meet the requirements of ISO 14064-2 must be justified and applied.

[26] Ecuadorian Technical Standard NTE INEN-ISO 14064 GREENHOUSE GASES - PART 1: Specification with guidance, at the organization level, for the quantification and reporting of greenhouse gas emissions and removals (ISO 14064-1: 2018, IDT)
[27] https://ghgprotocol.org/

The project anticipates that some financial contributions from companies looking to compensate for emissions under Ecuador's PECC will be channeled into the Socio Manglar subaccount of the Socio Bosque Fund to support community-based mangrove conservation and management beyond the project implementation period (see Appendix 12).

The benefits anticipated from PECC for participating companies and organizations are: (i) Improve corporate image, (ii) Recognition in several instances of sustainability commitments in the market, (iii) Use of Punto Verde brand, and (iv) Access to tax and labor incentives.[28] This last benefit relates to the reduction of taxes for purchases of energy efficient machinery and also the application for the "double deductibility" (*doble deducibilidad*) that give companies the possibility to reduce from corporate taxes an additional 100% of the donations, investments and/or sponsorships that are allocated to conservation programs.[29]

Currently there are 395 companies in Ecuador that adhere to PECC[30] and this number has been growing rapidly in recent years: in the services sector, manufacturing, agribusiness and food, transportation, flowers sector and in mining and oil. The construction, finance and health industries have six representatives each and the education and telecommunications sector have five representatives. In the tourism sector there is currently only one company.

The Government of Ecuador has awarded recognitions to 56 companies that have innovated their production processes to measure and reduce their carbon footprint. These are: Entregas y consolidación, Banco Internacional, Ferro Torre, Sevilla y Martínez Ingenieros Semaica, Ideal Alambrec, Corporación Superior Hospital Vozandes, Mexichem Ecuador, Orion Energy, Agripac, Netlife, Surpapelcorp, OCP, Procredit Bank, El Ordeño, Denmar Hazwat Asiservy, Hotel Le Parc, Mediterranean Shipping Company of Ecuador, Banco Guayaquil, Ciudad Comercial El Recreo and Holcim.

MAATE has not published projections on the amount of funding that it expects could be directed to conservation programs from PECC. However, they have indicated that mangrove conservation will be a priority theme. Given the number of companies involved already, CI-Ecuador believes this is potentially a significant source of funding over the medium to long term that should be pursued to build relationships between community groups involved in mangrove conservation and private companies and to address long term financing needs. A target of building up to US$ 300,000 per year from PECC has been set for the project and included in initial financial projections for covering the long-term costs of the Socio Manglar Program (See Appendix 12). Activity 2.2.1 includes the development of a communications strategy to present the Socio Manglar program to companies with the objective of getting them to engage directly with AUSCEMS and/or support the Socio Manglar program financially, including through contributions to the Socio Manglar subaccount.

[28] Acuerdo Ministerial No. MAAE-2021-018. Expedir el Programa Ecuador Carbono Cero

[29] Acuerdo Ministerial nro. MAATE-2022-113. Normativa para la calificación de programas, fondos y/o proyectos de prevención, protección, conservación, bioemprendimientos, restauración y reparación ambiental y para la certificación de los beneficiarios de la deducción del 100% adicional para el cálculo de la base imponible del impuesto a la renta

[30] https://www.ambiente.gob.ec/el-maate-invita-a-las-micro-pequenas-y-medianas-empresas-a-participar-en-la-convocatoria-sumate-a-la-accion-climatica-programa-ecuador-carbono-cero-pecc/

4.5.3 Public and philanthropic projects and investments

There are six recent and current large internationally funded projects related to mangrove conservation, AUSCEM, fisheries and fisheries management. These projects represent an investment of around US$122 million in total. Funding has had only a minor focus on climate change adaptation, mitigation and ecosystem services (only one of the projects identified), nor has there been a strong focus on engaging the private sector on these issues. Additional gaps that are critical for climate change mitigation and adaptation include strengthening capacity for coastal planning, policy development and implementation. Key synergies of the proposed project with the largest existing projects are described in Table 25.

Table 25. Additional major investments and synergies

Types of synergies	Projects
Building on previous experiences from GCF to scale up the impact	**GCF FP019 Priming financial and land use planning instruments to reduce emissions from deforestation (US$41 million, start May 2017 and end May 2022).** The proposed project will seek to build on the experience from this GCF project, focused on the Amazon, related to financial instruments, in particular with regard to lines of credit for sustainable practices and certification of products. **GCF FP110: Ecuador REDD-plus RBP for results period 2014 (US$18.6 million, start Feb 2020 and end Feb 2026).** This US$50M project strengthens institutional capacities in the Ministry of Environment and Water in the implementation of the REDD+ Action Plan and improvement of the forest monitoring system, primarily in the Amazon region. The proposed project will complement these efforts by focusing on mangrove forests and deforestation which are currently not covered.
Co-financing from other climate funds	**REDD Early Movers (REM) (€41 million, start May 2019 and end 2023).** This project supports the implementation of the REDD+ Action Plan in Ecuador, including supporting management of 14,163 ha of mangrove under the Socio Manglar incentive program (US$133,740/year) and investment in sustainable economic initiatives for local associations (including in mangrove forests).
Scaling up activities implemented with the support of other funds	**GEF 4770 Integrated Management of Marine and Coastal Areas of High Value for Biodiversity in Continental Ecuador (US$4.2 million, start Jan 2016 and end Oct 2020).** This project developed strategies for an integrated management approach for the use and conservation of coastal and marine areas of high biodiversity value, including mangroves. The proposed project aims to scale up

	and expand coverage, by renewing AUSCEMs and integrating fisheries management within conservation areas. **GEF 9124 Coastal Fisheries Initiative (US$6.6 million, start Dec 2016 and end Jun 2022).** This project worked to strengthen the governance of two artisanal and small-scale fisheries associations in Peru and Ecuador: the proposed project will support additional associations. The proposed project will also adopt and implement strategies developed by this GEF project to manage key fisheries such as crabs and black cockles. **GEF 5771 Improving Mangrove Conservation across the Eastern Tropical Pacific Seascape (ETPS) through Coordinated Regional and National Strategy Development and Implementation (US$1.9 million, start July 2016 and end July 2019)**. (Regional project). CI will replicate the design of Mangrove Actions Plans and fisheries.
Implementing lessons learned from initiatives financed by other funds	**GEF 9369 Implementation of the strategy plan for Ecuador's mainland marine and coastal protected areas network (US$5.8 million, start Nov 2017 and end Jun 2022).** This GEF project is providing tools and information about the conservation and sustainable use of marine and coastal biodiversity for coastal planning, which will be used by the proposed project as part of the support to local governments and MPAs with mangroves. **GEF 4452 Standardized methodologies for carbon accounting and ecosystem services valuation of Blue Forests (US$4.5 million, start August 2014 and end March 2017).** (Global project). CI generated information on the legal framework, socioeconomic conditions, and mangrove conservation activities to enhance the ecosystem services of mangrove areas.

4.5.4 **Sustainable Finance Roundtable**

The Sustainable Finance Roundtable (*Mesa de Trabajo de Finanzas Sostenibles*) is an effort led by the Ministry of Economy and Finance (MEF), as the cabinet ministry for public finances, and MAATE. This initiative offers a space for articulation between the different efforts to promote sustainable finance in the country. The Sustainable Finance Roundtable seeks to establish measures and actions so that the financial resources managed in the national financial system contemplate sustainability criteria during their execution, and that the incorporation of sustainability criteria allows national financial entities to access new sources of international financing.

The Sustainable Finance Roundtable has four strategies:

1. Enabling conditions: Analyze current regulations, strengthen the regulatory framework for public climate finance and the regulatory framework that considers environmental and social risks, green credits, and inter-institutional coordination.
2. Inclusion of sustainability criteria in the financial system: environmental and social standards for development banking, risk analysis, principles and criteria for sustainable banking.
3. Development of sustainable financial mechanisms: green and climate change credit lines, public-private partnerships, green and sustainable businesses, identification of financing sources.
4. Climate finance: linking climate change objectives with financial instruments, methodologies for measuring and monitoring climate change spending and investment.

The Sustainable Finance Roundtable offers an opportunity to initiate a dialogue and learn about the needs of other actors, such as regulators, public banks and private banks, in the area of sustainable finance. It also allows for improved coordination between the different initiatives undertaken by the actors to have a financial system that promotes the flow of capital towards sustainable and climate change activities and projects.

4.6 Private sector initiatives

4.6.1 Shrimp Aquaculture

Shrimp farming has historically been the single biggest driver of mangrove deforestation in Ecuador. Effectively engaging with the shrimp aquaculture sector, through better enforcement and through voluntary action, is an important element of strategies for effective mangrove conservation and restoration.

Shrimp aquaculture in Ecuador is recognized for using low stocking density production to decrease disease risks, although the sector remains GHG intensive. This strategy, widely adopted after disease outbreaks in the 1990s severely impacted national production, utilizes semi-intensive culture to produce high quality product with lower environmental impacts. Overall growth of the sector has increased from about 50,000 MT in 2000 to 510,000 MT in 2018 (FAO, 2020). Land-use change from virgin areas mostly took place between the 1960s and 1990s, signaling that recent production increases are due to intensification and conversion of already disturbed lands (e.g. rice fields) (CEA Consulting, 2018). Shrimp production intensity averages 1.92 MT/ha/y in Ecuador, which is significantly lower than intensive production seen in Thailand (18.2 MT/ha/y) and below production intensity averages of China, India, and Indonesia (4.5 MT/ha/y, 3.6 MT/ha/y, and 3.3 MT/ha/y, respectively) (CEA Consulting, 2018). There is substantial room for improvement in energy usage in the sector. For example, less than half of shrimp ponds in Ecuador, approximately 100,000 ha out of 215,000 ha total, utilize efficient water pumps, and the electrification of an additional 100,000 ha of ponds could prevent 87 million gallons of diesel used per year and result in 877,000 tons avoided emissions of CO_2 per year (GPS Grupo, 2020).

The private sector, most notably the shrimp aquaculture industry, has had limited engagement with mangrove conservation, despite the role of mangroves in protecting their vulnerable coastal infrastructure and increasing market demand for sustainable production. Increasing private-sector participation is constrained, among other factors, by lack of information about the benefits of mangroves,

limited technical capacity to identify and adopt practices that restore or conserve mangroves, and in the case of small shrimp farmers, limited access to finance.

In 2008, Executive Decree No. 1391, established a pathway to legality for informal shrimp farms that had encroached on mangrove areas, if they reforested 10%-30% of the area occupied. This resulted in approximately 4,000 ha of reforestation by shrimp farms seeking compliance, but currently is not integrating new areas (see section 3.2.7).

Beyond the need for legal compliance, market opportunities and barriers are also driving a shift within Ecuador's shrimp aquaculture sector. Voluntary, market-facing certification and labeling schemes are drawing increasing attention as a way to differentiate Ecuadorian shrimp as sustainable, healthy and good for the environment. Sustainable shrimp currently sells at a price premium of about US$0.05/lb, with variation across geographies.

A variety of different initiatives underway include requirements to eliminate deforestation and enhance mangrove restoration, with potential for scaling up and improving practices across the shrimp aquaculture sector. While there has been growing interest in sustainable practices in the shrimp aquaculture sector, less than 1% of all shrimp farms in Ecuador operate under certification schemes which align with climate resilience and emissions reductions.

4.6.1.1 Aquaculture Stewardship Council

Aquaculture Stewardship Council (ASC) provides a certification standard to minimize unintended social and environmental impacts of aquaculture production around the world. Using more than 150 performance metrics, shrimp farms committed to, and are independently verified as, complying with best practices to, amongst others, help protect surrounding ecosystems (including mangroves), biodiversity and vulnerable natural areas, reduce the use of pesticides and chemicals, preserve water quality, and safeguard the rights of workers and neighboring communities.

ASC certified shrimp farms must minimize impacts on their neighboring ecosystem in ways such as partial restoration of lost mangrove forest, the development and implementation of a biodiversity-focused environmental impact assessment (B-EIA) and ensuring farms are not sited in critical habitats. Since shrimp farming often occurs along coastal areas, a permanent coastal barrier must be in place between the farm and the coastline.

ASC certification is growing rapidly globally, from 75,000 MT sold in 2015, to 200,000 MT in 2020. Ecuador has one of the largest areas of shrimp farms certified under ASC, with approximately 15% of production certified, and a total volume (including shrimp and tilapia) of 75,000 MT sold in 2020. Currently 15 companies in Ecuador are participating in ASC, with 28 certified shrimp farms (49 sites). Products from ASC-certified farms and chains of custody can display the ASC logo to improve market access and the perceived value to consumers of their products.

The ASC shrimp standard (Version 1.2.1, published 14 July 2023) contains seven core principles: 1) compliance with applicable national and local laws and regulations; 2) Site and operate farms in a sustainable manner; 3) develop and operate farms with consideration for surrounding communities; 4) operate farms with socially responsible practices; 5) manage shrimp health and welfare; 6) manage broodstock; and 7) use resources in an environmentally efficient and responsible manner. Principles 2 and 7 have the closest relevance to climate adaptation and mitigation goals.

Principles 2 and 7 have the closest relevance to climate adaptation and mitigation goals of the project:

- Principle 2 (Site farms in environmentally suitable locations while conserving biodiversity and important natural ecosystems) comprises 6 criteria, each with one or more indicators. Criterion 2.4 requires that farms use ecological buffers and coastal barriers. Barriers provide resilience against climate-related storm surges and sea level rise, and restrictions on how close to the mean high tide line farms can locate physical structures (including ponds) reduce the risk of damage due to climate-related storm surges and sea level rise.
- Principle 7 (Use resources in an environmentally efficient and responsible manner) is made of 7 criteria, each with one or more indicators. Criterion 7.4 requires efficient use of marine ingredients in shrimp feeds, potentially reducing the greenhouse gases embedded in production on a per kg basis. Marine ingredients (e.g. anchoveta) are also prone to climate related supply fluctuation, meaning reduced use of these ingredients provides farmers with added resilience to climate-associated production shocks. Criterion 7.6 requires that farmers monitor and record energy use, potentially reducing energy requirements (and embedded greenhouse gases) per kg of shrimp produced.

4.6.1.2 Sustainable Shrimp Partnership

The National Chamber of Aquaculture has also been working on the development and implementation of a national initiative to create a brand to differentiate the Ecuadorian product in the global seafood market. This Sustainable Shrimp Partnership (SSP) is an industry led initiative that works with ASC criteria as a base, with three additional criteria: zero antibiotics, traceability, and neutral impact on water[31]. In 2020, there were 3,933 registered shrimp farms in Ecuador operating on 216,000 ha (Seafood Watch, 2021), which means there is significant scope for growth for ASC and SSP coverage, leveraging market access and differentiation to achieve environmental outcomes, including carbon neutrality and mangrove restoration and protection.

4.6.1.3 Climate Smart Shrimp

ASC and SSP, with their requirements to eliminate mangrove deforestation, can contribute directly to reducing emissions from mangrove conversion if widely adopted, since they prohibit areas deforested after 1999. The importance of climate change adaptation is further emphasized by CI's Climate-Smart Shrimp (CSS) initiative.

Climate Smart Shrimp (CSS) is a novel approach that incentivizes mangrove restoration while also increasing the amount of shrimp a farm can produce. By applying this model, shrimp farmers, local communities, and other stakeholders work together to sustainably intensify production in a portion of a farm's ponds in exchange for restoring mangroves in the remaining ponds.

CSS involves working with shrimp pond farmers to sustainably intensify shrimp production, constructing treatment wetlands, and restoring coastal ecosystems, while securing buyers for the 'Climate Smart Shrimp' produced (Figure 35). For small- and medium-sized farms, primary incentives to participate include access to capital and technical assistance, while large-sized farms, who often already have access

[31] https://www.sustainableshrimppartnership.org/

to capital and expertise, are more strongly incentivized by connections to sustainability-oriented buyers in North American and European markets who are willing to preferentially source responsibly produced shrimp. The CSS approach can realize climate change resilience and ada ptation benefits while also increasing production and profitability to meet development goals.

Accessing shrimp aquaculture as a sustained partner in mangrove restoration will increase both funding for restoration and expand the number and diversity of stakeholders conserving, protecting, and rebuilding natural infrastructure at scale, including eliminating pressures for deforestation. The project includes activities with Ecuadorian shrimp producers to expand the use of ASC/SPP certification, directly restore mangroves and to generate additional financial contributions for the Socio Manglar Program that will support community-based mangrove conservation and management beyond the implementation period of the project.

A key element to promote CSS is ensuring that adequate financing mechanisms exist to address the needs of shrimp farmers. On the one side, small- and medium-pond owners traditionally face issues when accessing formal investment channels due to a higher level of informality and less banking experience and readiness for the required assessment processes, while on the other hand, the banking system does not understand the challenges and paths to invest in CSS production systems.

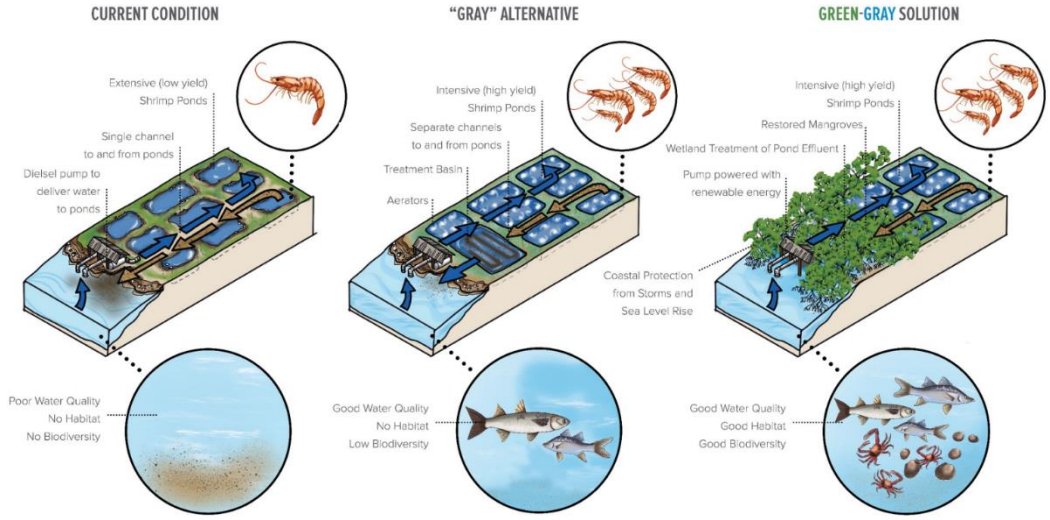


Figure 35. A visual comparison of the "gray" alternative to intensification (middle) versus applying a green-gray climate adaptation approach to sustainably intensify shrimp production using the CSS model (right).

An important barrier to access finance is the lack of technical knowledge within financial institutions about the industry and its sustainability pathways, reducing the possibility that the traditional banking system invests in farms that seek to transition to more sustainable models. Establishing partnerships that allow access to information, training and implementation of demonstration cases fills that knowledge gap so that the shrimp sector becomes more attractive and less risky for the financial institutions.

Shrimp price fluctuations are a key concern for most shrimp farmers. Small and medium-sized farms are especially sensitive to decreases in shrimp prices and are less able to sustain periods of low prices, meaning low prices often result in farm consolidation. Demand for certified shrimp is strong in North America and Europe – while price premiums are not always present, certification is often seen as a requirement to access markets. The market will determine the percentage of shrimp that is exported to different end markets.

About half of seafood is sold in retail markets (grocery stores) and half is sold in restaurants. The demand and sourcing preferences for restaurants is difficult to aggregate and synthesize given the large number of individual, non-consolidated restaurant businesses. Demand and sourcing preferences for retailers, namely grocery stores, are easier to assess as grocery stores are highly consolidated. >90% of all grocery companies in North America and 85% of all grocery companies in Northern Europe have public commitments to sell sustainable seafood, including certified shrimp. [32]

Price premiums for certified or certified+ shrimp can be elusive. Instead, market access via preferential sourcing are common incentives for farms to attain certification. For example, many retailers will not purchase shrimp unless it is certified, although they often don't pay a premium. A sourcing agreement, based on certified or certified+ shrimp production, can also increase a farmer's access to financing, as investors are more willing to make loans to farmers who have guaranteed markets for their products.
That is exactly what players such as the eco.business Fund do. The eco.business Fund is a US$390 million fund that provides financial services to financial intermediaries in Latin America, supporting the green economy transformation of the region. Both Ecuador and the aquaculture/shrimp sector are becoming a flagship of their work on supporting the transition of an industry to a more sustainable model. The fund has ambitious targets for the aquaculture sector in Ecuador, and to achieve those goals it helps financial institutions develop tools, skills and demonstration cases for key investments. The eco.business Fund trains banks on diverse technical and financial aspects, and it is also launching the Sustainability Academy, an online platform to provide access to education materials and tools on key sectors sustainability approach. Alliances with key stakeholders including CI and its model of CSS; ASC and SPP are critical to strengthen the content and scientific approach, and thus influence the target audience for those trainings.

Besides lack of knowledge, there are other important barriers to access finance, such as early-stage companies with unstable cash flows or lack of collateral to access traditional funding sources like the banking system. Whereas larger companies can successfully access finance, it is a challenge for small- and medium-sized companies. For example, in August 2022, Santa Priscilla, a large Ecuadorean producer, was able to obtain an IFC loan of US$45 million[33]. Investment funds can fulfill some of these gaps with a diversity of instruments between debt and equity that can adapt to specific needs and business stages. To fill the gap in access to funding sources, CI is developing a fund with a specific focus on supporting adoption of the CCS approach. The Climate Smart Shrimp Fund (CSSF)[34] will provide loan packages, supported by a technical assistance facility, that enable shrimp farmers to transition to more sustainable and efficient production systems while simultaneously restoring mangrove ecosystems. The initial

[32] https://www.packard.org/insights/perspective/from-company-commitments-to-collective-global-action-whats-next-for-our-sustainable-seafood-strategy/
[33] https://www.globalseafood.org/advocate/ifc-announces-45-million-loan-for-leading-ecuadorean-shrimp-producer/
[34] https://www.climatefinancelab.org/ideas/climate-smart-shrimp-fund/

objective is to create a US$100 million fund with a focus on supporting CSS in Indonesia and Ecuador. Pilot loan deployment of the CSSF is currently underway with one company in Ecuador.

5 Project Framework and Theory of Change

5.1 Current Conditions and Trends

Current trends and drivers of emissions and vulnerability are described in greater detail in preceding sections, but key points for the Theory of Change are summarized here for clarity.

Sea level rise (~12 cm by 2040 and 49-64 cm by 2100)[35], increased impacts of El Niño events, and augmented intensity and variability of precipitation due to climate change are projected to increase flood frequency, intensity and damages, threatening coastal infrastructure, settlements and economic activities.

Flood impacts are concentrated in recurring El Niño events and other extreme sea level events. SLR will magnify El Niño damages.

In addition to maintaining biodiversity and many ecosystem services, mangroves play a dual role both in reducing climate change vulnerability of coastal communities to flooding events, and in increasing carbon storage. Although mangrove areas are slowly recovering and increasing (+0.35% per year) primarily due to short-lived regulatory measures adopted in 2008, an average of 990 ha of primary mangrove forests are still felled each year. Areas under community management and PAs are gaining mangrove coverage while unprotected areas continue to have net loss of mangrove. At current rates and under the limited current interventions, it will take nearly 49 years to recover mangrove area to 1984 levels (~90% of original mangrove cover). Despite recovery of mangrove coverage, under current trajectories mangroves will continue to be a net source of emissions for decades to come (see Funding Proposal Annex 22 for GHG emissions calculations).

Nearly 96% of all mangrove areas (accounting for 91.3% of gross mangrove deforestation between 2008 and 2018) are concentrated in a subset of eight municipalities with a total population of 3.4 million people. With new and improved measures to protect and restore mangroves further protection would be achieved for vulnerable people.

Shrimp aquaculture accounted for US$6.2 billion in exports in 2022 (MercoPress, 2023), and shrimp farms are vulnerable to shoreline erosion and extreme sea level events. Shrimp aquaculture has also been directly responsible for 50.8% of mangrove deforestation over the last decade. The shrimp aquaculture industry has a strong vested interest in expanding mangrove coverage, because of their historical deforestation impacts, legal obligations, 'green' market requirements, investor interest and future benefits derived from the ecosystem services of mangroves, particularly flood control. Changing conditions create an opportunity for shrimp aquaculture operations to play a pivotal role in protecting and restoring mangroves. Other private sector actors, including investors and companies seeking to become carbon-neutral, create additional opportunities for private sector finance for mangrove conservation, improved management and restoration.

Challenges

Insufficient incentives and investments exist to sustain improved practices by communities that enhance climate resilience and reduce emissions: the conservation payments incentive program (the Socio Manglar

[35] https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool with 2100 range calculated based on the SSP2-4.5 and SSP3-7.0 scenarios

program) currently covers only 44% of active AUSCEMs and longer-term financing mechanisms are needed to sustain the Socio Manglar program.

Addressing illegal mangrove deforestation (excluding related to shrimp farms)

Community control and participation in conservation of mangrove areas, as well as national PAs, have proven effective tools for mangrove protection. However, the coverage of those mechanisms is still insufficient, and their sustainability insecure. Mangrove recovery under AUSCEMs and within PAs has had net coverage gains, while net losses continue in areas without these protections. Mangrove areas without community stewardship or protected-areas status total 36,186 ha (24.4% of total mangrove area), but account for 69% of all recent (2008-2018) mangrove deforestation. Although there has been mangrove recovery in unprotected areas, there was a total net loss of 770 ha in these areas between 2008 and 2018. Approximately one quarter of the areas under AUSCEM, established since 2000, have currently lapsed due to lack of support and technical assistance for legal proceedings and management activities, leaving these mangrove areas without effective protection. Even many current AUSCEMs are constrained by limited management capacities and lack of economic alternatives that could contribute to mangrove conservation and management.

Addressing deforestation related to shrimp farms

Prior to the development of this project, significant resources from the private sector had not yet been mobilized to support mangrove conservation and restoration. This sector, most notably the shrimp aquaculture industry, has had limited engagement with mangrove conservation, despite the role of mangroves in protecting their vulnerable coastal infrastructure and the increasing market demand for sustainable production. Increasing private-sector participation is constrained, amongst others, by lack of information about the benefits of mangroves, limited technical capacity to identify and adopt practices that restore or conserve mangroves, and in the case of small shrimp farmers, limited access to finance. There has been growing interest in sustainable practices in the shrimp aquaculture sector, but still less than 1% of all shrimp farms in Ecuador operate under certification schemes that include actions leading to climate resilience of coastal communities and emissions reductions objectives. As part of the project, the NCA will work with CI to roll out a national certification scheme, the Sustainable Shrimp Partnership, which includes a no-deforestation requirement, and to promote “Climate Smart Shrimp” production methods that includes mangrove restoration.

Governance, regulatory and enforcement barriers

Governance, knowledge of regulatory frameworks and enforcement are inadequate for protection and restoration of mangroves by public, private and community-based actors. Detection of mangrove deforestation often lags far behind the occurrence of events and usually depends primarily on ground-based observation from government agents and complaints filed by citizens. MAATE field staff are limited and there is poor coordination amongst overlapping government agencies (MAATE, VMAP, municipal governments, the Navy, etc.), which means that relatively few deforestation events are identified, and action taken. Despite the high rates of ongoing clearing of mangroves, only 13 judicial and administrative proceedings were processed for deforestation in 2011-2016, and of these only three had been resolved by 2017. The lack of effective enforcement and sanction has been emphasized by community stakeholders during the FPIC process of this project.

Overall, businesses, communities and local governments do not have information or access to technical support needed to adopt practices to reduce emissions and/or exposure to climate risks. Growing awareness of the importance of mangroves for the economies, populations and infrastructure of the coast has led to changes in public policies (including the Socio Manglar incentive program and legal requirements to restore mangroves), which has contributed to more recent net gains in mangrove coverage. Many key stakeholders, including the general public, are still lacking information about laws and regulations, the economic value that mangrove ecosystem services provide, and technical aspects of conservation, restoration and resource management.

Proposed project activities will address these barriers to achieve the overarching goal of the project.

Goal Statement: If local communities are provided with knowledge and resources for mangrove management and livelihoods development, and if the private sector and government actively collaborate on mangrove protection and restoration, and the enabling environment for mangrove protection is strengthened, **then** coverage and quality of mangrove ecosystems will be increased, resulting in reduced climate change impacts on vulnerable coastal populations, increased economic resilience, and reduced GHG emissions **because** healthy and more extensive mangroves reduce flood impacts and sequester carbon.

Outcomes and the project contribution:

Outcome 1. The area of mangroves under effective climate-adapted management is increased. The project will expand the mangrove areas under effective community management, support adaptation planning in existing PAs and strengthen management of other areas through support for improved land-use planning by local government and improved application of existing regulations on mangroves. The project targets 156,633 ha of mangroves under effective climate-adapted management by the end of the implementation period.

Outcome 2. Flood risks associated with climate change are reduced by expanding mangrove areas under effective climate-adapted management. The project will increase mangrove cover from reduced deforestation and restoration activities, which will result in reduced flood risk for an 89,600 vulnerable people.

Outcome 3. GHG emissions from deforestation are reduced and carbon sequestered by expanding mangrove areas under effective climate-adapted management, including mangrove restoration. Reduced deforestation and restoration activities will result in an estimated net reduction of 732,000 tCO_2e over the project implementation period and expected 4.6 $MtCO_2e$ over a 20-year project lifespan period.

Outcome 4. Institutional framework for mangrove protection and coastal planning is strengthened. Project activities will result in improved regulatory systems or incentives for climate resilience and their effective implementation at the level of the national government, nine subnational governments and 60 AUSCEM-holding groups.

Co-benefit 1. Biodiversity and ecosystem service benefits are increased. The increased forest cover from reduced deforestation and restoration will provide additional habitat for biodiversity (5,725 ha) and increase the ecosystem services from the area gained. While the project does not propose to try and directly measure this co-benefit (due to the complexity and methodological challenges involved), global estimates of the biodiversity ecosystem service value of one hectare of mangroves average US$21,100

per hectare per year (in 2018 prices) according to a recent review of 250 attempts at valuing the ecosystem services of mangroves[36]. However, see also Annex 3, which uses a more conservative estimate of the economic value of Ecuador's mangroves and the project.

Co-benefit 2. Economic resilience of coastal communities is increased. Project activities to secure mangrove management rights for local communities, including overfishing rights, improve livelihood activities and support small-scale community businesses will result in increased economic resilience for 41,500 people from coastal communities.

Co-benefit 3. Uptake of sustainable shrimp production practices is increased. The project will contribute to international and national initiatives to increase sustainability of shrimp production practices and to increase adoption of nationally and internationally recognized aquaculture standards and/or improved practices that include commitments to no deforestation covering at least 20,000 ha of shrimp farms.

Co-benefit 4. Economic value of fisheries for artisanal fishers is increased. The increased forest cover from reduced deforestation and restoration (5,725 ha) will provide additional habitat for fisheries areas and nurseries. Based on average estimates of catch, sale value and production, the additional habitat will increase the economic value of artisanal fisheries by US$12.6 million per year (see Annex 3 for fisheries value calculations).

Project Components and Project Results

Project Component 1: Mangrove areas under effective and climate-adapted management increased, including through community-based management (AUSCEMs) and protected areas implementing climate adaptation plans.

> **Output 1.1.** Reduced exposure to flood risk for vulnerable people and reduced GHG emissions from mangrove restoration are achieved by strengthening community-based management through AUSCEMs and PAs.
>
> **Output 1.2.** Improved livelihood activities and more economically productive community businesses enable local people to become more resilient to climate change and incentivized to participate in, and maintain, mangrove conservation and restoration.

Project Component 2: The private sector becomes a transformational agent for change by reducing GHG emissions and providing financial support to conserve and restore mangroves that increase climate resilience for other coastal populations.

> **Output 2.1**. Shrimp aquaculture farms adopt practices and production standards that require elimination of deforestation and active reforestation in coastal and mangrove areas.

[36] Getzner, M. and Islam, M.H. 2020 Ecosystem Services of Mangrove Forests: Results of a Meta-Analysis of Economic Values. Int. J. Environ. Res. Public Health doi: 10.3390/ijerph17165830

Output 2.2. Sustainable management of mangroves is improved through agreements with the private sector, including direct financial support for mangrove conservation and restoration.

Project Component 3: Create the enabling conditions for sustaining reductions in mangrove deforestation and increased mangrove restoration by strengthening governance, climate change adaptation strategies, coastal management policies, and legal enforcement.

Output 3.1. Decision making for mangrove management by national government agencies and local governments is based on generation and provision of accurate and up-to-date data on mangrove condition and socio-economic information on mangrove dependent communities.

Output 3.2. Legal and regulatory frameworks at local and sectoral level are harmonized and include climate resilience and mitigation strategies and enforcement.

Accelerating the rate of mangrove recovery at a pace commensurate with growing climate risk, after decades of deforestation, requires a coordinated multi-pronged approach, involving diverse instruments and stakeholders, to overcome key barriers, including:

- Gaps in coverage, legal recognition, and organizational capacity to ensure that proven community-based management strategies and PAs continue to sustain, conserve and restore mangroves.
- Insufficient incentives and investments for practices by communities and businesses that enhance climate resilience and reduce emissions.
- Insufficient access to financial incentives, both public and market-based, to incentivize communities´ continued commitment and private-sector action, particularly in shrimp aquaculture, to decisively drive a model of economic development that reinforces mangrove conservation and recovery.
- Businesses, communities and local governments lack information or access to technical support needed to adopt practices to reduce emissions and/or exposure to climate risks.
- Lack of enforcement that allows the drivers of mangrove deforestation (Shrimp Aquaculture sector, small scale land clearance for crops or pasture) to continue.
- Weaknesses in governance, including gaps in knowledge of legal and regulatory instruments, limited institutional capacity, poor inter-institutional coordination and lack of articulated stakeholder engagement, allow for continued illegal destruction of mangroves and hinder proactive planning, enforcement and policy formation.
- Information for climate resilience is deficient and poorly integrated into decision-making and planning across all structures and scales of governance.

The interventions also need to be designed in a way that minimizes potential technical risks that could arise from the proposed interventions. The main technical risks to address within the design of technical interventions are:

- Some community members might not benefit equally from the project, exacerbating inequalities; and,
- Poorly implemented project activities could create tensions between different stakeholders who may have conflicting interests regarding mangrove protection.

In addition, socio-political disruption, health risks and natural disasters could cause interruptions to activities and changes in local, regional or national priorities.

The project theory of change also relies on the following assumptions (all are important but the most important have been highlighted in bold):

- **Community associations feel sufficiently incentivized by project activities to engage in mangrove conservation and restoration.**
- When community associations have resource rights over mangroves, they are more likely to implement sustainable practices.
- **Equipping community associations with the necessary knowledge and skills for mangrove management and restoration will enhance their ability to implement effective conservation practices.**
- There are sufficient business opportunities for mangrove community associations that can be developed as part of incentives for better mangrove management.
- **Exposure of private sector actors to market drivers and climate risks motivates increased investments in mangrove protection and climate smart practices.**
- Commercial bank lending rates remain at levels that would not discourage investment in sustainable aquaculture practices.
- Local governments will make use of improved data availability in their decision making and land-use planning.
- **Government agencies will at least have their current resources and capacities to support the project.**
- **There will be political will to strengthen the application of legal and regulatory frameworks during and after the end of project implementation.**

Figure 36. Theory of Change Diagram (goal, outcomes, outputs and activities)

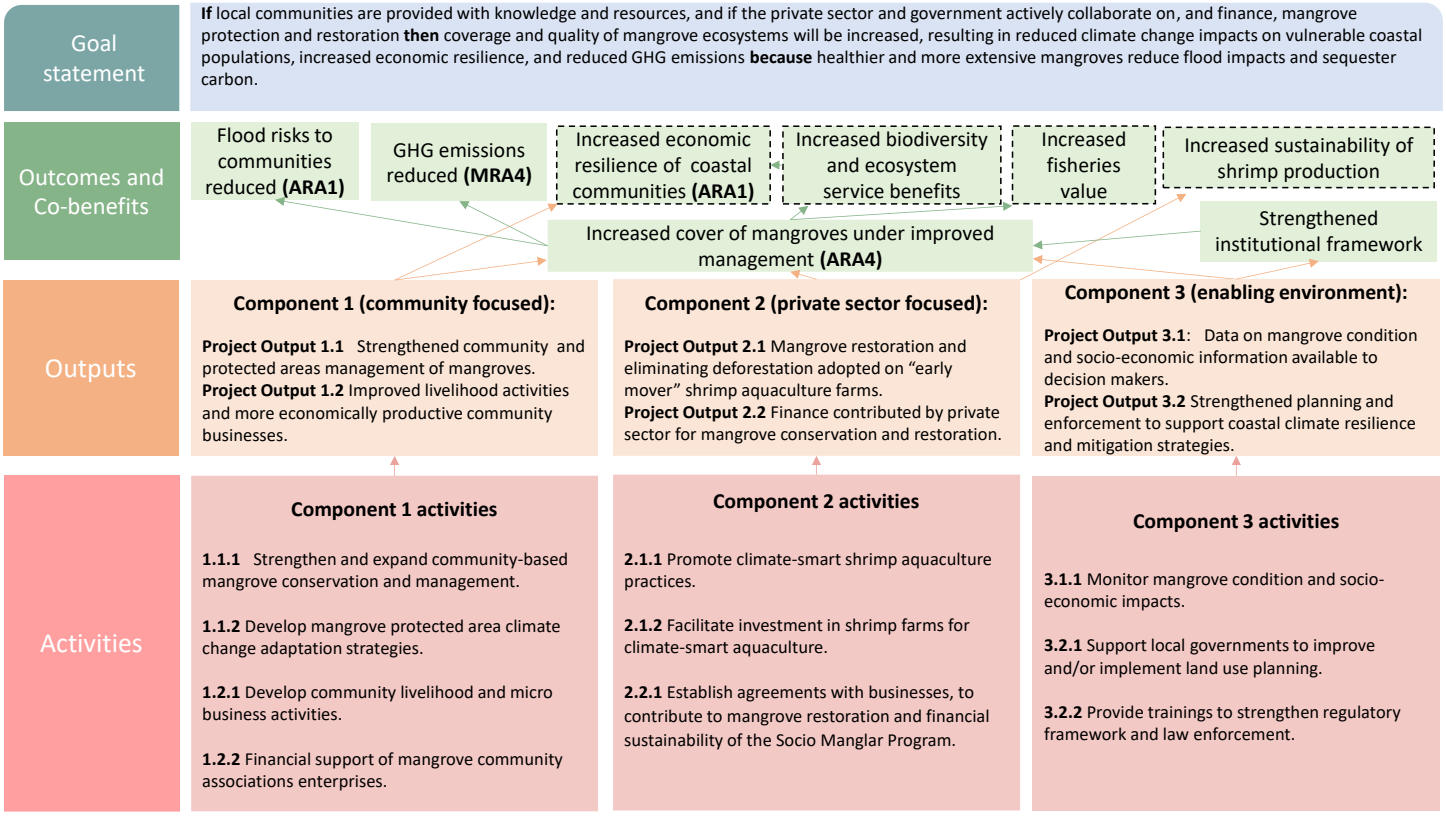
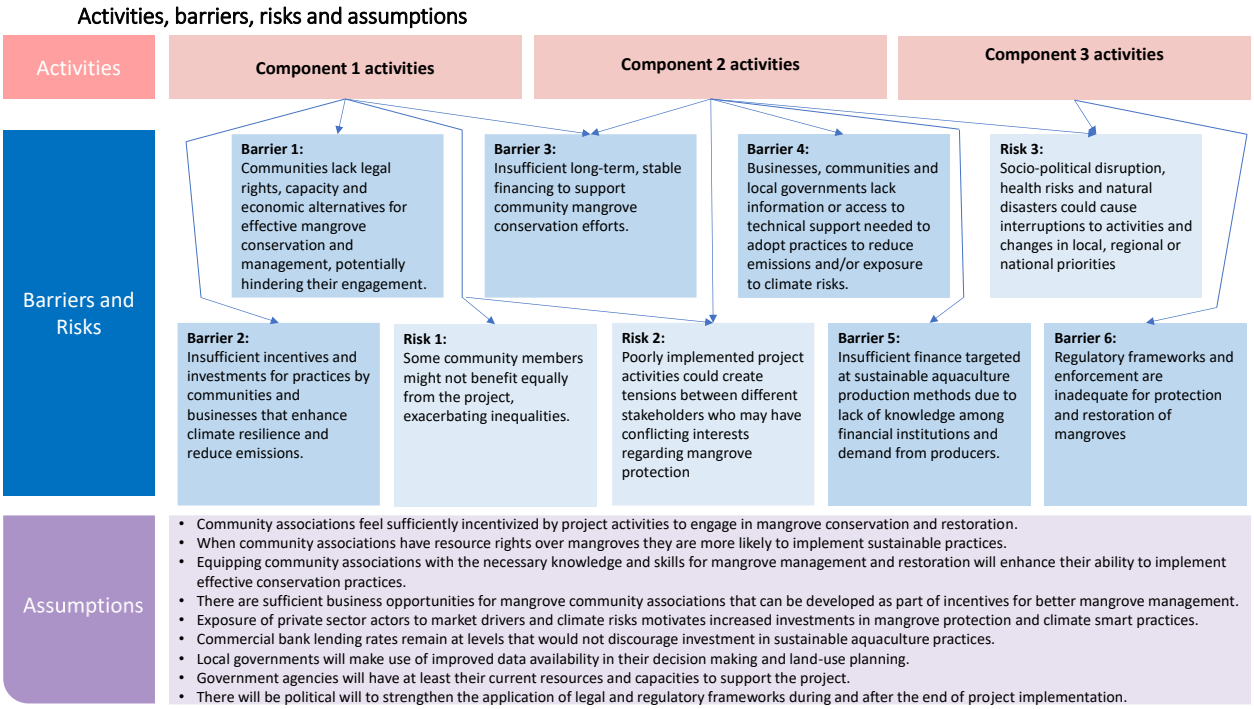


Figure 37. Theory of Change Diagram (barriers, risks and assumptions)



5.2 Options Assessment

The outcomes and results described in the Theory of Change were identified from an array of potential options to address vulnerability to climate change impacts, especially coastal flooding, and for reducing deforestation risks to mangroves, affecting both GHG emissions and adaptation.

A. No change

Current conditions, as described in section 2, if continued would generate emissions from gross deforestation and limit the extent of mangrove coverage protecting vulnerable communities from flood risk and other climate-change impacts. Historic baseline rates of mangrove deforestation of the 2008-2018 reference period may also be conservative and underestimate future rates of net deforestation because this period coincided with the adoption of a suite of new mangrove protection measures including the promotion of AUSCEMs and Socio Manglar incentive payments and an increase in enforcement action against the shrimp farming sector, which may not continue without further consolidation.

B. Enhanced 'gray' infrastructure

Conventional built infrastructure, in the form of seawalls and rock breakwaters, can protect coastlines but is often cost prohibitive and can create unintended negative impacts, such as erosion to adjacent stretches of coastline. Conventional engineered structures have a projected useful life, meaning after a certain time they will deteriorate and no longer provide the service they were designed to perform. Built structures are also static, they do not adapt as environmental conditions change, nor are they able to recover, or grow back, after an

environmental disturbance. Funding and implementing regular operation and maintenance of structures such as seawalls and levees is critical to guarantee their long-term performance[37].

The estimated cost to construct one meter-wide seawalls in Ecuador is estimated at US$0.95 million per kilometer[38], with as estimated useful life of 30 years. Using gray infrastructure only to reduce flood risks in coastal Ecuador is cost prohibitive and would require establishing institutional mechanisms to ensure long-term performance and eventual replacement that currently do not exist within local and regional government structures of vulnerable coastal communities.

C. Resettlement of vulnerable populations

Currently, 198,000 people live in coastal areas at high risk of flooding (including both coastal and riverine flooding) according to the National Risk Management Service, SNGR. Based on the modeling approach used as the basis of this project[39], 22,400 people are estimated to be at risk of coastal flooding annually, even with current mangrove cover. Re-settlement of a population of this magnitude, including both rural and urban families, would entail enormous economic and social disruption. This option would also still assume that improved measures to protect existing mangroves are taken.

D. Reduce deforestation rates of remaining mangroves

Halting loss (gross deforestation) of mangroves provides multiple benefits in a cost-effective manner. With 990 ha of ongoing gross deforestation annually, reducing emissions, enhancing carbon stocks and increasing coastal protection can be achieved through a variety of measures:

a. ***Community Stewardship.*** As previously noted, community stewardship under AUSCEMs have been demonstrably effective in reducing deforestation, and a significant proportion of mangroves lie either outside any form of protection or are covered by AUSCEMs that are either inactive or unsupported by Socio Manglar incentive payments. Increasing the coverage, improving the governance, and enhancing the economic viability of community stewardship can contribute to expanding, sustaining and improving the performance of AUSCEM (see 4.2.3).
b. ***Strengthened PAs.*** 41% of mangroves lie within PAs boundaries and these have been demonstrated to be effective in reducing deforestation (see 4.2.3). Ecuador has relatively limited scope for expansion of existing, or creation of new, national PAs, requiring complementary community, governmental and private-sector approaches. However, PAs management is also in need of improvement to ensure more systematic incorporation of climate-change considerations into management planning.
c. ***Governmental capacity***. By definition, nearly all mangrove deforestation is currently illegal. Enforcement action is lacking, often despite local community demands for action. This limited enforcement is a function of limited knowledge and capacity by key agents

[37] For planning level estimates, assume annual operation and maintenance costs equal to 1% of the total construction cost

[38] WRI Aqueduct Floods (beta version). Accessed September 2020. Cost incorporates a country's purchasing power parity.

[39] Based on the Menendez et al., 2020 model. See Appendix 6

with enforcement responsibility as well as delayed and insufficient data resources to identify and document illegal activity. Despite the importance of enforcement and sanctions, prevention is generally considered of primary importance. Mechanisms for minimizing deforestation risks include better data and monitoring to anticipate threats, proactive planning to protect mangroves as well as to limit development in areas of increasing climate-change driven flood risk.

E. Restoration of mangrove areas

While, as noted above, prevention of mangrove destruction provides what is likely the most attractive ratio of benefits to costs, in certain areas where mangroves have been destroyed, their restoration is the best means to ensure protection of vulnerable populations and infrastructure. These include ocean-facing buffers for settlements and shrimp farms and areas where mangrove cover can contribute to altering sediment dynamics impacting shipping and ports. See section 4.3

F. Private sector engagement

Private-sector activity, most notably shrimp aquaculture, has been the primary cause of mangrove loss over the last 50 years, and continues to be the single largest contributor to gross mangrove loss. Mangrove conservation cannot be achieved without engaging the private sector in some capacity. Regulatory and market changes are creating shifts in motivations and behavior, creating possibilities for a sector-wide shift towards a deforestation-free shrimp supply chain from Ecuador, leveraging additional private investment and creating collective pressure for change.

Table 26. Summary of Options Analysis

Option Description	Potential for Application	Advantages	Drawbacks
1. No change		No investment required	Increased vulnerability of people and ecosystems as detailed in Section 2.
2. Enhanced built infrastructure	Very low	Well-established metrics to estimate risk reduction benefits	High cost, requires long-term operation and maintenance, and eventual replacement.
3. Re-settlement of vulnerable communities	Very Low	Directly targets vulnerable populations.	High cost. Social disruption. High environmental and social safeguard risks. Difficult to implement and likely to suffer from reversal from new informal settlements.
4.a Reduce deforestation: Community stewardship	High	Multiple benefits. Integrates income generation opportunities and employment that can	Vulnerable to failure if grassroots capacity is insufficient, internal conflict

		enhance resilience and long-term sustainability. Cost-effective.	arises, or economic benefits seen as insufficient.
4.b Reduce deforestation: Protected areas	Medium	PAs have proven effective at reducing deforestation. Multiple benefits. Relatively low cost.	Limited scope for expansion of PAs. Potential for conflict with local resource users if not properly integrated.
4.c Reduce deforestation: Governmental capacity	High	Creates framework conditions for all actors, allows for long-range planning. Leverages public finance. Can integrate multiple public social and environmental benefits.	Vulnerable to changes in political leadership and discontinuity of public finance.
5. Restoration of mangrove areas	Low-medium	Targeted intervention for areas with deficient coastal protection.	Relatively high cost. Long-term accretion of benefits as compared to mature mangroves.
6. Private sector engagement	Medium-High	Leverages investment. Harnesses key deforestation driver to contribute to solutions.	Illegal and informal outliers are less concerned with reputational and enforcement risks, continue to perceive benefits from mangrove deforestation to site new shrimp farms

Based on the above analysis, the proposed project has been designed to accommodate multiple options as a blended approach, centered on natural climate solutions. While additional gray-infrastructure investments and possible resettlement of the most vulnerable communities may need to be implemented through other public investments, maintaining and expanding mangroves is an effective means to contribute to key goals and would ultimately be complementary, not substitutive, of such investments.

5.3 Selection of Project Priority Areas

Eight municipalities with the highest potential for achieving mitigation and adaptation objectives related to mangroves were selected as priority areas for project interventions. These municipalities include 95.8% of total mangrove areas and 71% of the total population at high risk of annual flooding of Ecuador's coastal mangrove area.

Six criteria were used to prioritize and select the GADs, with a prioritization threshold established for each criterion.

1. Total remaining area of mangrove in 2018, in hectares; priority is given to those GADs whose mangrove area is greater than the median of all GADs analyzed (1000 ha for municipalities and 500 ha for parishes).
2. Annual rate of gross mangrove loss between 2008 and 2018 (ha). A minimum threshold for prioritization of 40 ha/year was considered.
3. Annual rate of gross mangrove loss between 2014 and 2018, as a measure of the most recent dynamics of change. A minimum threshold for prioritization of 40 ha/year was considered.
4. Remaining area of mangrove in 2018 (ha); without a conservation status (Protected Area or AUSCEM). A minimum threshold for prioritization of 200 ha was considered.
5. Coastal population at high risk of annual flooding. A minimum threshold for prioritization of 1,000 people in high-risk flood areas (SNGR 2018) was considered.
6. Percentage of the shrimp ponds of each GAD at high risk of annual flooding. A minimum threshold for prioritization of 90% was considered.

The GADs selected by the first criterion were scored according to the second criteria. Those properties whose values were found to be above the threshold received a score of one. The final order of prioritization was given by the sum of these partial scores. The GADs with total scores greater than three points were selected.

5.4 Outcomes and Project Results

5.4.1 Overview

Mangroves provide essential functions for coastal protection and reduction of flood risks for vulnerable populations with a high incidence of poverty as well as for vital economic sectors for Ecuador's economy, principally shrimp aquaculture, 97% of which are small and medium producers. Mangroves also provide a suite of livelihoods and other ecosystem services making their conservation and restoration multi-benefit, no-regret approaches to addressing climate change.

Reducing gross deforestation rates of mangroves due to shrimp farming by at least 50% and restoring at least 4,850 ha of mangroves are the principle direct strategies for generating flood-protection benefits for 89,600 people, livelihoods benefits and economic resilience for 41,500 people from mangrove dependent communities, achieving net emissions reductions 4.6 $MtCO_2e$ over 20 years (732,000 tCO_2e during project implementation), and integrating climate-change adaptation strategies into the local governance structures and policy instruments for 3.4 million people.

The project will focus on a combination of measures to reduce mangrove deforestation and increase reforestation, centered on community-based conservation approaches, increased private-sector engagement and improved government agency and public-sector capacity centered on three main Components and six project Outputs.

Component 1 focuses on actions to increase both the area of mangrove under protection by local community stakeholders and the quality and effectiveness of management for these areas, as well as national PAs, to reduce flood risks and provide multiple benefits.

Component 2 focuses on engaging the private sector, particularly shrimp aquaculture, to become a transformational agent for change, reversing its previous role as an agent of mangrove loss, by integrating climate-smart production practices to reduce pressures for mangrove deforestation as well as catalyzing new sources of financing for long-term sustainability.

Component 3 focuses on creating the enabling conditions, through improved governance and the generation of timely, targeted information, which are the scaffolding supporting mangrove conservation, planning, regulation and benefits to the broader coastal and national communities.

Each component addresses critical barriers; none is sufficient alone to produce the desired climate outcomes of maintaining mangroves to reduce vulnerability, especially to coastal floods, and to reduce emissions. Local action by communities requires responsive public institutions, reliable information, accessible finance and constructive relationships with the private sector. For the private sector, realizing sustainable growth opportunities and contributing to recovery of mangroves cannot be achieved in atomized fashion, but requires clear consistent, regulation as well as supportive government action to position the country's shrimp sector as a pioneer in climate-smart production.

5.4.2 Outcomes' contribution to GCF Integrated Results Management Framework (IRMF)

A detailed description of project impacts and outcomes with regards to the GCF IRMF is included in sections E.3 and E.4 of the Log Frame within the Funding Proposal. The project outcomes will be measured according to the core indicators of the GCF IRMF and the project's contribution to the IRMF indicators is briefly summarized here:

ARA1 Most vulnerable people and communities
All three components, by working synergistically to conserve and expand mangrove cover as a means to reduce flood risk, contribute to reducing the impact of coastal flooding for 89,600 vulnerable people, 68% of whom live in poverty. Component 1 specifically targets work with 41,500 people whose livelihoods directly depend on mangroves, primarily through artisanal fisheries. Avoided loss of lives is difficult to estimate *ex ante*, and is based on modelled values for economic benefits of mangroves for flood protection in Ecuador. Project activities, by increasing mangrove cover during the project lifespan, will result in avoided loss of economic assets of $280 million per year due to flood protection benefits of mangroves.

ARA4 Ecosystems and ecosystem services
All three components of the project, with convergent activities reinforcing sustainable management, conservation and restoration of mangroves, contribute to improved resilience of 156,633 ha mangrove ecosystems, by ensuring maximum contiguous coverage and sustainable practices that do not undermine the ecological and structural integrity of the ecosystem.

MRA4 Forestry and land use
All three components converge on a primary goal of reducing mangrove deforestation from shrimp farming by 50% from baseline levels. Component will result directly in 4,850 ha of mangrove reforestation in priority areas, which also reduce risk for populations in their areas of influence. These combined mangrove-based mitigation activities will result in 4.6 $MtCO_2e$ in emissions reductions over 20 years (732,000 tCO_2e during the project implementation period).

Degree to which GCF investments contribute to strengthened institutional and regulatory frameworks for low-emission climate-resilient development pathways in a country-driven manner

Strengthening the institutional and regulatory frameworks for low-emission climate-resilient development is the primary goal of Component 3, working particularly with local (municipal and parish governments) as well as national-level institutions responsible for planning, regulation, enforcement and information. Nine subnational governments and a variety of national government institutions (e.g., MAATE, Judiciary, INOCAR) will be strengthened through project activities, including training, regulatory reform, technical support for planning, and improved inter-institutional coordination. At the grassroots level, 60 mangrove-based associations will also benefit from training and technical support to strengthen their capacity for climate-responsive planning and development. The project also addresses current barriers and deficiencies by supporting the capacity of government entities to monitor and report mangrove forest cover and carbon stock information to enhance national mitigation efforts.

All three components contribute to maintaining and expanding mangrove coverage as a Fund-supported strategy to reduce flood risks through mangrove protection for 89,600 people.

Three million, four hundred thousand people living in the eight priority municipalities will be reached as indirect beneficiaries by risk reduction measures established as part of PDOTs, public investments and other policies and programs adopted by these subnational governments.

5.4.3 Project Outcomes, Results and Activities

Component 1: Mangrove areas under effective and climate-adapted management increased, including through community-based management (AUSCEMs) and protected areas implementing climate adaptation plans.

Legally recognized, community-based stewardship, despite having demonstrated its effectiveness in protecting mangroves, still has significant gaps in coverage that can be resolved through outreach and assistance in organizing, planning and a strengthened relationship with the government programs that recognize AUSCEM. For existing AUSCEM associations, ensuring that they have the organizational capacity to sustain their stewardship and renew their management plans and legal agreements is critical to ensuring that effectiveness of management is maintained.

Community-based mechanisms such as AUSCEMs are also frequently economically precarious. Generating stronger local economic benefits based on mangrove conservation, in the form of both public incentives (from the Socio Manglar Program), finance for restoration activities, and local sustainable enterprises and livelihoods activities is indispensable to ensuring that sustainable management and conservation of mangroves is economically viable to local communities and contributes to dignified, equitable livelihoods.

Restoration of 4,600 ha of mangroves under community stewardship as part of this component will contribute to enhancing mangrove coverage and associated benefits.

By ensuring that AUSCEMs and national PAs grow both quantitatively (in area covered) and qualitatively, in terms of robust management that integrates climate-change resiliency, mangrove areas will continue

to provide broad flood-protection benefits for an estimated 89,600 vulnerable people in their area of influence, as well as directly benefiting communities who are dependent on mangrove resources.

For all Component 1 activities, CI as EE will lead work in the south (Guayas and Jambeli) and will enter into a sub-grant agreement with PUCESE (Pontifical Catholic University of Ecuador Esmeraldas Extension), which will lead work in the two estuaries in the north (Cayapas Mataje and Muisne Cojimies).

Output 1.1 Reduced exposure to flood risk for vulnerable people and reduced GHG emissions from mangrove restoration are achieved by strengthening community-based management through AUSCEMs and PAs.

Activity 1.1.1 Strengthen and expand community-based mangrove conservation and management to reduce deforestation and increase mangrove restoration.

Sub-Activity 1.1.1.1 Host trainings and exchanges to strengthen governance capacity and planning of existing AUSCEMs

PUCESE will lead work in the two estuaries in the north (Cayapas Mataje and Muisne Cojimies) and CI in the south (Guayas and Jambeli).

CI and PUCESE will provide training, exchanges, and targeted material support as key tools to strengthen the inclusive governance of existing AUSCEM associations, focusing on a variety of topics and tools that will empower these associations to better protect mangroves at risk of deforestation, enhance their livelihood benefits and adapt to climate risk. As a result, at least 60 associations, representing 4,596 families (24% with women head of households), will have stronger human, organizational and operational capacity reflected in Management Capacity Assessments and the effective maintenance or renewal of AUSCEM agreements.

Existing AUSCEMs will receive ongoing technical assistance from CI or PUCESE for the management, renewal and reporting of their agreements with the MAATE (Undersecretary of Natural Heritage), including support for preparing semiannual reporting to MAATE and development and/or updating of management plans for the mangrove areas under their responsibility. In each of the southern estuaries, CI will have two project staff: one Mangrove Specialist and one Social Specialist responsible for daily activities in the field. For the two northern estuaries, PUCESE will employ a Project Coordinator, a Mangrove specialist, a Social Specialist and 10 community agents to support work in the field.

CI and PUCESE will provide training sessions in the field with all association members and the fishers' spouses interested in being part of the trainings[40]. For the leaders of the associations, follow-up sessions will be implemented to reinforce knowledge. Additional meetings involving multiple associations will take place in the capital cities of the provinces (Esmeraldas, Guayaquil and Machala). A total of 38 meetings with AUSCEMS have been planned from Year 1 to 6 (see Annexes 4 and 5). The key topics for the training are:

[40] There is one association in Jambeli Estuary that only has women as active members, the others are mainly formed by men.

- Leadership, understanding of the terms of the agreements, management activities of the AUSCEMS, the inclusion of new representatives of the AUSCEMS, reporting to the MAATE (Undersecretary of Natural Heritage), taxes and reporting to the tax authorities.
- The inclusion of women, youth, and other vulnerable groups.
- Adaptation strategies in the mangrove areas, rotation of fishing areas, and closed seasons.
- Safe operation and management of equipment used as part of AUSCEM management to reduce deforestation including boats and engines, control and surveillance during fishing activities, use and maintenance of GPS and other equipment.
- Conflict management between members and with other organizations such as shrimp farmers, local authorities, etc.
- Complaint process for cases of mangrove deforestation and degradation by using on-line and mobile applications for reporting. How to draft reports and complaints for MAATE. Procedures and mechanisms for coordination with MAATE (Undersecretary of Natural Heritage), VMAP and the Navy (Oceanographic and Antarctic Institute of the Ecuadorian Navy - INOCAR).

Trainings in adaptation measures for better management of the mangrove areas will be supported through field visits from the Adaptation, Mitigation and Gender Specialists.

Besides training, CI and PUCESE will organize fishermen-to-fishermen exchanges with the AUSCEMs that are longer established, have better management in place and strategies already under implementation. These peer exchanges will occur once a year in Years 2-5 and will be focused on different topics: management practices, restoration, gender, productive diversification and commercialization, monitoring, and adaptation measures. Annual exchanges between women leaders within the communities managing mangroves will also be organized in Years 2-5. All the exchange visits will contribute to both the activities in A1.1.1 and those in A1.2.1.

To ensure that the AUSCEMs can carry out their mangrove management and protection role, CI will provide equipment to support community patrols, threats, and environmental monitoring and to assist with reporting infractions. To this end, the associations will be provided with basic monitoring equipment (for measuring fish sizes as part of mangrove fisheries monitoring), GPS and demarcation signage.

Sub-Activity 1.1.1.2 Expand areas under active AUSCEMs

Mangrove areas without AUSCEMs are at high risk of deforestation and this sub-activity is designed to increase community protection of mangroves. The areas prioritized for expansion of AUSCEMs are those that are most likely to contribute quickly to the project's deforestation reduction targets because they have high threat, larger areas with good existing or potential governance structures and areas most likely to shield human settlements from coastal flooding. CI and PUCESE will support AUSCEMs that have currently lapsed with MAATE to renew their agreements (13,000 ha). In addition, for 10,000 ha of mangroves not yet under AUSCEMs, CI and PUCESE will support community associations to establish new AUSCEM agreements in close collaboration with MAATE (Undersecretary of Natural Heritage) for the selection of the new areas and the enforcement of the authority in the field. Technical support will be provided to the

community associations to develop the management plans and legal documents needed for the AUSCEM application process and to undertake a community consultation process that ensures FPIC. For these activities, PUCESE will lead work in the two estuaries in the north (Cayapas Mataje and Muisne Cojimies) and CI in the south (Guayas and Jambeli). In each estuary there will be one Mangrove Specialist and one Social Specialist that will be responsible for field activities. These activities will start in the second year and continue until the end of Year 5.

In the case of the estuaries in Cayapas Mataje, there are already 15 local associations that are interested in renewing their AUSCEMs agreements. Those associations represent 2,588 people and cover 13,383 ha. In the case of Jambelí there are 588 ha managed by local associations interested in accessing AUSCEMs and in Guayas, 2,903 ha.

Once AUSCEMs have been renewed or constituted, they will receive training and technical support as described in Sub-Activity 1.1.1.1

Sub-Activity 1.1.1.3 Expand areas covered by Socio Manglar incentives

CI and PUCESE will also provide technical assistance to current and new AUSCEM groups to prepare and apply for Socio Manglar Incentives, with the aim of expanding coverage from the current baseline of 33,467 ha of mangroves under 25 AUSCEMs receiving incentive payments to over 62,243 ha during the course of the project. In preparation for the application process support will be provided to develop an investment plan and financial accounting training will be provided to ensure adequate capacity for managing Socio Manglar funds (including verification that necessary bank accounts and legal documents are in place). For successful applicants, CI and PUCESE will provide follow-up training for the beneficiaries of Socio Manglar incentives (leaders and members of associations) on budgeting practices and on requirements for monitoring and reporting to MAATE. Two trainings per year will be organized by CI in Years 2-5. The trainings and technical support will also include diversity, equity and inclusion trainings with a particular focus on gender, governance and decision making, accountability, financial planning, tax reports and legal procedures for the associations and models for investing the incentive in economic alternatives.

This sub activity will take place in Years 2-5 of the project and PUCESE will lead work in the 2 estuaries in the north (Cayapas Mataje and Muisne Cojimies) and CI in the south (Guayas and Jambeli). The Mangrove Specialist and the Social Specialist will be responsible for daily activities in the field. This sub-activity will be developed in close coordination with the MAATE Socio Bosque/Socio Manglar team in the field and in the national office. This is an important strategy of the intervention to ensure the sustainability of the activities over time. The expansion of this incentive program will scale in accordance with available financing from public and private funding as described under Project Result 2.2.

Sub-Activity 1.1.1.4: Restoration of Mangrove Areas within AUSCEMs

GCF funding (targeting 4,600 hectares restored) will be invested to cover costs of mangrove restoration with AUSCEMs' involvement, which will be achieved through a combination of grant agreements signed with the associations and direct contracting of service providers for some restoration activities. The grant agreements cover the costs of nurseries, planting material, tools and labor. In addition, CI and PUSCESE will support training, monitoring and technical follow-up.

In addition, the project will support training, monitoring and technical follow-up. This will be done from Years 2 to 5 and with the support of the restoration specialist and the social technician based in each estuary. The northern estuary will be monitored by the PUCESE team, and the southern estuaries will be monitored by CI.

Details of the process for identifying priority areas for restoration are provided in Appendices 3 and 4.

Activity 1.1.2 Implementation of mitigation and adaptation strategies in 64,913 ha of mangroves located in PAs.

Sub-Activity 1.1.2.1 Integrate climate-change scenarios into planning of PAs and local management strategies.

Currently PAs do not have enough human nor financial resources to effectively implement conservation and management actions nor to include adaptation or mitigation practices. Well managed mangrove PAs have lower deforestation and therefore lower GHG emissions than unprotected areas. Improving PA effectiveness can further reduce GHG emissions from loss and degradation of the areas and increase new carbon sequestration through active restoration activities and natural mangrove recovery. Mangroves themselves are potentially vulnerable to climate change and therefore PA managers need to ensure that they are managing the PAs consistent with promoting ecosystem resilience. For example, one issue with SLR is the need for mangroves to be able to expand landward. Ensuring that there is space to do so could require management action in surrounding habitats. PAs have usually included inadequate adaptation practices in the management plans, so working to improve the planning and implementation of climate adaptation actions is important.

CI and PUCESE will work with MAATE staff paid with MAATE in-kind co-financing in four PAs – Manglares Cayapas Mataje, Manglares Churute, Manglares El Salado and Manglares Estuario des Rio Muisine – which are the PAs with the largest area of mangrove and the most deforestation (in terms of area), and therefore have the highest potential for further reductions in deforestation. CI, PUCESE and MAATE staff will work to integrate climate-change into planning instruments (management plans and annual operating plans) at each of the PAs. In the first year of the project, workshops will be organized to identify the conservation objectives and the specific climate change threats that each PA faces. During the second year of the project, the partners will develop assessments of each PA management plan, that will include recommendations for climate resilience and adaptation and identify strategies and actions with MAATE staff and local stakeholders. The assessments and recommendations are intended to be integrated into updated PA management plans at their next update (typically management plans are updated every five years but the timing that this will happen differs between the different PAs). These assessments will be developed under service agreements through a competitive bid process. During Years 2 and 3, twice-yearly training events will be developed in in each of the PAs to make PA managers aware of climate change risks and vulnerabilities and how to explicitly incorporate climate change adaptation into MPA management plans and objectives.

As part of Component 3, CI will review the vegetation cover information developed in Year 1 (Sub-Activity 3.1.1.2) and identify key deforestation hotspots. In coordination with MAATE, CI will

implement two workshops for PA staff per year to enforce the knowledge on the legal process for deforestation penalties (linked to component 3). In the third year, CI will work on the PA designs and will support the development of adaptation plans in each of the PAs. Finally, CI will support the enforcement of management practices through trainings in each PA. Management strategies will be designed and implemented at different scales, such as biosphere reserves and bio-corridors, that integrate conservation and sustainable development in mangrove areas, especially in border areas. Management of PAs to reduce deforestation will also be strengthened by improving staff training and providing equipment for threats monitoring, enforcement, and community engagement, including monitoring equipment such as data loggers, gear for underwater surveys, software and computers to ensure monitoring in line with the climate adapted management plans and analysis of information collected. This equipment will be managed by PA staff, with resources from the national environmental fund (FIAS) covering costs of operation and maintenance.

Project impacts and learning at these four PAs will be amplified through the national network of PAs (*Red de Areas Marinas y Costeras Protegidas del Ecuador*). PAs and PA networks need to be adaptively designed and managed to address altered coastal and oceanic conditions and habitat shifts due to climate change, which may affect future boundaries, locations, and sizes. Networks help reduce risk and promote resiliency. A network analysis and action plan will be developed in Year 3. For this activity, CI will work closely with the Undersecretary of Natural Heritage and the provincial offices of MAATE.

In subsequent years, knowledge on the design, implementation and monitoring practices will be presented to the PA Network to amplify action. For this, CI will hold a workshop in Year 4 with all the MPAs of the network, produce and distribute guidelines on how to integrate climate change into management plans and organize activities with local associations to highlight the importance of the topic. The PA network is critical to maintaining climate change resilience and rebuilding ecological and social resilience.

Output 1.2. Improved livelihood activities and more economically productive community businesses enable local people to become more resilient to climate change and incentivized to participate in, and maintain, mangrove conservation and restoration.

Activity 1.2.1. Technical and business development support to mangrove community associations, with an emphasis on women, youth, and other vulnerable groups.

Sub-Activity 1.2.1.1. Technical and business development assistance to 20 mangrove community associations for development of early-stage enterprises and livelihood activities, with an emphasis on women, youth, and other vulnerable groups.

By supporting mangrove dependent communities through groups formally linked to mangrove conservation through AUSCEM, ongoing conservation and stewardship can be made economically viable, with improved incomes reinforcing conservation, climate change mitigation and resilience objectives. By improving the economic productivity of community enterprises, the value of mangroves to the communities is also increased and this creates incentives for mangrove conservation. Increasing incomes to communities increases their resilience to climate change

shocks and provides more opportunities to adopt adaptation measures. CI and PUCESE will provide support to at least 60 community associations linked to protection of mangroves to design and implement business plans and strategies, including strategies for improving enterprise governance and administration, access to finance and to markets for more resilient livelihood strategies. PUCESE in the Northern estuaries and CI in the South will lead provision of technical support to 20 community associations from Year 1 of the project, with additional technical capacity provided through specialist consultants to address:

- Providing technical assistance to fishermen to improve practices and strategies for managing fisheries such as shellfish and crab, including options for diversification of fisheries. Activities will include four workshops with associations per year per estuary in Years 2-6 and four exchanges between groups to promote dissemination and replication of good practices;
- Technical assistance to groups of women in fisheries, activities will include annual exchange visits for women leaders in Years 2-5 (combined with exchange mentioned in Activity 1.1.1). Support to improve safety during extraction, marketing strategies and strengthening of productive aspects;
- Market study to identify how to shorten the connection with markets, access better prices, improve packaging and process products according to market preferences (to be conducted by a consultant);
- Direct technical assistance for market access, training in processing, direct sales and analysis of market options; and
- Identification / strengthening of local entrepreneurial options that allow for productive diversification, for example in ecotourism, agriculture, handicrafts, and hospitality.

For these activities, the estuary-based CI sustainable production specialist and the social specialist will work directly with the associations.

The main strategy of this Sub-Activity is focused on adding value to mangrove-dependent fisheries products. Product quality and food safety will be enhanced by monitoring cold chains, classification and selection of product sizes and classes according to market requirements.

Other community economic activities not directly related to seafood products will also be supported to enforce resilience of local communities and diversify income sources. These initiatives will receive technical support from CI, market analysis and study visits to other initiatives for one-to-one training. Examples of other community enterprises that could receive technical support, if requested by communities, include:

- Some organizations are currently working with new products obtained from mangroves, with support from non-governmental organizations and local universities. For example, these include extraction of mangroves, handicrafts, medicinal uses of mangrove botanicals and construction material based on the use of shell waste.
- Tourism and ecotourism activities are also present and/or promising in some mangrove areas. Some mangroves in ecological reserves receive thousands of visits annually, for educational, research and recreational purposes. In the Gulf of Guayaquil, Muisne and Jambelí Estuaries, tours are guided by community members, with boats, exhibitions and demonstrations of the extraction and collection process for crabs and shellfish, and other

fishing activities. Tours are guided mainly by the men of the community, while women provide meals comprised of fresh mangrove products.

Activity 1.2.2. Establish and consolidate financial mechanisms in support of mangrove community associations (micro- and small enterprises)

Sub-Activity 1.2.2.1. Create and implement grant mechanism for technical support to micro- and small enterprises of mangrove community associations.

Activity 1.2.2. is designed as a follow-on to support early-stage businesses (either new ones created in Activity 1.2.1. or existing ones).

CI will award small cash grants on a competitive basis for productive projects originating with the associations legally established in the areas of the project and supported under Activity 1.2.1. Various organizations with legal status in the provinces of Esmeraldas, Manabí, Guayas and El Oro will participate, including both AUSCEMs and other organizations with links to mangroves. The objective is to support promising micro- and small-scale enterprises by helping them to scale their operations with the aim of improving the income of these organizations and the standard of living of their members, while strengthening the incentives for sustainable use of mangrove environmental goods and services.

The enterprises that are operating in and around mangrove areas are mainly artisanal organizations, such as Artisanal Fishing Production Associations and Artisanal Fishing Production Cooperatives. These organizations report to the Superintendent of Popular and Solidarity Economy, which is the technical body for supervision and control of the entities of the Popular and Solidarity Financial sector, and of the organizations of the Popular and Solidarity Economy of Ecuador that, promotes its sustainability and correct functioning to protect its partners. There are other types of enterprises like Associative Companies and Microenterprises that have an annual income less than $100,000 and between one to nine employees. These report to the Ministry of Production, Foreign Trade, Investments and Fisheries.

To be eligible for the grants, the enterprises will require a simple business plan that includes a financial analysis demonstrating how the grant will transform the business (summary of business plan contents provided as Appendix 9).

This grant mechanism, totaling US$500,000, will be administered by CI and will provide an estimated 20-25 cash grants to community associations (US$10,000-50,000 per grant). Grant support can be invested in processing equipment, operating costs and other needs to scale up enterprises. Selection criteria for the grants have been designed (See Appendix 5 of this document), and a selection committee will include representatives from MAATE, associations and partner organizations of the project. CI will enter into grant agreements with grantees.

Sub-Activity 1.2.2.2. Support access to mechanisms and institutions providing credit and investment to micro- and small-scale enterprises of mangrove community associations.

This sub-activity is to help enterprises of community mangrove associations to take the next step towards growth by helping them access finance. In order to access credit and investment from existing private and public financial institutions, CI will support associations to develop cost and market analysis to increase the degree of formality of the mangrove community business, define

baseline indicators (e.g., operational efficiency and profitability of the operation, profit/ha/day, feed conversion index). This information and technical support will be used to provide assistance in the identification and application to national sources of finance, such as cooperatives, public financial institutions (BanEcuador) and other private financial entities that provide credit and investment to micro- and small enterprises.

CI will hire a Bioentrepreneur Specialist with expertise in small enterprise development to provide the technical support described in Activity 1.2.2. This specialist will support local associations in designing and implementing strategies for improving enterprise governance and administration, access to finance and to markets for more resilient livelihood strategies in the four estuaries. The Bioentrepreneur Specialist will also provide technical assistance to fishermen to improve practices and strategies for managing fisheries such as shellfish and crab, including options for diversification of fisheries, technical assistance to groups of women in fisheries outside the mangrove, workshops with associations, support to improve safety during extraction, marketing strategies and strengthening of productive aspects; direct technical assistance for market access, training in financial management, direct sales, analysis of market options; strengthening of local entrepreneurial options that allow for productive diversification and support the associations to apply to micro or small credits in local banks or cooperatives.

Component 2: The private sector becomes a transformational agent for change by reducing GHG emissions and providing financial support to conserve and restore mangroves that increase climate resilience for other coastal populations.

Engagement with the private sector in the project consists of enabling the adoption of improved shrimp production methods to reduce GHG emissions and advancing mangrove conservation and restoration through philanthropic support. CI will work with the NCA to provide training on the SSP approach, that includes a no-deforestation requirement and to promote "CSS" production methods that include mangrove restoration (250 ha planned on farms in the project). CI will engage consultants to support small and medium sized shrimp farms to access private finance. In preparation for the project, the ASC and CI provided seed funding (US$ 50,000 and $100,000, respectively) in 2021 to establish the Socio Manglar "subaccount" of Ecuador's Socio Bosque Fund. Investment returns on this funding will be available to support the Socio Manglar program during project implementation. ASC will request that their members contribute to growing this subaccount through voluntary contributions.[41] Additional fundraising by CI and the Government of Ecuador will grow the Socio Manglar subaccount to provide long-term community incentives for mangrove conservation.

Adoption of improved management and production practices in the shrimp sector would lead to reduced GHG emissions, improved climate resilience, and reduced environmental impacts, all while increasing production and profitability of the sector (see Section B1 for discussion of shrimp aquaculture and the reasons these changes have not yet occurred). By working on sector wide policy and market changes, and directly supporting a core group of 'early adopters' comprising at least 20,000 ha (approximately 10% of all shrimp farms in Ecuador) to adopt an integrated package of CSS practices, the project will:

[41] These funds will be reported as parallel co-financing for the project during implementation.

- Reduce deforestation on current shrimp farms and build climate resiliency by reducing the overall environmental footprint in terms of energy use, water quality, and biodiversity loss, and increased profitability (through increased yields). Since the project will be working to protect all the mangroves in the project area through either community AUSCEM agreements, PAs or through improved land-use planning with subnational governments, there is very little opportunity for leakage of deforestation caused by improved management on farms.
- Restore 250 ha of mangrove forests on current shrimp farm areas (resulting in removal of 0.1 $MtCO_2e$).
- Catalyze an estimated US$5 million in investment in the transition to CSS from private sector sources.

The rollout and adoption of the SSP approach and/or ASC certification nationally alongside the use of CSS will push the shrimp aquaculture sector to adhere to zero deforestation and promote mangrove restoration. The increased profitability of the CSS model will act as an incentive for farms to invest in it without the need for future public grant funding.

Output 2.1. Shrimp aquaculture farms adopt practices and production standards that require elimination of deforestation and active reforestation in coastal and mangrove areas.

CI and the NCA will provide direct technical support to aquaculture farms for adoption of the SSP standard and CSS. The NCA will advise on training materials and training sessions. CSS involves working with shrimp pond farmers to sustainably intensify shrimp production, constructing treatment wetlands and restoring coastal ecosystems. Sustainable intensification requires increasing technical capacity to enable 'best management practices' (see Activity 2.1.1.), financing of capital improvements (see Activity 2.1.2.), and policy alignment (see Activity 2.1.3.). The CSS strategy will be applied to farms in different geographies, in areas of high climate vulnerability, and near mangrove AUSCEMs and areas associated with Socio Manglar incentives. The project will specifically target areas where risks, vulnerability and ecosystem services overlap. More broadly, this project will strengthen the enabling conditions in policy, capacity, and market conditions to drive a sector-wide shift in production practices to favor zero-deforestation and restoration of mangroves in and around shrimp aquaculture areas.

Activity 2.1.1. Technical assistance for development and promotion of climate-smart shrimp aquaculture practices in 20,000 ha of farms.

CI (with NCA and ASC) will deliver technical assistance, in the form of coordination, technical support and capacity building, to catalyze the shrimp aquaculture and relevant stakeholders to rapidly adopt CSS practices. The NCA and ASC will act in an advisory role and provide input to training materials and trainings. Activities include dissemination of sustainable management practices (2.1.1.1), dissemination of best restoration practices (2.1.1.2), and ongoing socialization of CSS (2.1.1.3).

Sub-activity 2.1.1.1. Sustainable Intensification Practices

Intensification of production using a CSS approach creates the necessary conditions and incentives to integrate mangrove restoration into shrimp farming operations (2.1.1.2) while also enhancing climate change resilience of farms by protecting against SLR and storm surge and mitigating and sequestering carbon emissions. Successful uptake and implementation of CSS program activities in select regions of Ecuador will require substantial coordination and capacity development at multiple levels of government, the private sector (farmers, supply chain, and other companies), and civil society. CI will develop, print, and distribute guidelines for sustainable intensification best practices to engage with and train farmers, government agencies, and other private and public sector actors to strengthen and internalize technical capacity building. Rather than working only with individual farms to implement the guidelines and foster adoption of best practices, CI and NCA will utilize a 'jurisdictional approach' to coordinate alignment among relevant stakeholders throughout the region. Jurisdictional approach projects have been shown to foster wider, faster adoption of best practices, with a particular efficacy at enabling coordinated disease management, enhanced climate resilience, and environmental stewardship (Kittinger *et al*., 2021). Implementing a jurisdictional approach to best intensification practices requires coordinated activities, including:

- Partner selection (led by CI, in partnership with NCA), based on an assessment tool[42] (see criteria in Appendix 8), applicable regionally and across geographies, to evaluate candidate farms. Engagement to identify CSS project participants, and a final partner screening to select shrimp farms (small, medium, or large) willing to participate in the project.
- Develop a collaborative, time-bound workplan with all CSS project partners based on the baseline analyses, final partner screening, and engagement strategy with explicit commitments from each participating farm to produce shrimp meeting the CSS criteria and each participating entity to support the advancement of CSS with defined roles and outcomes (e.g. offtake agreements, policy support, conservation use agreements). Led by CI, in partnership with NCA.
- Workplan execution and stewardship (led by CI, in partnership with NCA). Conduct trainings and technical sessions for 200-250 farmers from small and medium size farms and other stakeholders (e.g. universities and NGOs working on the topic).

Sub-activity 2.1.1.2. Mangrove Restoration on 250 ha of demonstration farms

Technical assistance from CI and NCA will enable farmers to design and implement restoration initiatives on portions of their farms, which will confer water quality benefits within the farm as well as provide broader climate change mitigation and adaption benefits, including effective and efficient flood protection. The costs of the mangrove restoration on farms will be financed by the farms.

A target of 250 ha of mangroves will be restored in the immediate vicinity of shrimp ponds and in areas where ponds are no longer viable. Restoration designs as part of climate-smart business

[42] See https://ci-aquafarm-mapping.web.app/ for the CSS assessment tool developed for the Philippines and Indonesia that will be adapted for Ecuador

models will be developed by consultants hired by CI to establish hydrology and landscape conditions within the restored area while allowing the shrimp farm operations to be maintained or improved. This innovative approach improves upon the conventional approaches to coastal protection, by integrating ecosystems to improve the overall outcome for biodiversity, production, and coastal adaptation. The resulting designs, details and case studies generated through this project will provide tools to replicate at scale elsewhere in the region and the world, with potential to transform business-as-usual global shrimp farming practices and as a model for other agricultural production sectors.

This activity will involve the design, implementation and monitoring of mangrove restoration and conservation plans in and around shrimp farms to achieve biodiversity, water quality, and coastal adaptation objectives (led by CI, with partners from NCA, farm holders, members of local farming associations, and local communities) including:

- Design, from concept to implementation-ready drawings (CI)
- Restoration of 250 ha of mangroves with farm holders and local communities, linked to conservation agreements with farm holders and buyers. The farms will be responsible for the cost of restoration activities (other than CI's costs for design and monitoring). CI will provide quality control and oversight as well as monitoring of implementation.

Sub-activity 2.1.1.3. Education, Outreach and Enabling Conditions Implementation of Sustainable Shrimp Aquaculture

There are many examples of exploitation and mismanagement of mangroves and shrimp farms, and hence the need to address these challenges through effective public policy that embraces partnerships between government agencies, local communities and the private sector, all of whom operate in the same space. Stakeholder consensus around the benefits and importance of CSS is a critical enabling condition of implementation of CSS at project sites and project initiatives and is critical to achieving program sustainability. Consensus requires alignment among a diverse set of stakeholders, ranging from community members, local and national government, public institutions, universities, local organizations, national and international financial institutions, supply chain actors, and most importantly, shrimp farmers and technicians. Additional efforts to communicate project activities and outcomes will promote climate-smart shrimp among other producers in Ecuador while signaling for supplemental interest and investments.

A CI Communications & Knowledge Management Manager, the Manager of Component 2 (Incentives, Financial Mechanisms and Climate Finance) and the Climate Smart Aquaculture specialist will lead activities that will target specific stakeholder groups, including:

- National-level socialization of the shrimp aquaculture industry, through the establishment of an Aquaculture Roundtable with representative leaders from key national stakeholder groups.
- Socialization with national and international financial institutions.
- Socialization with regional and national governments, including mechanisms for integration between MAATE, Ministry of Finance and Undersecretary of Finance, collaboration with the Sustainable Finance Roundtable (led by Ministry of Finance and MAATE).

- Socialization with restoration organizations and mangrove stewards, including regional meetings for participatory roadmap and capacity building workshops.
- Socialization with community members and general public, based on a communication strategy for social media, email, newsletters and videos.

A total of 35 workshops are planned to socialize CSS production models (with an estimated average of 20 people per training). A further 19 workshops are planned for CSS technical training aimed at small- and medium-sized companies (with an estimated average of 20 people per training).

In addition to the activities listed above to disseminate knowledge gathered by the project, collections of key documents and resources will be housed within existing knowledge portals including a) the website and training initiatives led by NCA as part of the SSP initiative, b) the eco.business Sustainability Academy platform, and c) ESPOL University, with its course on Marine engineering and Aquaculture engineering (a key stakeholder of the CSS initiative), and d) the GMA knowledge hub.

Activity 2.1.2 Facilitate partnerships and access to mechanisms for credit and investment in shrimp farms for expansion and consolidation of climate-smart aquaculture practices.

CI will work with different actors of the shrimp supply chain to address finance access barriers and facilitate the flow of credit and investment for farm operations that seek to transition their production models to more sustainable ones.

The limited offer of financial products, both from the financial system and other sources, is a significant barrier for shrimp farms wanting to adopt the SSP and CCS models. The eco.business Fund is financing green credit lines to key banks such as Produbanco, Banco de Guayaquil, Banco del Pacifico and Banco Pichincha, and is an important ally in promoting a sustainable model of shrimp production; training bank staff on impact and risk management in relation to the shrimp business and testing models so that the institutions feel confident in investing in a shrimp related business.

As new financial instruments are being developed, business demand for technical support to ensure successful investments is also increasing. CI will coordinate with the eco.business Fund to support and expand initiatives such as the Sustainability Academy, the eco.business Fund's platform for training financial intermediaries, to small and medium farms, and other service providers in sustainable production models and investments that derive into more sustainable operations (see 2.1.2.1 below).

Implementation of demonstration cases, from diagnosis to work plan development, implementation and measurement, is critical to develop the skills of investors, suppliers and farmers. To strengthen these successful investment cases, CI will provide technical support to businesses in the project feasibility and implementation phases. Criteria for selecting beneficiaries will be developed to include conservation priorities (mangrove conservation or restoration component), market opportunities in connection with SSP and/or ASC, and particularly links to investors or banks that can provide the required funding for making an operation more sustainable (see 2.1.2.2 below). Support from the project will be conditional on the business making commitments to invest in mangrove restoration and/or conservation.

CI will also promote the implementation of a roundtable created by the National Mangrove Plan with the industry to include the CSS concept into the agenda and priority discussion topics and the solutions to address finance access barriers described in the project approach. Links to the commercial sector will be critical to reduce risks of investments in the shrimp industry, so working in connection with SSP (through the NCA) as well as international buyers to secure commitments to CSS is important (see also sub-activity 2.1.2.3).

Sub-activity 2.1.2.1. Education as a tool to facilitate access to credit and other investment to shrimp farms for expansion and consolidation of CSS practices.

CI will partner with the eco.business Fund to provide technical support to the Sustainability Academy, a portal that combines education materials, workshops, self-assessment tools, and case documentation on several sectors, including shrimp aquaculture. The purpose of the Academy is to help farmers reduce the costs associated with attaining certifications or improving their sustainability approaches.

CI will support the Sustainability Academy by expanding its content to include CSS, good aquaculture practices, mangrove conservation and restoration, safeguards implementation, and other climate and conservation-oriented programs, such as Socio Manglar.

Improved portal content will be available to the public, but the project will also target and fund specific segments of small and medium farmers that could benefit from the training opportunities. The project will bring together stakeholders to make the Sustainability Academy and the existing financial products more available to small and medium farmers that are not necessarily clients of the banking system to date, expanding the base of beneficiaries of the program.

Sub-activity 2.1.2.2. Project feasibility as a tool to mobilize capital towards CSS production.

To promote sustainable intensification of shrimp farms (focused on CSS, and standards including ASC and SSP), it is critical to have a clear plan for the technical and investment needs and the impact expected in terms of efficiencies, net gains, as well as qualitative benefits associated to changes in those production models. Furthermore, if farms developed these plans and determined investment needs, it will be more attractive for the financial sector to provide funding and support the sector to transition to more sustainable production schemes.

To address investment needs, the project will seek to identify and support shrimp farmers on the design of sustainability efforts as a tool to mobilize capital towards CSS, ASC and SSP models. CI will assist these needs through technical support from consultants to be selected based on a Request for Proposals during project implementation. Shrimp farmers will be eligible for project support if they comply with initial requirements: i) a concrete investment opportunity that can improve efficiencies, and ii) a link to a financial institution interested in financing such investment. CI will assess all requests and prioritize opportunities based on a series of eligibility criteria that includes the following:

- Located in one of the sites prioritized by the project;
- Area with existing or lost mangroves or in close connection with mangrove ecosystems;
- Private ownership of land or public concession assigned for the period of the investment;

- Operating business with three or more years of operation history;
- Legal permits in place and up to date;
- Certified or interested in engaging with ASC and/or SSP programs and/or interested in implementing CSS model in the production area. Interest should be documented through former efforts such as an assessment to achieve certification or a letter of interest/endorsement by the certification programs or the NCA; and
- Commitment to safeguards in connection with social and environmental key practices that CSS is promoting.

The technical support from the project will be used with the goal of unlocking private finance to specific geographies with a role in mangrove conservation or restoration but not necessarily those farmers being the most investable in the sector. Furthermore, there is an understanding that many small and medium farmers operate in the area, and they are the ones that face more challenges in their capacity to attract investment into their operations. The technical support will be used for the following purposes:

- To strengthen weaknesses in management areas that limit the capacity of attracting capital to promote sustainable intensification at farm level, or
- To refine an investment opportunity through a feasibility assessment, business plan development, impact targets such as efficiencies and improved conditions, and definition of Key Performance Indicators (KPIs) to monitor advancement towards those goals.

Sub-activity 2.1.2.3. Commercial commitments as a risk management tool to facilitate access to financial services.

The CI project staff (Climate Smart Aquaculture Specialist) will facilitate agreements between retailers, importers/exporters, processers, and farmers to guarantee purchase of climate smart shrimp.

CI will work with NCA and ASC to continually strengthen training materials for the CSS concept and to refine the concept itself based on industry feedback. CI will engage a consultant in Year 3 to develop a marketing strategy for CSS in Ecuador. This will include assessing market engagement for CSS with retailers, including market traceability, market recognition and establishing buyer assurance mechanisms. CI will also collaborate with NCA and ASC and third-party independent auditors that confirm farm adherence to the CSS standard to:

- Develop market recognition and support for climate smart shrimp, and
- Connect and coordinate with national and international buyers.

Output 2.2. Sustainable management of mangroves is improved through agreements with the private sector, including direct financial support for mangrove conservation and restoration.

Activity 2.2.1. Establish agreements with businesses, including aquaculture companies, to contribute to mangrove restoration and financial sustainability of the national Socio Bosque Incentive Program (the Socio Manglar Program).

Sub-activity 2.2.1.1. Grow the Socio Manglar subaccount of the Socio Bosque Fund to support long-term community management of mangroves.

Ecuador's Socio Manglar incentive mechanism provides a tangible, government-supported pathway for shrimp farms and other enterprises operating on Ecuador's coast to make effective their commitments to mangrove conservation. CI, in preparation for this project, has worked with the ASC to create and contribute to the capital of the Socio Manglar subaccount of Ecuador's Socio Bosque Fund, with an initial donation of US$150,000 (US$50,000 from ASC and US$100,000 from CI). The Socio Bosque Fund is managed by Ecuador's Environmental and Sustainable Investment Fund (FIAS), and the new Socio Manglar subaccount is managed using the same operating procedures. FIAS is a private, non-profit entity to support finance for environmental and conservation purposes in line with MAATE priorities. Each fund managed by FIAS has a governance mechanism for decision making and FIAS has a board with the participation of the private and public sectors. All funds are audited, and information is presented to the board and to each governance mechanism. FIAS also has an investment committee that oversees the policies and strategies implemented with the funds based in Ecuador and with the funds invested internationally. See Appendix 12 for further details on the Socio Manglar subaccount and its management by FIAS.

FIAS is a private, non-profit entity that has a track record of the management, mobilization, investment and implementation of public and private funds to finance nature conservation and mitigation and adaptation to climate change, complementing the efforts of the Government of Ecuador. FIAS currently has more than US$100 million in five funds under management, with contributions from the Government of Ecuador and international donors, including CI. CI has a permanent voting seat on the "Technical Committee" responsible for the management of the Socio Manglar subaccount. Through its role in the Socio Manglar subaccount governance and ongoing financial and technical monitoring, CI will ensure compliance with GCF requirements both during the project implementation period and beyond. CI will also obtain written confirmation from MAATE and FIAS that remaining funds in the GCF funded Socio Manglar subaccount after project lifespan will continue to be used in supporting communities managing mangroves. CI will monitor financial and technical reports of the Socio Manglar subaccount (financial reports) and broader Socio Manglar program (technical reports). Further details on CI's role in supervision, monitoring and ensuring compliance with GCF requirements after the project implementation period are included in the Term Sheet, Annex 14.

The Government of Ecuador (through MAATE) currently finances the Socio Manglar Program directly from its annual budget and the REDD Early Movers project. An objective of this GCF project activity is to build up the Socio Manglar subaccount to provide a more stable and long-term sustainable source of financing for the Socio Manglar program. Two main sources of further funding for the Socio Manglar subaccount will be targeted: aquaculture enterprises looking to expand their environmental commitments[43] and Ecuadorian businesses seeking to compensate for their carbon footprint under Ecuador's Carbon Zero program (PECC). Public sector funding sources will also be targeted if opportunities arise. In addition, four million dollars (US$4 million) are requested from the GCF and will be managed separately from the other funds of the Socio

[43] Such commitments would be voluntary and not be a condition for support from the project

Manglar subaccount in an interest-bearing account (see below), with the interest generated used to pay for Socio Manglar incentive payments to communities under the Socio Manglar program.

CI will also work with ASC, the corporate partners of their value chain and their membership (aquaculture enterprises) to secure voluntary commitments to contribute to the Socio Manglar program.

To strengthen private sector action, CI, will develop a communications strategy highlighting the importance of mangroves and the role the private sector can take in protecting and restoring them. The strategy will be for several audiences, including international companies in the ASC value chain, national shrimp farms and other Ecuadorian companies (i.e., others not linked to the aquaculture sector) looking to compensate their carbon footprint. Meetings to present the Socio Manglar program (including the Socio Manglar subaccount) and the opportunities for private sector engagement with it will be organized in Years 2 and 3 in both Quito and Guayaquil.

GCF funds of US$4 million are requested to capitalize the Socio Manglar subaccount managed by FIAS. These funds will be granted to FIAS as an endowment in perpetuity for the subaccount and will be held in a designated interest-bearing account with the interest used to pay annual incentives to AUSCEMs in the Socio Manglar Program. The $4 million amount will capitalize the subaccount at a level that, along with other contributions (see next section), will generate enough income to provide incentive payments for the additional AUSCEMs eligible for payments resulting from Component 1 of the Project. FIAS will manage the GCF resources in a separate interest-bearing account alongside other contributions to the Socio Manglar subaccount. Other non-GCF contributions to the Socio Manglar subaccount will be invested according to the investment policy of FIAS. All financial contributions managed by FIAS, including those contributed by GCF, will be managed in accordance with its existing management procedures, which have been assessed to be compliant with GCF requirements. See Appendix 12 for details of the Socio Manglar subaccount and projections for growing its capital. CI-Ecuador, with support from CI's Conservation Finance Division, will monitor the use of GCF funds within the subaccount managed by FIAS.

In addition to capitalizing the Socio Manglar subaccount, the $4 million in GCF funds are expected to catalyze mobilization of private investment into the subaccount. Increasing the subaccount's capital with GCF funds early in the project (Year 2) is expected to provide a level of confidence from potential private sector donors because the subaccount will already be functioning with sufficient capital to provide incentives to some AUSCEM groups. Private-sector donors are more likely to contribute alongside public funding such as from GCF since it will demonstrate there are realistic long-term prospects for the subaccount to act as a mechanism to provide incentive payments and to attract sufficient additional capital to allow the Socio Manglar program to expand. The US$4 million is requested from GCF as a grant, rather than a reimbursable grant or loan, since i) the Socio Manglar subaccount is intended to operate in perpetuity, ii) interest earned on it will be used to provide incentive payments in the form of grants to AUSCEM groups and iii) there is no revenue to the Socio Manglar subaccount (other than the interest on the capital) with which to repay a reimbursable grant or loan.

Component 3: Create the enabling conditions for sustaining reductions in mangrove deforestation and increased mangrove restoration by strengthening governance, climate change adaptation strategies, coastal management policies, and legal enforcement.

Actions by local communities and the private sector to protect mangroves and maintain flood-protection benefits as a nature-based climate change adaptation and mitigation strategy depend significantly on the government creating the necessary governance, regulatory and enabling conditions. These both dissuade and control illegal activities and ensure that a full range of climate considerations are incorporated into planning and investment decisions.

By generating and disseminating better climate-change and mangrove-forest information to decision makers and stakeholders, project activities, particularly those focused on public entities, the project will contribute directly to increasing climate knowledge for use in decision making and will provide the foundation for achieving project outcomes 1 and 2 and their associated impacts.

Improved legal and regulatory capacity, focused on planning, preparedness and enforcement, will contribute to sustaining mangroves as well as enhancing awareness and resilience of direct and indirect beneficiaries, primarily concentrated in the eight priority municipalities of the project area and will contribute directly to strengthened institutional and regulatory systems for climate responsive planning and development.

Output 3.1: Decision making for mangrove management by national government agencies and local governments is based on generation and provision of accurate and up-to-date data on mangrove condition and socio-economic information on mangrove dependent communities.

Activity 3.1.1. Monitoring of mangrove condition and socio-economic impacts in mangrove dependent communities.

Sub-activity 3.1.1.1. Demonstrate the impact of mangrove conservation and restoration on national mangrove cover, stocks, and socio-economic indicators through monitoring linked to the national MRV, and build long-term monitoring capacity.

> The reduction of emissions and the environmental and social benefits associated with the implementation of project activities will be monitored through a transparent structure that integrates remote sensing and community participation. This activity will provide the data needed for monitoring of the GHG emission reductions achieved by the other components.
>
> **Monitoring, Reporting and Verification (MRV) of Mangrove Cover and Carbon Stocks**
>
> CI will enter into subgrants with two local universities or NGOs (sub-grantee to be chosen based on quality of proposals) to collaboratively generate data and capacity at multiple levels to improve MRV systems for mangroves, to be integrated both into project M&E and the national REDD+ MRV system. Ecuador's NDC is strongly linked with the terrestrial ecosystems. The information that this project will generate will be connected with the national MRV system and the various initiatives that Ecuador is implementing to reach the targets included in the NDC. The information

generated in this sub-activity is also fundamental to the implementation of the PECC with the private sector (linked to sub-activity 2.2.1.1. above).

During the monitoring process, CI and MAATE will supervise the execution of activities and verify the procedures carried out by the associated communities and universities, as well as the data collected to ensure its quality and avoid tracking and measurement errors. The quality control of the data will be preceded by training sessions delivered by CI or field personnel and other actors involved in the measurements.

As described in section B1, natural changes in mangrove cover due to the complex hydrological dynamics of mangrove ecosystems are an important contributor to mangrove losses and gains. Improving the understanding of these natural changes is essential for future mangrove cover monitoring. MAATE, local universities and community stakeholders such as mangrove associations will be trained by CI to monitor the dynamics and structure of the mangroves and the biodiversity they contain. The areas that will be monitored will include (1) areas affected by natural disturbances (2) restored areas of mangroves and other natural forests and (3) areas of infrastructure development and deforestation not controlled by project activities. A subgrant will be awarded to a local university to collect the mangrove 'blue carbon' monitoring information. CI will also provide a training on the collection of mangrove 'blue carbon' data to the sub-grantee and other stakeholders, including MAATE staff.

Updated geospatial data on mangrove coverage and change will be gathered and integrated into national forest inventory and FRELs. This requires the investment in drones, overflights, satellite data, ground truthing and enforcement response. Also, software and a laptop for data processing, analyzing, and reporting will be purchased for this sub-activity.

CI will enter into a subgrant with a local university or NGO to analyze mangrove cover and provide results to the national MRV system. For this project, carbon will be monitored at the beginning of the project and again at the end. Since carbon accumulates slowly, more frequent measurement is unlikely to show statistical differences.

The method for carbon monitoring will follow the internationally recognized methods outlined in the "Coastal Blue Carbon methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows", a field guide for practitioners (Howard *et al* 2014). The field guide is a well-respected source for blue carbon measurement techniques and meets requirements under the IPCC for delivering data at the Tier 1, 2, and 3 level. For this project, carbon will be monitored using the stock difference method. This method estimates the difference in carbon stocks measured at two points in time and results in Tier 3 estimates.

Information will be directly linked to the National Environmental Information (*Sistema Único de Información Ambiental - SUIA*) and the national MRV system of the MAATE's Subsecretary of Climate Change. CI will draw on the expertise of its global experts in blue carbon and ensure implementation and transfer of knowledge to national actors. The project's CI mitigation specialist and the restoration specialist will support the work in the four estuaries.

CI will disseminate information to decision makers at the local and national level, through annual forest cover reports for local governments and MAATE and other decision makers and creating maps for local communities.

Socio economic impact evaluation (SIE)

The SIE has the main objective of assessing the effects from project proposed activities on environmental and socioeconomic outcomes (i.e., climate mitigation and emissions reductions, resilience, enhanced livelihoods). The SIE will aim to detect an effect between treatment and control groups within the project implementation period for the project activities.

In addition to collecting baseline data and monitoring the indicators of the selected activities, the SIE will require collecting additional data on observable covariates to create the counterfactual, i.e., what would have happened in the absence of the intervention (Ferraro, 2009; Ferraro & Hanauer, 2014). Data collected will be used to measure differences between treatment units (e.g., communities, mangrove plots) and control units against intermediate outcomes as the project progresses which would be indicative of trends of the long-term outcomes.

CI will conduct the SIE in Year 1 following project start-up for the baseline and in Year 5 and 6 for the endline. CI's Moore Center for Science will support the establishment of the monitoring system and the processing and analysis of the information. CI will also enter into grant agreements with local universities in Ecuador for the gathering and training. Eligibility criteria for selection of the local universities is provided as Appendix 7.

Output 3.2. Legal and regulatory frameworks at local and sectoral level are harmonized and include climate resilience and mitigation strategies and enforcement.

Activity 3.2.1. Support local governments (2 provincial governments, 2 municipalities and 5 parishes) to improve and/or implement Coastal Development and Zoning Plans (PDOTs) and other participatory planning instruments that incorporate climate change adaptation and mangrove management, applying a gender approach.

Sub-Activity 3.2.1.1. Provide technical assistance to subnational governments for improvement of PDOTs and other participatory planning instruments to integrate climate-change adaptation and mangrove management measures.

CI will work with local governments to enforce their capacity to manage their territories with a clear perspective of integrated coastal zone management and marine spatial planning that are critically important to realizing flood protection benefits from mangroves as well as other ecosystem services from coastal ecosystems. CI will work with nine local government administrations to integrate natural climate change adaptation measures into their planning, including mangrove conservation and restoration. The local governments have been prioritized based on the extent of their mangrove cover. To support this work, CI will provide a subgrant in Year 2 to a local organization (university or NGO to be selected based on proposal) to generate climate risk information to inform local planning.

CI will work with five Parish administrations (*Parroquias*) to develop climate change risk-management plans that value impacts and involvement of men and women. CI will provide technical support to these local governments for planning that will help them increase the economic, social, health and cultural resilience of individuals and communities. The risk-management plans will include activities for monitoring and evaluation of the adaptive capacity of men and women considering their access and control of resources, participation and roles within organizational processes.

CI will work with two Municipal governments (Guayaquil and Machala), responsible for land-use planning and zoning through their PDOTs. CI will provide technical input and facilitation of participatory planning processes to integrate strategies for climate-change adaptation, including strategies for conservation and restoration of mangroves.

CI will support two provincial governments (Guayas and El Oro) with technical support to integrate climate change considerations into the provincial planning and to support budget planning to promote additional climate change investment. These activities will support management of priority conservation areas, local fishermen, strengthen capacities for the preparation of management plans for the coastal areas, and develop land use and management plans and integrated coastal management plans. The project will also support the integration into the provincial plans of actions to create the enabling conditions necessary for the long-term conservation and restoration of mangroves. These include organizing mangrove associations into a provincial network of nurseries for reforestation, execution of actions for the conservation of coastal and terrestrial biodiversity with an emphasis on mangrove ecosystems, support for the diversification of productive activities of fishing organizations through competitive funds, insertion of women in the value chain of mangrove, and afforestation and reforestation campaigns of mangrove ecosystems.

CI will engage a consultant in Year 2 to provide territorial planning support to local governments for these activities. The CI Local governance & Integrated Coastal Management Specialist will provide support to these government entities across the 4 estuaries of the project.

CI will provide ongoing support, monitoring and public communication for the implementation of plans, corresponding public investments and municipal ordinances and other legal instruments determined by PDOTs.

Activity 3.2.2. Strengthen regulatory framework and law enforcement by agencies and institutions responsible for control of mangroves, with a focus on human rights.

Sub-activity 3.2.2.1. Provide technical and legal support for harmonization and adoption of improved sectoral policies and regulations and technical assistance for implementation of CODA (*Código Orgánico del Ambiente*).

CI staff and consultants engaged by CI will conduct an analysis of multi-sectoral legal framework for mangroves and climate change and the creation of multi-sectoral working groups

("*mesas técnicas*") to generate proposals for regulatory changes in Environment, Aquaculture, Navy, Ports, and GADs. Examples of such changes may include updates to the regulations regarding illegal shrimp farms not covered by Executive Decree 1391 which have not been expropriated or approved, procedures for the restoration of mangroves, and regulation of areas that were formerly mangroves.

CI will also support the discussion of legal reforms and new regulations in the context of the Roundtable for Sustainable Shrimp (see Activity 2.1.1.), to be convened by the MAATE and the VMAP. CI will provide staff time and cover workshop costs to implement this roundtable.

Sub-activity 3.2.2.2. Provide technical and legal support leading to reforms to Ministry of Environment, Water and Ecological Transition (MAATE) processes of complaints, enforcement and sanctions for infractions affecting mangroves.

In Years 2-5, the project's CI Legal Specialist and Local Governance & Integrated Coastal Management Specialist will work with partners to re-establish the strategy of the UOCVs for law enforcement and sanctions for illegal activities affecting mangroves. A joint effort between the INOCAR, MAATE, VMAP, NGOs and the NCA, the UOCVs' main goal is to avoid and control the clear-cutting of mangrove forest areas through the cooperation of public, private and NGO entities. The implementation of this initiative includes the surveillance technical system, the legal control technical system and the report and communication system.

In Years 2-5, the project's CI Legal Specialist and Component 3 Coordinator will support 140 MAATE staff members with responsibilities for mangrove administration, planning, PAs, and provincial districts by providing them training on the laws and regulations relating to mangroves and the administrative procedures for enforcement and sanctions. A system to follow up deforestation complaints will be improved by the CI project staff and implemented in collaboration with government officials so complaints from local associations, local governments and citizens will have a transparent follow up process.

Sub-activity 3.2.2.3. Provide training for judges and other institutions regarding regulations and sanctions for crimes involving mangroves.

In Year 3, CI will engage a consultant to develop a training curriculum relating to mangroves specifically aimed at judges and other staff of the judiciary system, including from the Public Prosecutor, Navy, and Ministry of Fisheries and Aquaculture. Training workshops will be conducted by CI's Legal Specialist and the Local Governance & Integrated Coastal Management Specialist for judges and judiciary staff. This training will be integrated into the regular training curriculum of the named institutions.

In Years 1-3, CI will engage a consultant to design an online and mobile app to facilitate reporting of deforestation and other impacts on mangroves. The consultant will also provide training to users of the app (MAATE staff and AUSCEMs).

6 Economic and Financial Analysis

The Economic and Financial Analyses are provided as separate annexes to the Funding Proposal. Annex 3a provides calculations for the analyses in an Excel file and Annex 3b is an explanatory narrative. A summary of the key findings is provided here.

The project economic analysis has been applied to four scenarios: a baseline/ business as usual 'without project' situation and three alternative designs of the project. The three designs are 1) the project as it is designed and described in the Funding Proposal, 2) an alternative project that only focuses on mangrove restoration and not the conservation of existing mangroves outside of protected areas, and 3) an alternative project that only includes activities to conserve existing mangroves (using the same approach to conservation as in the designed project).

The economic cost-benefit analysis examines the costs and environmental service benefits of the four scenarios. The two environmental services for which most research on their valuations in Ecuador's mangroves has been done are included in the analysis: fisheries benefits and coastal protection benefits. These two environmental service benefits alone hugely outweigh the costs of mangrove protection and restoration in all four scenarios. In addition, GHG emissions reductions associated with each scenario have been included in the economic analysis as benefits. The value of recreation/tourism services in Ecuador's mangroves has been estimated based on estimates of the number of visitors that the mangrove areas receive. Finally, published estimates from global studies have been used to estimate the value of ecosystem services for which Ecuador-specific information is lacking. These include wood for timber, wood for energy and harvesting of wild honey. The huge economic benefits of maintaining and restoring mangroves are consistent with existing literature on the value of mangroves both within Ecuador and globally. Since the objective of the analysis is to examine whether the economic benefits of the project activities outweigh the related costs, rather than to get an absolute value for all environmental benefits, we have not therefore attempted to include a value on other services such as fodder, pharmaceuticals, pollution abatement, protection from sedimentation, nutrient cycling, protection from salt intrusion and aesthetic value that are also associated with mangroves.

The economic analysis results, under the model assumptions, show that in all four scenarios the economic benefits outweigh the costs. For example, the net present value (NPV) of maintaining mangroves under the current 'without project' scenario is estimated at USD 6.9 billion over 20 years. This figure rises to USD 7.1 billion if the proposed project is implemented. The restoration and conservation scenarios have NPVs over 20 years of USD 7.0 billion and USD 7.0 billion respectively.

The results of the economic analysis are also presented for the incremental change due to the three project scenarios by showing the difference in NPVs for the three project scenarios by comparison to the 'without project scenario'. The incremental comparison of NPVs shows how the NPV of all three project scenarios is negative at the mid-term (year 4) point and end of the project implementation but becomes positive by the end of the project lifespan Over the estimated 20-year lifespan of the project, the project scenario has an NPV of USD 158 million more than the 'without project' scenario. The 'project' scenario has a benefit to cost ratio of 4.7. The restoration only scenario has the lowest benefit to cost ratio (3.4) and an NPV over 20 years of USD 59 million more than the 'without project' scenario). The 'conservation only' scenario has a benefit to cost ratio of 3.4 and an NPV over 20 years of USD 82 million more than the 'without project' scenario.

Since this is a publicly funded project focused on delivering public goods and services and is not expected to generate revenues, no financial analysis has been included.

7 Implementation Arrangements

Implementation Arrangements are described in the Funding Proposal and are repeated here for completeness of this document. If there are differences in the information provided in the two documents then the Funding Proposal should be considered the correct version.

NDA and Government Partner

Ecuador's Ministry of Environment, Water and Ecological Transition (MAATE), as the GCF National Designated Authority (NDA), will ensure that activities implemented by the project align with strategic national objectives, priorities, and standards, including the National Climate Change Strategy, and help advance ambitious action on adaptation and mitigation in line with national goals and needs. The EE will engage with the NDA throughout project implementation. The NDA will contribute to the development of the multiyear workplan and will be provided with detailed reporting on the status of project activities and impacts. MAATE, through its Undersecretariat of Natural Heritage and Undersecretariat of Climate Change, will also contribute to project activities and provide grant and in-kind co-financing as described elsewhere in this proposal.

Accredited Entity

Conservation International Foundation (CI), through its CI-GCF Agency, will serve as the Accredited Entity (AE) for the project. The CI-GCF Agency will be responsible for the overall oversight of this project as defined in the Accredited Master Agreement between the GCF and CI, including technical, financial, and administrative monitoring and supervision (through reporting, audits, and annual site visits) and review and approval of the Executing Entity's (EE) annual workplans and budgets. CI-GCF will also be responsible for providing support, guidance and backstopping to the EE; monitoring of the achievement of project results and Outputs; reporting to the GCF; and project closure and evaluation. CI-GCF will conduct these responsibilities, and disburse GCF funds to the EE, in line with CI's Accreditation Master Agreement (AMA) with the GCF. The CI-GCF Agency currently serves as AE for FP26, *Sustainable Landscapes in Madagascar*, a GCF project addressing mitigation, adaptation, and sustainable livelihoods, and for FP158, *Ecosystem-based Adaptation and Mitigation in Botswana's Communal Rangelands*.

Project Governance

The project's governance structure includes the Project Steering Committee and the Project Management Committee. The Project Steering Committee will be comprised of the following individuals: i) the Undersecretary of Climate Change of MAATE or his/her delegate; ii) the Undersecretary of Natural Heritage of MAATE or his/her delegate; and iii) the Vice President of CI-Ecuador or his/her delegate; and will be chaired by the Undersecretary of Climate Change.

The principal functions of the Project Steering Committee will be to provide strategic guidance and support adaptive management of project implementation, review progress and evaluation reports; discuss problems or strategic issues that might arise during implementation, and provide support for the necessary inter-institutional coordination and contributions to project activities. The Steering Committee will also participate in the selection of the Project Director, through a competitive process.

The Project Steering Committee will meet at least twice per year, to review the progress of the ongoing semester or year and to advise the Project Director on strategic and policy-related decisions. The Project

Steering Committee will be convened by the Project Director in advance to give the members sufficient time to schedule the meeting and agree on the agenda. The Project Director will prepare minutes of each meeting. Extraordinary meetings of the Project Steering Committee will be convened when deemed necessary and by request of one of its members. The Project Steering Committee may also invite key stakeholders to support specific themes.

The Project Management Committee comprise the following individuals: i) the Director of the Marine, Coastal and Oceanic (MAATE staff); ii) the Director of Climate Change Adaptation (MAATE staff); iii) the Director of the Coastal and Marine Program of CI-Ecuador; and iv) the Project Director; and will be chaired by the Director of the Marine, Coastal and Oceanic. The MAATE staff are public employees and their participation is not remunerated by the Project.

The Project Management Advisory Committee will meet at least four times per year to advise the Project Director and the National Project Director (NPD) on technical matters, and to discuss challenges and collaboration opportunities during implementation. The Project Management Advisory Committee may invite key partners to receive advice on specific themes.

For both the governance committees, members who are government employees will not be renumerated by GCF funds.

The NPD will be appointed by MAATE's Undersecretary of Natural Heritage of the MAATE. The NPD will advise the Project Director on government policies and priorities; review coherence of the project activities, including results, risks, planning and procurement processes; advise on the project's annual Procurement Plan for project services and goods, and review the technical and financial quarterly project reports to the AE.

Technical Advisory Committees will be created for each of the Components and each of the Estuaries of the project. In the case of Component 1, the technical advisory committee will include MAATE, the Risk Secretariat, Universities working in climate change adaptation and mitigation, and representatives from AUSCEM. The Component 2 committee will include MAATE, the VMAP, the NCA, the Fisheries and Aquaculture Public Research Institute, shrimp farmers, and other value chain members. The Component 3 committee will include MAATE, the Planning National Secretariat, Provincial, municipal, and Parish governments, and representatives of the INOCAR, the Prosecutor's Office, and Judiciary Council. At the level of each estuary, a committee will be created to integrate the Zonal Directors of MAATE with the planning activities of local governments and AUSCEMS representatives.

Executing Entity

CI will self-execute this project. CI Foundation, acting through its country office in Ecuador (sometimes referred to in this document as "CI" or "CI-Ecuador"),[44] will be the Executing Entity (EE) for all activities of this project. CI-Ecuador will be responsible for project execution, management of sub-grantees and their activities, reporting to the AE, and ensuring optimal alignment of Government of Ecuador policies and priorities in coordination with MAE to achieve project outcomes and Fund-level goals. As EE, CI, acting

[44] All references to "CI Ecuador" denote the actions undertaken by the project's CI staff employed through CI Ecuador, a branch office of Conservation International Foundation registered in *Ecuador* as an external company. The legal entity for this reference is Conservation International Foundation. CI Foundation will be the legal entity entering into any agreements, sub-agreements, or MOUs used in this project.

through its country office in Ecuador, will enter into subsidiary agreements (including sub-grant agreements, services agreements, and MOUs) for this project. The CI-GCF Agency has assessed the capacity of CI-Ecuador and has determined it to be capable of applying CI and CI-GCF standards and policies in the execution of this Project. Throughout Project implementation, CI-Ecuador will be supported by various CI divisions which will lend specific expertise, including CI's Americas Division, Conservation Finance Division (supporting private-sector funding), and CI's Center for Oceans (supporting blue carbon and mangrove restoration), and Social Policy Division (supporting safeguards and gender).

For more than 30 years, CI has been protecting nature for the benefit of all. CI employs more than 1,000 people and works with more than 2,000 partners in 30+ countries. Since 1987, CI has supported more than 1,200 PAs and undertaken interventions across 77 countries, protecting more than 601 million hectares of land, marine and coastal areas. CI has been operating in Ecuador for over two decades; in the Galapagos, marine and coastal areas of continental Ecuador, Andes Choco and the Amazon to implement conservation solutions within priority landscapes. CI has supported the creation and management of marine and coastal PAs, working in close collaboration with artisanal fisher associations to promote capacity building and sustainable management measures of resources (in Galápagos with the spiny lobster, tuna and prawn fisheries and in mainland Ecuador, with black shell and red crab fisheries).

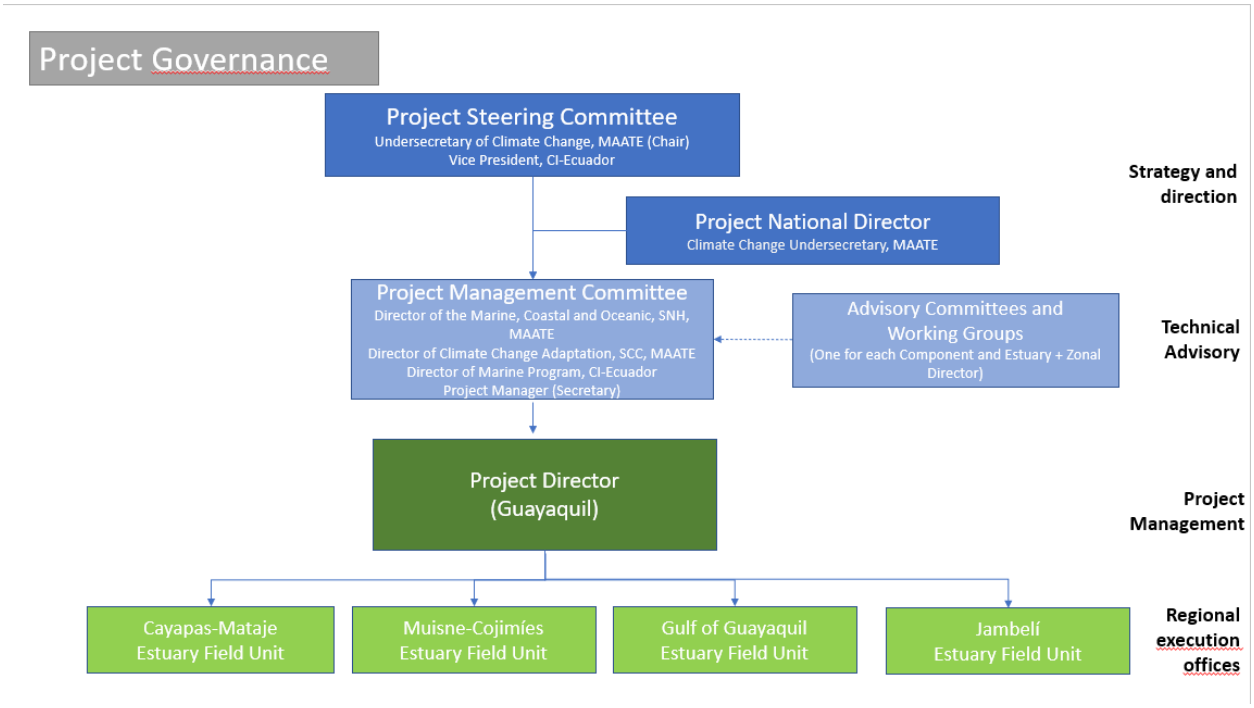
Staffing

CI-Ecuador will establish the main Project Management Unit (PMU) at CI's office in Guayaquil. The PMU will be headed by a full-time Project Director, who will be responsible for coordination with all stakeholders and successful implementation of the project and attainment of results specified in the project's Funding Proposal, to the required standards of quality and within the specified constraints of time and cost. The PMU will be responsible for overall project management and planning, providing support to the execution of day-to-day activities, coordinating with the national government and project partners, coordinating with the AE, managing and overseeing grants, and coordinating project execution across two project offices and four estuary sites. The PMU will also include the Operations and Finance Director, the Grants and Contracts Manager, the Project Accountant, and will receive support from the CI-Ecuador Senior Operations Director. Upon project inception, the Project Director in coordination with the Operations and Finance Director will prepare a Project Operations Manual, including responsibilities, procedures and details for a smooth and effective implementation, which will be approved by the Project Steering Committee. The project will also have dedicated full-time staff, including Monitoring & Evaluation Manager, Safeguards Manager, Gender Manager, Communications & Knowledge Manager, Procurement Manager and 3 Component Leads. Additional Project staff as detailed in Annex 4 will be based in Guayaquil and Esmeraldas.

In addition, CI, in coordination with MAATE, will establish an Estuary Field Unit (EFU) in each of the Project's four target estuaries (Cayapas-Mataje, Muisne-Cojimíes, Gulf of Guayaquil, and Jambelí) as regional execution offices. These EFUs will be housed in the MAATE Provincial Directions in Esmeraldas, Guayaquil, and Machala (as in-kind support from MAATE), and will each be led by two CI staff: an Estuary Coordinator and a Social Technician. Establishing EFUs in the estuaries directly involved in the day-to-day activities of the local associations is a cost-effective strategy for achieving the goals of the project. Evaluations on mangrove areas has shown that frequent technical support leads to sustainable change in behavior and practices in local communities to change behavior and practices. The Estuary Coordinator

will ensure effective liaison and coordination with local stakeholders and local governments, Component Leads, the PMU, and the other EFUs in implementation of the project activities, and the supporting staff will support implementation of Conservation and Stewardship Agreements with fishing associations and in-kind grants to local NGOs and universities.

Figure 38. Project Governance



Subgrantee Organizations

CI will provide GCF funding to several sub-grantee organizations to implement certain project activities or sub-activities (See Annex 23 of the Funding Proposal). CI will enter into a grant agreement compliant with GCF requirements with each of the sub-grantees. CI Ecuador will manage and monitor these subgrants, will approve grantees' annual workplans and budgets, and will have ultimate approval authority over their activities.

PUCESE will execute activities under Component 1 in the two northern estuaries in the project: Cayapas Mataje and Muisne Cojimies. PUCESE has prior experience working with local communities and local associations that depend on mangrove resources as well as developing research on mangroves and climate change. PUCESE is based close to the project area and has opened a new campus near the target Cayapas Mataje estuary. CI will enter into a cash grant agreement with PUCESE for the implementation of its designated activities in Component 1. CI Ecuador will apply risk mitigation measures and manage and monitor in-kind sub-grants to ensure that goods are used in a manner consistent with CI and GCF policies, including safeguards and prohibited practices.

FIAS will manage the Socio Manglar subaccount of the existing Socio Bosque Fund, under Output 2.2. $4 million of GCF funds will be provided to FIAS as a grant and held in an interest-bearing account apart from other Socio Manglar subaccount funds from other contributors. Interest generated from the account will be used by FIAS to pay Socio Manglar incentive payments to communities managing mangroves. FIAS is a private, non-profit entity that focuses on the management, mobilization, investment and implementation of public and private funds to finance conservation of natural resources and biodiversity, mitigation and adaptation to climate change and environmental quality, complementing the efforts of the Government of Ecuador. FIAS currently has over US$ 100 million in five funds under its management, with contributions from the Government of Ecuador, Germany, and Italy and other international sources. CI has contributed to three FIAS funds to date, including a US$ 4 million in grant funds for the Ecuador Azul Fund managed by FIAS.

Other Subgrants

CI will also provide goods and equipment via in-kind grants to PUCESE for Component 1 activities in the two northern estuaries and MAATE for Component 1 activities. CI will enter into an in-kind grant agreement (that will include CI and GCF terms and conditions) with each sub-grantee entity. CI Ecuador will apply risk mitigation measures and manage and monitor these sub-grants to ensure that goods are used in a manner consistent with CI and GCF policies, including safeguards and prohibited practices.

Two types of grants will also be made with community AUSCEM associations as described under outcome 1. The first type of grants will cover agreements for conservation, management and restoration activities as described under Activity 1.1.1. The second type of grants to community associations will be small cash grants for the development of enterprises and livelihood activities as described under Activity 1.2.2. Selection criteria for the small grants are included Appendix 5 of this document.

CI will enter into sub-grants with local universities to support data gathering related to monitoring on blue carbon, mangrove forest cover and socio-economic impacts of the project. Evaluation criteria for the selection of these universities are included in Appendices 7, 10 and 11.

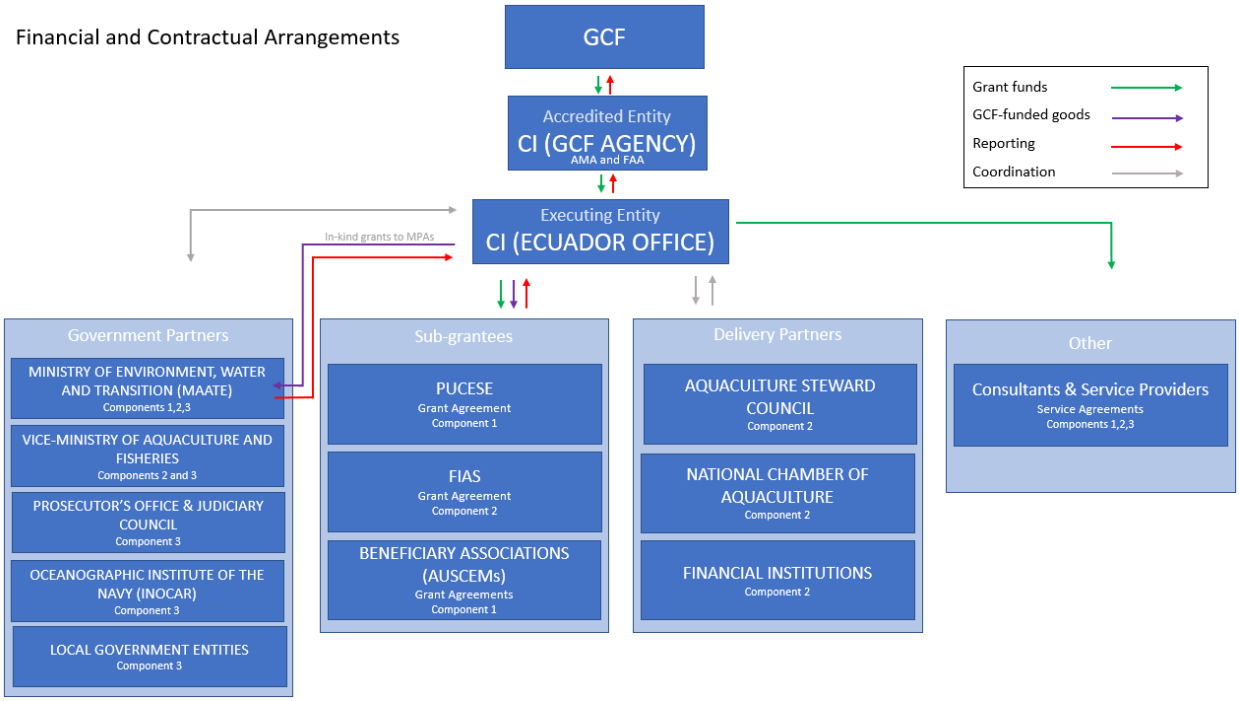
Other Implementation Partners

As described in section B.3, important partners will contribute to the implementation of the project but not receive GCF resources. CI will coordinate implementation of the project with these Implementation Partners (detailed in Annex 23) and will enter into agreements with them as appropriate to ensure clarity of roles and responsibilities of each party.

CI will work with key government partners, in addition to the NDA. The VMAP will support the CSS initiative in Output 2.1 and will support the harmonization of the legal framework under Output 3.2 . Provincial, municipal and Parish governments/administrations are key partners who will receive technical assistance to integrate climate-change adaptation and mangrove management measures into land-use planning as part of Activity 3.2.1. The INOCAR, Prosecutor's Office, and Judiciary Council will participate in training and capacity building under Activity 3.2.2.

Partners from the private sector will contribute to and support activities in Component 2, including the NCA, ASC, financial institutions, and the eco.bussiness Fund.

Financial and Contractual Arrangements



8 Sustainability

Project investments will cover startup costs driving a paradigm shift in the institutional, organizational and financial frameworks governing mangroves as a climate-change adaptation and mitigation tool, by both the private and public sector. The project includes various activities, which will be sustained after the project implementation period as explained below for each outcome.

Project Component 1: Mangrove areas under effective and climate-adapted management increased, including through community-based management (AUSCEMs) and protected areas implementing climate adaptation plans

Historically, a strong network of PAs together with local stewardship by community beneficiaries directly dependent on mangroves have together proven to be the most effective tools for maintaining and enhancing mangrove cover, with benefits for vulnerable populations beyond their immediate boundaries. Project investments in strengthening the administration of these areas, expanding their coverage, and explicitly incorporating climate risks and benefits into management will consolidate a foundation that will be institutionalized and extend beyond the project lifespan.

Sustainability beyond the project funding period will be ensured by a combination of legal, financial and social mechanisms:

- **Legal instruments.** AUSCEMs and Socio Manglar agreements create legally binding terms and agreements for community-based mangrove conservation and incentives for up to two decades. Project investments will support training, planning and administrative support to overcome initial establishment costs for agreements and thus scale up long-lasting coverage of these programs.

  AUSCEMs establish (renewable) ten-year commitments from communities to conserve and sustainably manage mangroves, recognized and enforced by the environmental authority. These AUSCEM contracts, established voluntarily and with mutual consent, between the government and community beneficiaries create strong formal commitments to mangrove protection, reinforced by the recognition of community stewards´ exclusive rights to sustainable economic uses. The Project will ensure AUSCEM protections for a target of 70,000 ha of mangrove including continuity or renewal of existing agreements (60,000 ha) and formalization of lapsed or new AUSCEMs (10,000 ha). Areas restored to mangroves under this component will be within AUSCEMs or within formally PAs to ensure continued protection of these areas beyond project implementation. In the case of areas within AUSCEMs, continued responsibility for ensuring protection of the restored areas will be included within the AUSCEM agreements.

  Reinforcing the terms of AUSCEMs, Socio Manglar agreements combine both legally binding commitments and incentive payments. The project will expand the coverage of Socio Manglar agreements to cover an additional 20,000 ha. In addition to the financial incentive, Socio Manglar agreements typically include additional legal provisions in their contracts beyond the terms of AUSCEMs including financial planning, accounting, tax obligations and reporting to the environmental authority and to the members.

These Socio Manglar agreements embody a 10-year renewable commitment on the part of the Government of Ecuador to sustain these areas and benefits. As noted in the project Theory of Change, an important assumption of the project is that the government continues to be committed to the use of AUSCEMs and Socio Manglar agreements.

The project also includes incorporating climate adaptation into the strategies of government-run MPAs. By integrating these strategies into the management plans of these MPAs, any long-term costs associated with them will be integrated into the regular MPA budgets. Ecuador's MPAs already have consistent funding annually from the government but there are also additional actions ongoing to increase the sustainability of funding for the MPAs through two dedicated Trust Funds. This work on MPA sustainable funding is not directly part of this GCF project but will contribute to the long-term sustainability of the GCF investments.

- **Local capacity:** Legal commitments and financial commitments will contribute to reinforcing a solid foundation of grassroots capacity built by the Project. Social capital and local livelihoods require legal and financial instruments, and vice versa. Mangrove-based associations already have a strong predisposition and interest in mangrove conservation, driving the signing of AUSCEM agreements covering 60,000 ha to date. By investing in organizational and planning capacity across 59 associations with AUSCEMs, the project will strengthen human capacity of these local organizations and PA staff to value benefits of mangroves, including climate resilience, based on a participatory, gender-sensitive approach. Further reinforcing local commitments to mangrove management, local enterprises will perceive increased economic benefits through the implementation of business plans and strategies that are economically viable and have continuity after project end.

  Local capacity and knowledge will also be strengthened on GHG monitoring (Output 3.1). This capacity for ongoing monitoring efforts will be integrated into national level GHG monitoring such that information on mangrove loss and associated GHG emissions will continue to be monitored after the project ends.

Project Component 2: The private sector becomes a transformational agent for change by reducing GHG emissions and providing financial support to conserve and restore mangroves that increase climate resilience for other coastal populations.

Long-term sustainability is the underlying rationale for this project outcome. By recognizing and internalizing the value of mangrove conservation and restoration in private-sector practices and investment decisions, the project will lay the foundation for ongoing action.

In the shrimp aquaculture sector, shifting a significant proportion of production area to climate-smart practices will lead to on-farm improvements in mangrove conservation and other climate-related practices over 20,000 hectares of aquaculture. By linking these actions by early adopters to public-private dialogue and market engagement, the project aims to shift policies, commercial strategies and common practice broadly across the sector, positioning the Ecuadorian shrimp sector internationally and driving demand and therefore further adoption of ASC/SSP certification and CSS practices. Once established as common, profitable practices and demand grows, any ongoing investment to maintain ASC/SSP certification status and CSS practices is expected to come from the companies themselves, either through self-financing made possible by enhanced profitability or from private financial institutions.

Certification schemes are designed to reward responsible farming practices. Globally, buyers in major markets are making strong commitments to purchase farmed seafood products from certified sources and ASC is a recognized leader in seafood certification. This growing demand provides the incentive needed for shrimp farms to invest in more sustainable practices and to undergo the assessments necessary to obtain certification. Once obtained the added value from the certification provides a strong incentive to maintain standards so as to compete in the marketplace that increasingly rewards strong social and environmental standards. Once there are early adopters of improved standards and the incentives of certification are more broadly appreciated by the industry, there will be a strong influence on other farms that have not yet adopted standards such as ASC, SSP or CSS. The project will remove the knowledge barriers that are currently blocking more widespread participation in certification and by the end of the project there will be more examples of small and medium farms that have obtained private financing that will serve as examples for the industry and for the financial institutions that invest. The market-based incentives created by certification, and the influence of best practice among early adopters, combined with improved regulation (through the activities of Component 3) should mean that more attention is paid to environmental concerns including ensuring no further clearing of mangrove beyond the project implementation period.

Across different economic activities, the project's structuring and strengthening of financial mechanisms with the support of the private sector, in particular for the Socio Manglar program, will secure investments during the project lifespan to capitalize ongoing support as well as consolidate mechanisms that can continue to attract additional finance post-project.

In addition, development of market recognition and support for climate smart shrimp and the design and implementation of agreements with shrimp farmers and national and international buyers will be implemented starting the second year of the project. By midterm, 1 agreement with key market buyers and another by the end of the project will be negotiated. This process will include of communication events with farmers and traders (Activity 2.1). At the end of the project the role of the NCA and SSP is key for the continuation of the involvement of market arrangements for CSS farms.

The project will expand a dedicated long-term finance mechanism to assure continuity of resources for the Socio Manglar incentive payments for communities, and leverage commitments from the Government of Ecuador, which will provide US$ 449,000 per year for these incentives during the project (included as co-finance). The project will contribute to capitalizing the Socio Manglar subaccount of the existing and highly successful Socio Bosque Fund that supports community management of terrestrial forests. The Socio Manglar subaccount has been created as part of the project preparation. The Socio Bosque Fund is managed by the national endowment and investment fund for the environment – FIAS[45]. Four million dollars (US$4 million) of GCF funding is requested to increase the capital of the Socio Manglar subaccount and will be managed in an interest-bearing account whereas other contributions to the subaccount will be invested according to the investment policy of FIAS. The GCF contribution is expected to leverage additional private investment including from companies involved in shrimp aquaculture and Ecuador's PECC. Projections for the growth of the capitalization and use of the subaccount are provided in Appendix 12. As part of project preparation, US$ 50,000 has already been provided by the ASC and US$100,000 from CI-Ecuador to establish the Socio Manglar subaccount. By clearly demonstrating and documenting

[45] Fondo de Inversión Ambiental Sostenible – FIAS.

emissions mitigation benefits the project will also contribute to creating the necessary conditions for results-based payments (RBPs) for mangrove conservation in the long-term.

Project Component 3: Create the enabling conditions for sustaining reductions in mangrove deforestation and increased mangrove restoration by strengthening governance, climate change adaptation strategies, coastal management policies, and legal enforcement.

Sustainability and long-term permanence of improvements to policies and public institutions will be ensured by a combination of legal/regulatory instruments and institutional capacity.

A key set of outputs of this Project Outcome relate to the inclusive development of policy, planning and legal instruments that will govern management, enforcement and government budget allocations. These instruments will extend beyond the end of GCF funding and will include instruments at various levels:

- GADs will have codified mangrove conservation and climate considerations in local development plans, regulations and policy frameworks (e.g., municipal ordinances, budgets, PDOTs, COA, integrated coastal development plans), ensuring the basis for long-term application of these regulatory instruments guiding development and public investment.
- Harmonized public policy instruments for the management of the mangrove ecosystem (e.g., procedures for assuring transparency in regulation, decision making and enforcement action, inter-agency cooperation for establishing technical standards
- Improvements in procedures at MAATE for reception and processing of complaints, enforcement and sanctions, reflected in regulatory reforms formally adopted by Ministry and/or other public entities.

In addition, capacity building for national and regional institutions will help ensure that institutions can continue to monitor the effectiveness and sustainability of their actions after project completion and improve their effectiveness. Key partners in project implementation have been, and will be, involved in all aspects of project design and execution to ensure that they can sustain these activities after the GCF funding concludes:

- Mangrove forest and carbon monitoring (PUCESE and other local universities*).* Forest monitoring data specific to mangroves, including robust accounting of soil organic carbon, will be generated by the project with the aim of including a robust set of data and methodologies for inclusion by Ecuador´s MAATE in the national Forest Reference Emissions Level (FREL). Ecuador's FREL, generated and reported by MAATE, serves as the basis for monitoring, reporting and verification of UNFCCC commitments as well as arrangements for results-based payments (RBP). By incorporating this very significant carbon pool and sequestration into national monitoring, Ecuador will be able to provide a more comprehensive accounting of emissions and reductions as well as potentially mobilizing additional carbon finance.

- Enforcement and judicial employees. Institutionalization of training programs, curricula and materials developed by the program will provide the basis for ongoing replication by MAATE and the Judicial Branch after the project concludes.

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11. Appendices

Appendix 1: (Translated from Spanish) The methodology for assessing the management effectiveness of concessionary organizations:

1. Determining compliance with the terms of the agreement by:

Establishing the level of compliance with the commitments stipulated in the agreement issued by the MAATE.

- Reviewing the level of compliance with the approved Management Plan, and the benefits of the activities implemented.
- Review the most recent mapping of mangrove coverage carried out by the MAATE in each of the concessions granted to the 20 beneficiary organizations subject to this evaluation.

2. Determine the performance of the grantee organization through:

- Interview and review of documentation.
- Interviews with other actors (i.e., institution responsible for technical assistance, authorities and independent informant) to triangulate information and obtain independent points of view.

3. Determine performance of entity responsible for technical assistance, by:

- Interview and review of documentation.
- Interviews with other actors (i.e., beneficiary organization, authorities and independent informant) to triangulate information and obtain independent viewpoints.

4. Determine the endorsement of the controlling authorities through:

- ● Assessing performance by the MAATE through: Interview and review of documentation. Interviewing other actors (i.e., beneficiary organization, entity responsible for technical assistance, other authorities and independent informant) to triangulate information and obtain independent views.
- Assess the performance of other competent authorities through: Interview and documentation review. Interviews with other actors (i.e., beneficiary organization, entity responsible for technical assistance, MAATE and independent informant) to triangulate information and obtain independent views.

Bioeducar.2017. Management Effectiveness Evaluations Of Beneficiary Organisations Of Sustainable Use And Mangrove Custody Agreements In The Provinces Of Guayas And Manabí. Integrated Management of Marine and Coastal Areas of High Biodiversity Value in Continental Ecuador (MAE), Conservation International Ecuador (CI-Ecuador) and the Humanist Institute for Cooperation with Developing Countries (Hivos), thanks to funding from the Global Environment Facility (GEF) and technical assistance from the Food and Agriculture Organization of the United Nations (FAO).

Appendix 2: Socio economic impact evaluation (SIE) Methodology

Socio economic impact evaluation (SIE)

The SIE has the main objective of assessing the effects from project proposed activities on environmental and socioeconomic outcomes (i.e., climate mitigation and emissions reductions, resilience, enhanced livelihoods). The SIE design can potentially detect an effect between treatment and control groups within the project implementation period for the following activities:

- Management tools and incentive systems applicable to mangroves and coastal communities and integrate climate change adaptation strategies (Activity 1.2.1).
- Implementation of Community-based Restoration Plan in 2000 ha of newly forested area (Activity 1.2.2).
- Implementation of 10 agreements for the financial sustainability of the National Incentive Program Socio Manglar (Activity 3.1.1)
- Develop agreements with private companies to increase reforestation and community resilience targets (Sub-Activity 3.1.2)

In addition to collecting baseline data and monitoring the indicators of the selected activities, the SIE will require collecting additional data on observable covariates to create the counterfactual, i.e., what would have happened in the absence of the intervention (Ferraro, 2009; Ferraro & Hanauer, 2014). Data collected will be used in measuring the difference between treatment units (e.g., communities, mangrove plots) and control units against intermediate outcomes as the project progresses, which would be indicative of trends of the long-term outcomes. The programmatic activities are set to test the projects theory of change and to show how the project activities improve the current conditions (e.g., land use and land cover change, resilience, and socioeconomic) relative to desirable conditions in coastal localities in Ecuador. However, capturing an effect from the indicators selected that are related to intermediate outcomes will require collecting quality data and scientific rigorous methods. It will be difficult to demonstrate desirable changes or to detect an effect in the six years of the project for several of the proposed activities; those effects may be detectable in the longer term, beyond the project's life.

Impact Evaluation Design

Rigorous SIE methods help to assess effectiveness: what works, what does not, and the causal effect on desired outcomes from interventions. Conducting a SIE is also important because the design of the intervention can lead to unintended consequences or spillover effects; for example, restricting fishing in one location can lead to overfishing in other locations (Pfaff & Robalino, 2017). If not done properly a policy or program assessment can provide biased results because in most interventions the treatment is not randomly assigned to the units of interest. In consequence, the results do not capture the treatment effect on the outcome or overestimated effects, whether these are positive or negative (Imbens & Wooldridge, 2009; Khandker, Koolwal, & Samad, 2010).

For situations where randomized controlled trials are not possible, researchers rely on observational or quasi-experimental approaches for SIE, which account for the identification of the counterfactual approaches and provide a rigorous solution to empirically quantify the counterfactual scenario to attribute the causal impacts to the interventions (Woodhouse *et al*., 2015). A quasi-experimental design

for SIE controls for the non-random allocation of interventions and reduces bias in the estimated impacts through a matching procedure. Additionally, SIE contributes to providing the scientific evidence to test whether the causal changes are connected to the policy intervention pathways and reveals the ways the program is leading or not to the outcomes, e.g., improved incomes, less mangrove degradation, sustainable yields. Conducting an SIE would also help untangle interdependencies and feedbacks between the elements in the social-ecological system, as in the case of Ecuador (Figure 1).

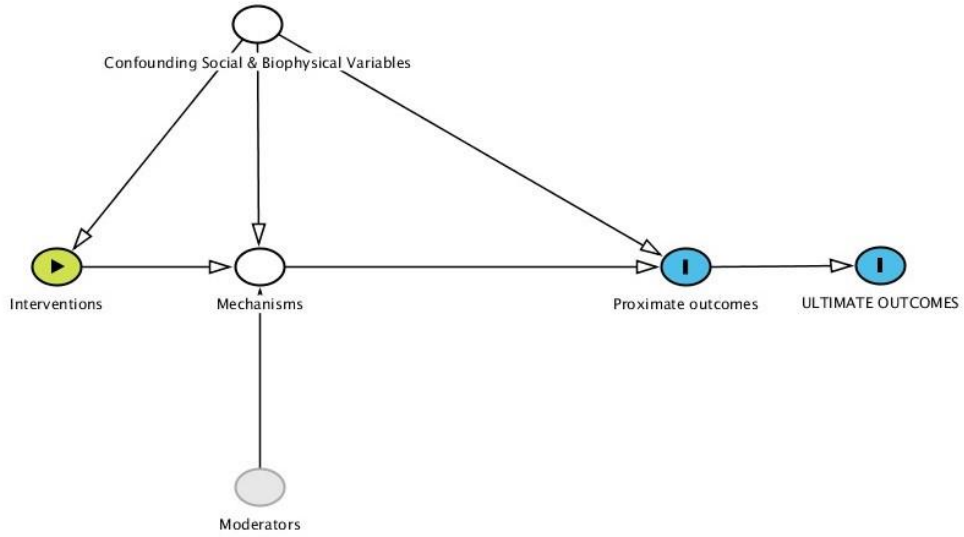

Figure 1. Simple exemplification of the causal pathways of connecting ovals and directionality. The graph depicts how the local interventions in Ecuador (green oval) affect the proximate outcomes which lead to ultimate high-level outcomes (ovals in blue). The source of confounding variables (white ovals) are the elements of the coupled social-ecological systems. The values for these variables will be collected through different instruments. The directionality of the causal pathway is indicated by arrows. The pathway is moderated by variables represented with a gray oval, some of which may have an effect at local or regional level; these moderators (e.g., participation in community activities, community capacity) affect the magnitude of the impact of the interventions or the mechanism. The causal relationship conforms the assumptions in the theory of change to be tested through the impact evaluation design.

The theory of change for the SIE design relies on fitting models using measurements on observable covariates known to affect the treatments and the outcomes, or both (Ferraro & Hanauer, 2015; Pan & Bai, 2018). Some of the covariates include data from the ecological system (e.g., land use change, temperature, precipitation, hydrology, water biophysical characteristics) and the social system (e.g., community governance structure, decision making processes, and management). We will use social science tools like questionnaires, Likert scales, ranking scales as well as biophysical science methods like remote sensing to collect relevant data. We will apply all data collection instruments to a random sample of treated and control units of analysis (e.g., pixels, participating and non-participating households, communities). We will gather additional information with key informants directly in charge or working on the intervention activities. To conduct the comparison across treatment versus control groups, we will

randomly select units of analysis. We will estimate a sample size large enough to provide sufficient statistical power to detect a treatment effect between units (Ellis, 2010).

The treatment variable is a dichotomous measurement on whether the unit of analysis is exposed to the intervention or not. The outcome variables are continuous longitudinal or categorical data values measured for the units and periods relevant to the SIE (e.g., index of socioeconomic status changes, levels decentralization in community decision-making, avoided carbon emissions). We will use a matching procedure to reduce selection bias when estimating the impact that can be attributable to the intervention in the presence of systematic differences between treated and control or the counterfactual units. The procedure involves pairing treatment and comparison units that are similar in terms of their observable characteristics that affect the outcome and treatment (Rubin & Thomas, 1996). We will build the counterfactual based on selected observables. These socioeconomic and biophysical temporal and spatial data will enable us to implement several econometric modelling technics. For example, to identify the counterfactual, we will use propensity score matching (PSM) to match treated with untreated units based on observable covariates. PSM is used to quantify the probability of receiving the intervention (Guo & Fraser, 2014). Specifically, the control and treated units would have similar distributions of confounding characteristics of the respective unit of analysis (e.g., elevation at pixel level, assets for households, and institutional governance for communities).

In addition, we will implement a Multilevel or Hierarchical Model with matching (MLM or HLM) of nested data to what nested factor help explain differences within and across units. Researchers will use HLM for data that have a clustered structure where individual units are nested into clusters (e.g., pixels or households nested into regions, into provinces, into countries). This approach is intended to avoid bias that can arise from omission in the matching techniques model of individual and/or cluster-level confounders (Arpino & Cannas, 2016; Arpino & Mealli, 2011). Once we have identified the pool of matched treated and control units of analysis, we can measure the difference to get the average treatment effect on the treated (ATT) by using difference-in-difference, post matching regression, time series analysis, and multilevel models (Jones & Lewis, 2015).

The SIE will be implemented in year two for the baseline and in year five and six for the endline. For this sub-activity the support of Social Science at CI will be key for the design of the monitoring system and the processing and analysis of the information. Also, the project will implement service agreements with local universities in Ecuador for the data gathering and training.

Appendix 3: Methodology for Identification of Priority Areas for Mangrove Reforestation

The following procedure was applied for the selection of potential mangroves to be restored:

A set of polygons was established consisting of mangroves registered in 1999, 2006 or 2016 and no longer appearing in 2018.

For this group of polygons, five criteria were analyzed:

1. Area: patch size (polygons smaller than one hectare were eliminated).
2. Connectivity with current mangroves: Percentage of the perimeter of the polygon that connects with current mangroves.
3. Proximity to ports: Distance to the nearest port to the polygon.
4. Shape index: Ratio between the surface area of the polygon and the surface area of a polygon of equal perimeter.
5. Maximum vulnerability: Referred to the CIIFEN vulnerability assessment. To integrate the CIIFEN vulnerability data (six criteria), the 'very high' and 'high' categories were prioritized for each census sector. For each census sector, the number of criteria corresponding to these categories was counted. That is, each census tract could have a rating from 0 to 1. 0 corresponds to census tracts where no criteria were rated 'very high' or 'high'. While a census tract with a score of 6 corresponds to a site of 'high vulnerability' for the six criteria analyzed. This integrated result was crossed with the mangrove polygons and each polygon was assigned the maximum number of prioritized criteria in that polygon.

Each of the above criteria was categorized on a priority scale of low, medium and high.

Each of these categories received a rating, as follows: low (1), medium (2) and high (3).

To define the overall prioritization, these partial ratings were added together.

The overall sum was reclassified into three categories: low, medium and high.

Appendix 4: Site Selection Criteria for Reforestation Areas

Conservation Priority	Why is the site important for biodiversity or ecosystem services?
	Is information about the site's importance available? What types of information? Do you have access to this information?
	If additional assessments are undertaken to assess conservation priority, bear in mind the need for baselines to be used for future monitoring.
	Does coastal autonomous local governments with mangroves have as a priority to include the mangrove ecosystem in their territorial planning and environmental management?
	Does the autonomous governments consider the health of the mangrove ecosystem within their scope to confer environmental licensing to shrimp farms in its administrative territory?
Threats to biodiversity or ecosystem services	What are the major threats and how difficult will it be to address them?
	Who is responsible for the major threats?
	Are the conservation activities you might include in an agreement sufficient to reduce or eliminate the threat? If not, what else is needed in the overall strategy for the site?
	Can the government offer guarantees so that the threats to mangroves caused by human activity are successfully combated?
Resource users as an effective conservation partner	How are they organized? What is their governance structure?
	How are decisions made? If through traditional structures, how are women or other marginalized people included?
	Do they have elected leaders? For how long? What is their role?
	Who can provide consent on behalf of the community?
	How can we ensure that decision-makers reflect community-wide perspectives?
	Do they have traditional resource management rules? What kinds of rules?
	How are rules enforced?

	What are the main institutional or capacity weaknesses of the resource users?
	Do resource users carry out communal activities? What types of activities?
	What are their main economic activities? Do these activities differ between men and women or other social groups (e.g., youth)?
	Are there established markets for their products? If so, who are the main buyers?
Resource rights	Who owns and who uses land and resources? (e.g., A man might own the land, but his wife is the one who farms it.)
	Who holds legal rights over resources to be protected (land titles, use rights, benefit, sharing rights)? If users are not owners, how will their rights and needs be respected?
	Are there conflicts of use between different resource users?
	If resource users do not hold legal rights, do they have customary rights? Can they exclude others from using the resources to be protected? How?
	Can legal rights be obtained by/transferred to the resource users? How?
	Is the carbon sequestration coming from restoration areas included in a claim for an institution?
Legal context	Do overlapping rights conflict with conservation objectives (e.g., subsurface mineral rights)?
	What legal options do resource users have to protect their resources?
	Is the rule of law reliable (e.g., application of penalties by authorities, effective court system)?
	What options are there for legal protection in the long term (e.g., transfer of resource rights, protected area establishment, etc.)? How viable are these options?
	New legal tools will be designed to assign tenure and custody rights over the restored areas.

Policy context	What are the likely effects on the project of supportive policies (e.g., government support for community-based management) and of unfavorable policies (e.g., policies that promote habitat conversion)?
	Are there policies that will directly impact the implementation of conservation agreements (e.g., plans for hydroelectric dam construction)?
	What previous conservation and/or development efforts have taken place with this group of resource users or in the area?
	Will local governments include in their territorial planning: funds, ordinances and actions for the conservation of mangroves?
Implementation capacity	What is the conservation (or other) mission of the proposed implementer?
	Do they have good relationships with the community or a track record of good relationships in similar places?
	Do they have experience in implementing relevant activities (e.g., community engagement, reforestation, species management, patrolling, etc.)?
	Do they have good relationships with local, regional and national authorities to support the implementation of the activities in the field?
	Do they have good relationships with shrimp producers to support the implementation of the activities in the field?
	Do they have experience engaging with marginalized populations (such as women, ancestral users, youth, etc.)?
	What are their weaknesses? Do they need support from other partners?
	If additional partners are needed (e.g. to deliver development benefits such as fisheries extension services), who are they and what is their capacity?

	In the event that this becomes a long-term agreement, is the implementer prepared to accept this responsibility or is there an alternative vision for long-term management?
Stakeholder and conflict analysis	Who are the main stakeholders who can influence use of the resources to be protected under the conservation agreement?
	Which actors need to be engaged to ensure success of the agreement?
	Are there organizations undertaking related activities in the area? Do their efforts offer potential synergies?
	What existing or potential conflicts are there among the resource users? Are they caused by internal or external factors? What are they?
	Are there parties who will not be involved directly in the project but who will experience impacts that must be considered?
	What options are there for managing existing or potential conflicts that you have identified?
	Could there be duplication of investment and efforts due to high interest from other organizations to invest in similar issues to the GCF initiative?
Project costs	What are the expected costs of designing and negotiating the conservation agreement?
	What are the expected opportunity costs (e.g. the value of forgone timber harvests; see p. 2)? What are the expected costs of the anticipated conservation activities? What is the expected cost of the benefit package? (for detailed explanation, see Annex 3)
	Once the agreement is signed, what are the expected operating costs (salaries for the engagement team, travel, workshops, etc.)?
	What are the expected costs of biological and socioeconomic monitoring?
	What are the expected costs of long-term technical support?

	What are the expected costs of capacity building, training, communication, equipment, supplies that can be covered by local government, universities or AUSCEMs?
Financing options	What potential sources exist to fund design of the agreement and implementation of activities, as well as long-term sustainable funding? (bilateral and multilateral institutions, corporate and private donors, foundations, payments for ecosystem services, etc.)
	What financing mechanisms might be considered for long-term financing of the site? (PES, REDD+, government support, trust funds, corporate offsets, etc.)
	What are the expected costs of fundraising activities to secure long-term financing?
	Could financial mechanisms such as debt swaps or taxes reductions paid by aquaculture sector be applied to invest in the conservation of the mangrove ecosystem?
Management sustainability	What will be the medium and long-term management needs for the site? Such needs can include resource management and governance, as well as management of a long-term conservation agreement if that is part of the potential project vision.
	Who can take responsibility for these management needs?
	What investments might be required to ensure the needed management capacity?
	What commitment mechanisms should be assumed by the mangrove users so that they support the sustainability of the actions implemented by the project?
	What legal mechanisms should be implemented to ensure the commitment of the authorities regarding mangrove conservation?
Exit Strategy	How long will the conservation investor need to support the conservation agreement?
	How will the conservation agreement transition away from dependence on the conservation investor?
	How long will the implementer need to be directly involved in the conservation agreement?
	How will the conservation agreement transition away from dependence on the implementer?

	How to ensure that the technical capacity achieved is transferred and used at different academic, private, political and social levels?

Appendix 5: Criteria for evaluation of grant applications support to micro- and small enterprises of mangrove community associations.

Selection Criteria	Points	Description	Association 1	Association 2	Association 3
1. Women's involvement	10 points	Are women included as members of the AUSCEM? In what percentage? Are they part of the ASUCEM board?			
2. Access to technical support	10 points	Are NGOs, Universities, or other organizations directly supporting the AUSCEM in implementing, monitoring, and reporting?			
3. Number of beneficiaries	10 points	The number of direct fishermen and their families that receive benefits from the AUSCEM.			
4. Access to training and improvements	5 points	The members of the AUSCEM have been directly involved in the training activities that the project has implemented in the Estuary. Is the new knowledge being implemented in the AUSCEM?			
5. Compliance reports to MAAE	5points	Has the AUSCEM been providing the reports directly to MAATE annually? Do the reports have been approved?			
6. Use and Custody Agreement	10 points	Have any infractions and affectations to mangrove areas in the past two years?			
7. Evaluation of the technical proposal	50 points	Decisions of the Technical Committee conformed by MAATE, PUCESE, CI, and other organizations.	MAATE		
			CI		
			PUCESE		
			Other		
Total (100%)					

The Value of Mangroves in Ecuador for Flood Risk Reduction

An analysis for Conservation International in support of a Green Climate Fund proposal with the government of Ecuador

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Overview

Mangroves provide coastal protection by reducing the flooding that would occur from storms and the resulting damages to people and property if these mangroves were absent. The 'avoided damage' valuation approach uses the cost of damages prevented by mangroves to estimate the value of mangroves (see Figure 1). This value is estimated using a combined set of process-based storm and hydrodynamic models. The models (i) identify the area and depth of flooding; (ii) run model scenarios with and without mangroves; (iii) for five storm frequency events, 1 in 5, 10, 25, 50, 100-yr driven by the frequency of local storm data. Flood extent and depth data are overlaid on produced capital stock and population, downscaled to 90 x 90 meters to identify a probabilistic distribution of flood damages (risk) and avoided damages (habitat benefits). Based on work recently developed for the World Bank Changing Wealth of Nations project (Lange et al. 2021) we estimated flood risk and mangrove benefits for three time periods 1996, 2010 and 2015, with global data on the historical distribution of mangroves.

Methods

Below we summarize the core methods and models. These methods have been applied in previous projects to assess the value of mangroves for coastal protection in the Philippines, Jamaica and globally (Menéndez et al. 2018, Beck et al. 2019a,b, Menéndez et al. 2020, Lange et al. 2021). These models have been extensively validated (Menéndez et al. 2018, 2019, 2020). We use this approach in coastal profiles (from land to sea) spaced 1 km apart for all mangrove coastlines. We group profiles to create core 20-km study units.

(i) **Estimate offshore dynamics from storms.** We first define the atmospheric events (e.g., cyclones and extratropical storms) that could affect the profiles in each study unit. These storms could be hundreds of miles away from the coast. We identify the maximum waves and sea levels (i.e., surge) driven by these storms. The data sets on tropical cyclones and waves are global and provide locally specific information from more than 7,000 historical cyclones (Knapp et al., 2010) and 32 years of data on waves and sea level, respectively.

(ii) **Estimate nearshore dynamics.** Once we resolve offshore dynamics, we obtain maximum waves and storm surge on the seaward side of each profile. These waves and storm surge interact with the sea floor and other nearshore features (e.g., islands), which affects water height and direction through shoaling, refraction, diffraction, and breaking processes.

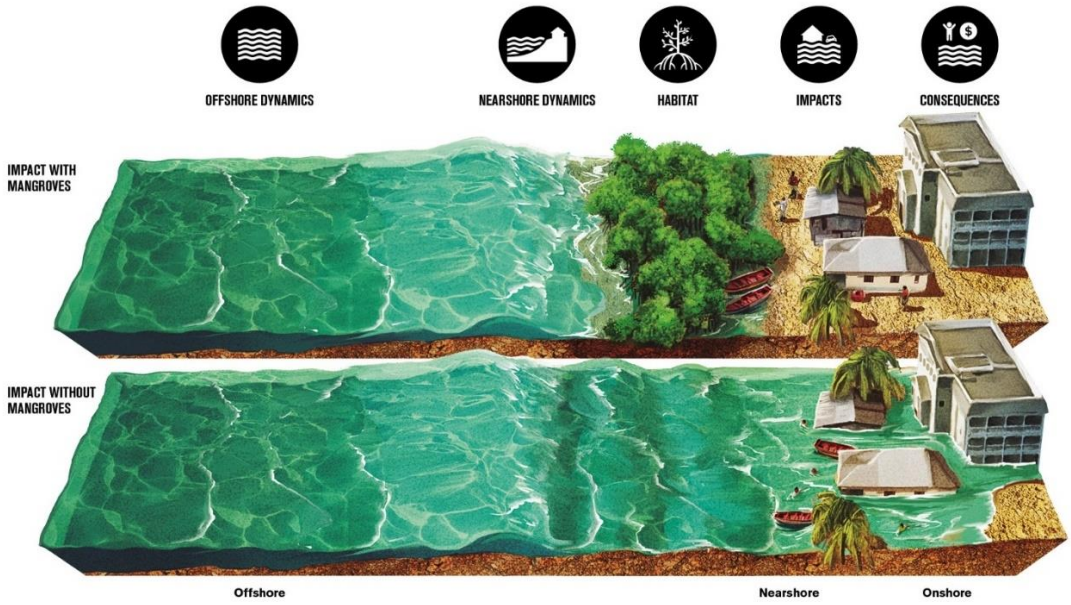
(iii) **Estimate the effects of mangrove habitat on flood reduction.** Waves and storm surge are dissipated as they propagate through the mangrove forest towards the shore. We developed and validated a model in the Philippines that assesses the effects of mangroves on waves and storm surge and calculates the resulting flood height at the coast. We use the maximum flood height of each storm to reconstruct long term time series. Then, we apply an extreme value analysis to obtain 1-in 5, 10-, 25-, 50- and 100-year extreme sea levels at the coast.

(iv) **Calculating impacts by developing flood maps.** To estimate the extent and depth of flooding onshore due to extreme sea levels at the coast (1-in 5, 10, 25, 50 and 100 year). We use a GIS model that intersects flood height with topography and accounts for hydraulic connectivity (i.e., ensuring that flooding in a 90m x 90m cell is physically connected to nearest neighboring cell). The outcome of this stage are flood maps for different return periods (1-in- 5, 10, 25, 50- and 100-years) with and without mangroves for each of the 3 years assessed, 1996, 2010, and 2015 (see Figure 2 for an example flood map).

(v) **Assessing Consequences by valuing flood risk and mangrove benefits.** The expected flood risk and benefits provided by mangroves are assessed socially and economically. We intersect the flood maps with population data from GHS-POP (https://ghsl.jrc.ec.europa.eu/ghs_pop2019.php) and built stock data from the Penn World Table version 9.1 (https://www.rug.nl/ggdc/productivity/pwt/). This intersection gives the number of people and the value of assets to coastal flooding. We determine flood damage using depth-damage curves, which identify the flood damage that would occur at specific water depths. Two sources of information have been used to obtain these damage curves: the EU Joint Research Centre (JRC) (Huizinga et al., 2017) and US Hazus (Scawthorn et al., 2006).

Additionally, we use data from the Ecuadorian census identifying the distribution of the overall population and those living in poverty. The latter is defined in the census as "Poverty due to Unsatisfied Basic Needs (UBN)" using a multidimensional poverty measure developed in the 1980s by the Economic Commission for Latin America and the Caribbean (ECLAC). The method covers five dimensions (economic capacity, access to basic education, access to housing, access to basic services and overcrowding) and within each dimension there are indicators that measure deprivation.

Figure 1: Key Steps and Data for Estimating the Flood Protection Benefits Provided by Mangroves. Step 1. Offshore dynamics: Oceanographic data are combined to assess offshore sea states. Step 2. Nearshore dynamics: Waves are modified by nearshore hydrodynamics. Step 3. Habitat: Effects of mangroves on wave runup are estimated. Step 4. Impacts: Flood heights are extended inland along profiles (every 1 km) for 1 in 10, 25, 50, 100-yr events with and without mangroves to estimate impacts. Step 5. Consequences: The consequences to land, people and built capital damaged under the flooded areas are estimated (adapted from Beck et al., 2019a). ©PuntoAparte.



Results

The maps below summarize a few of the key results provided in the attached spatial databases.

Figure 2: Projected flooding in Ecuador with (in blue) and without (in red) mangroves for a 1 in 25-year storm event based on the methodology of Menendez et al. (2020).

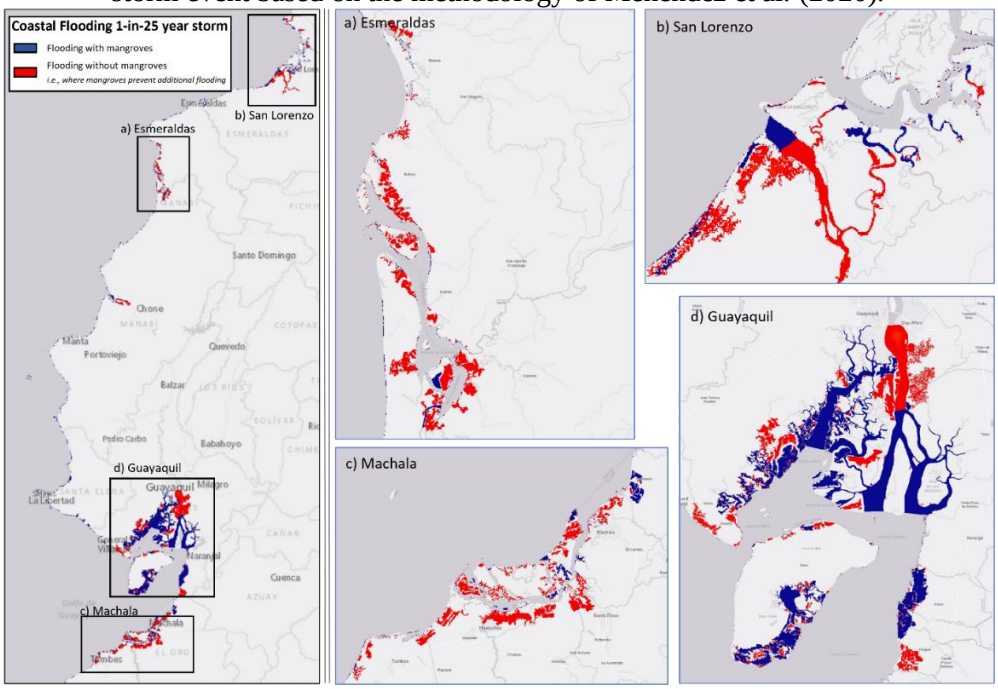


Figure 3: Mangroves Distribution and their Annual Expected Benefit for flood risk reduction by parish across Ecuador (2010).

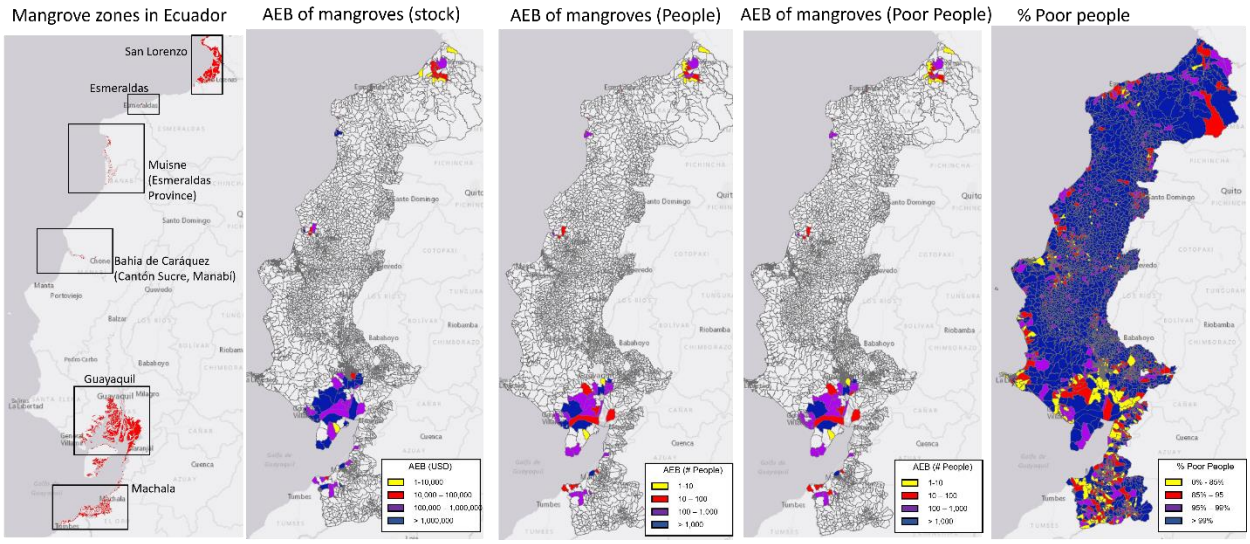


Figure 4: Mangrove Distribution and their Annual Expected Benefit for flood risk reduction by parish across Guayaquil.

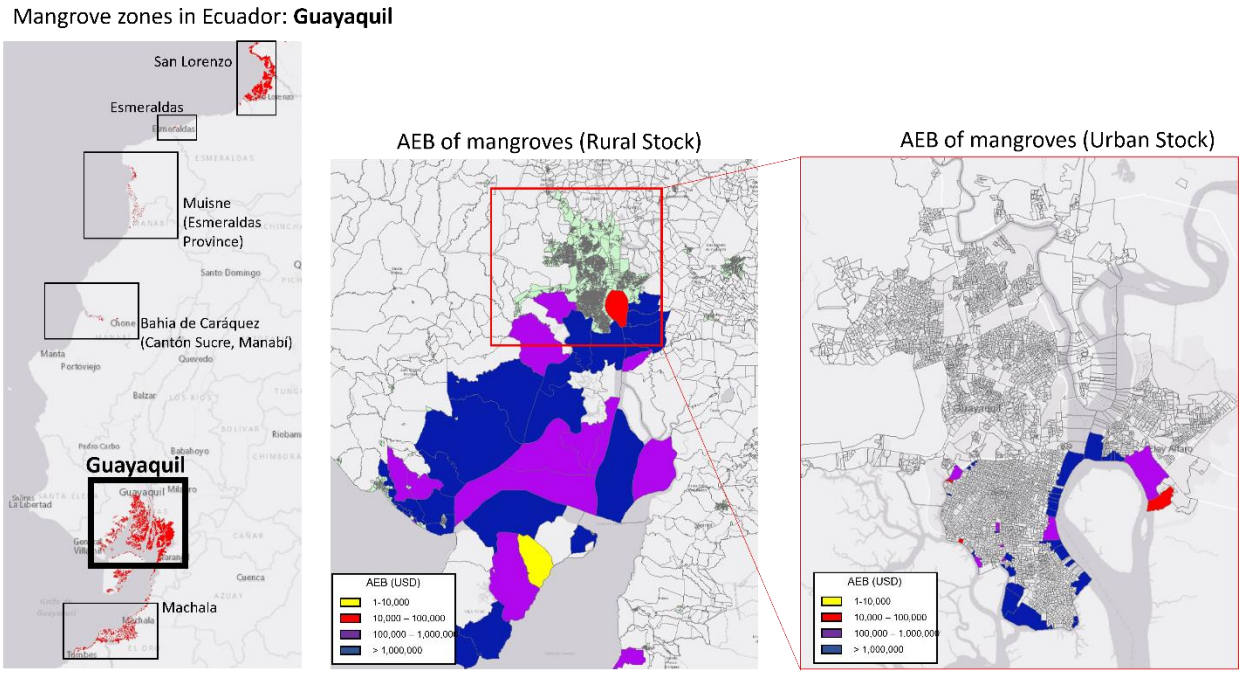


Figure 5: Annual Expected Benefit for flood risk reduction to people by parish across Guayaquil.

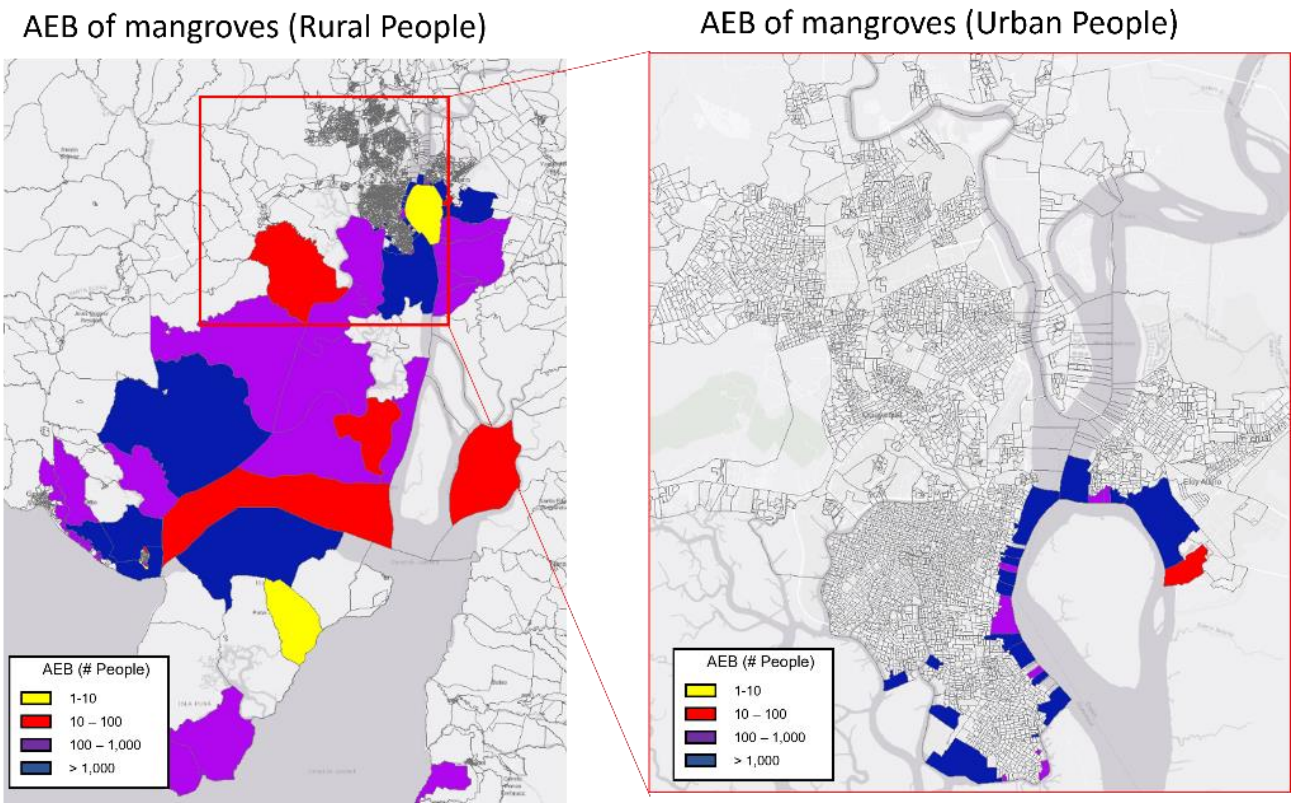


Figure 6: Annual Expected Benefit for flood risk reduction to people living in poverty by parish across Guayaquil.

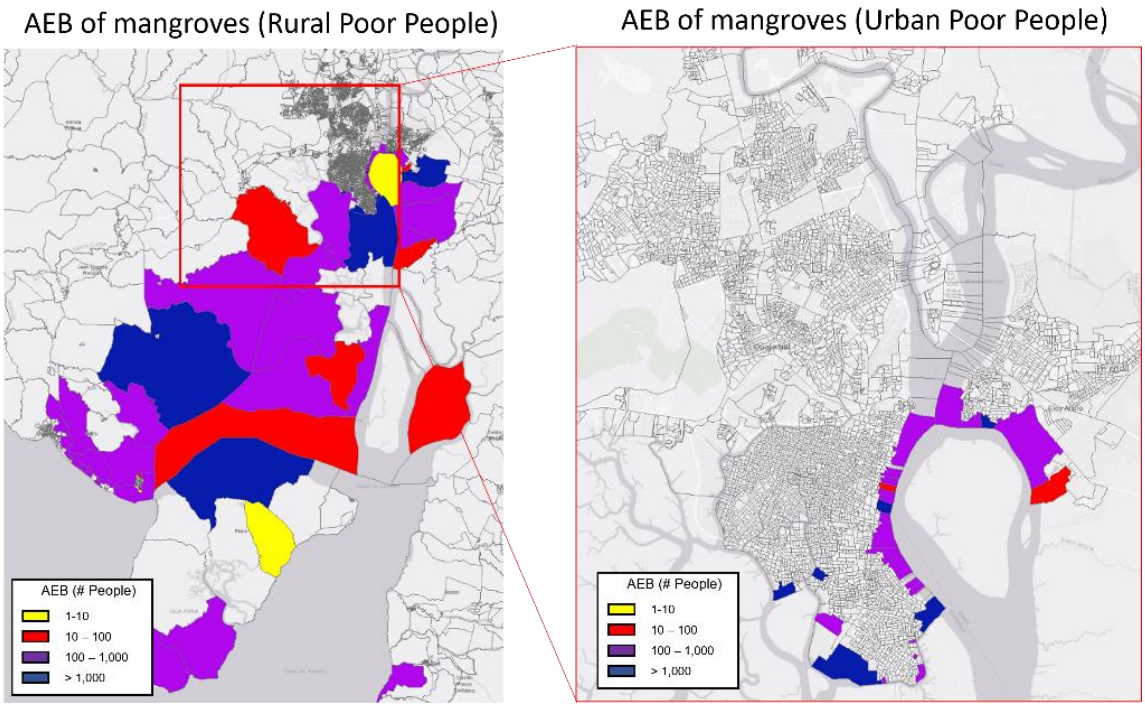


Figure 7. Change in Mangrove Distribution in Ecuador 1996, 2010, 2015.

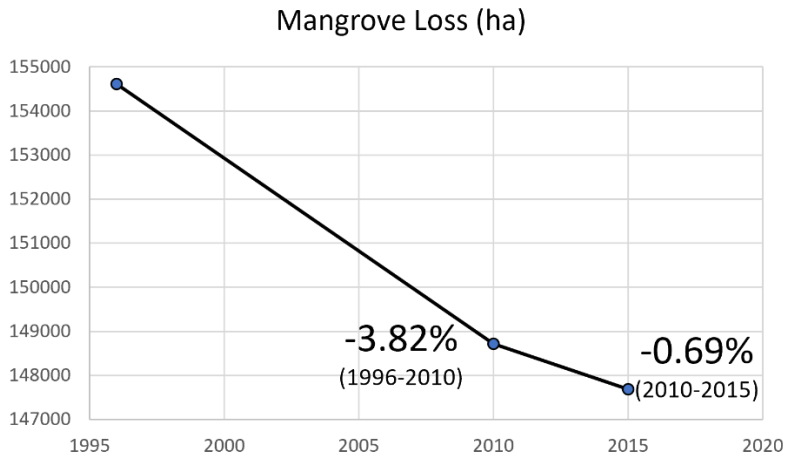


Figure 8. Change in Flood Risk on Mangrove Coastlines 1996, 2010, 2015.

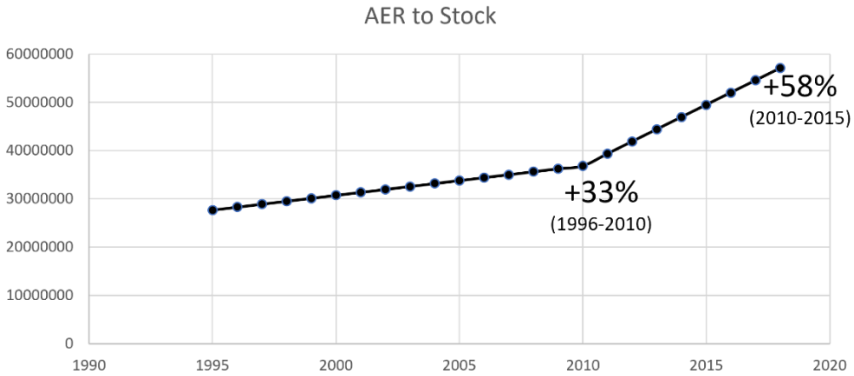
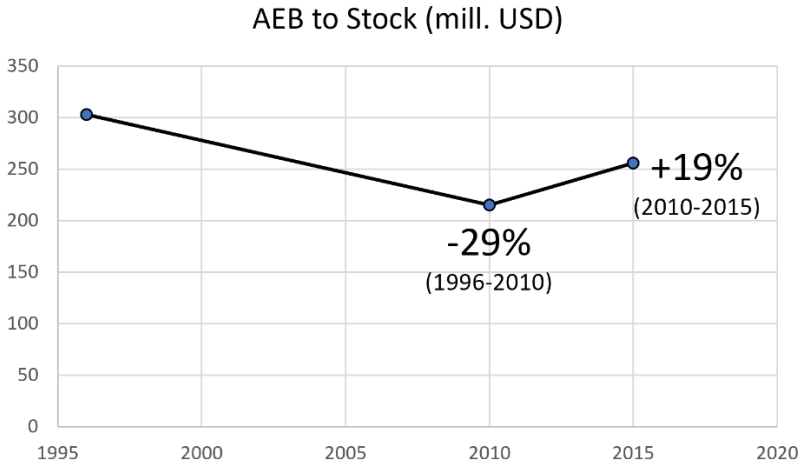


Figure 9. Change in Mangrove Benefits in Ecuador for Flood Risk Reduction 1996, 2010, 2015.



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Appendix 7: List of eligibility criteria to select universities to support the collection of socio-economic monitoring data

The following is a list of suggested criteria to help CI-Ecuador select universities that would conduct household surveys for the socioeconomic data collection and monitoring in participating villages and control villages as part of the proposed project Activity 3.1.1. The list can be extended to include criteria related to more specific climate change measures related to vegetation change, soil sampling in mangrove habitat and wetlands. This is an idealized list and universities may not be able to check all suggested criteria, as such, the list is proposed to help guide the selection process.

Expertise in Social Sciences. Strong departments or faculties specializing in social sciences (e.g., sociology, anthropology, economics, environmental studies, development studies). Faculty and students from these units and disciplines would have a solid foundation for conducting household surveys and for understanding socioeconomic factors associated with climate change adaptation and mitigation through the protection of mangroves and wetlands.

Field Research Experience. A track record of conducting field research in rural or remote areas of Ecuador, preferably in coastal areas. Experience in working with communities, understanding local contexts, and adapting research methodologies to challenging environments is ideal.

Collaboration with local organizations. University units with established partnerships with local NGOs, community-based organizations, or government agencies in rural areas, especially in coastal areas. Having connections with local entities will facilitate access to remote communities and enhance community engagement.

Sensitivity to Local Culture and Traditions. University units, faculty, and students that demonstrate cultural sensitivity and an understanding of the local customs and traditions of the communities in the project area is critical. Respectful engagement with the community is crucial for obtaining accurate data and fostering trust.

Expertise in Survey Design and Implementation. Faculty or research teams with demonstrated expertise in household survey design and application. This includes knowledge of survey design, sampling techniques, questionnaire development, and data collection protocols (including ability to comply with Conservation International's Internal Review Board and/or current local University's ethics protocol for research with human subjects). Experience in using digital survey tools or mobile data collection methods such as KoboTool Box, is highly desirable. Strong ethical and professional values guide engagement with individuals in communities whose beliefs, values, and culture are important to protect and respect.

Data Management and Analysis Skills. Strong capabilities in data management and analysis, including proficiency in data cleaning, data entry, data coding, and statistical analysis using software such as SPSS, STATA, or R. Individuals with data visualization, detail-oriented, and capable of managing large datasets efficiently are desirable.

Geographic Information System (GIS) Specialists. Faculty and students who can analyze and visualize geospatial data are desirable. These skills are essential for mapping, spatial analysis, and data visualization

to enhance the understanding of the project's spatial dynamics and contribute to decision-making processes.

Geographic and Ecological Understanding. Priority will be given to university faculty and students with a good understanding of the local geography and ecosystems along Ecuador's coastlines. Having this knowledge can contribute to better contextualization of the project objectives, and reasons for data collection, and enable the identification of relevant socioeconomic and environmental variables for analysis.

Community Engagement and Capacity Building. This project has strong community engagement and capacity-building components, as such, university units and faculty who are willing to engage in training local field assistants, involving community members in the data collection process, and promoting participatory approaches to research is desirable.

Multidisciplinary Approach. We value and encourage multidisciplinary collaborations across various fields, including natural sciences, environmental studies, climate change, and policy. Faculty and students with multidisciplinary, transdisciplinary, or interdisciplinary approaches can provide a more holistic understanding of the project's objectives and facilitate integrated data analysis.

Language Skills. Given that the surveys and data collection will be conducted in rural areas, proficiency in Spanish is essential, and having knowledge (both written and spoken) of other local languages is preferable.

Appendix 8: CSS Criteria for Suitable Aquafarms

Criteria	Type	Details	Data Source
Proximity to Roads	Filtering Criteria	Keep only grid tiles <= 2 km	OpenStreetMap
Proximity to Populated Areas	Filtering Criteria	Keep only grid tiles <= 2 km	High Resolution Settlement Layer 2019
Proximity to Coastal Border	Filtering Criteria	Keep only grid tiles <= 2 km	Ecuador Administrative Boundaries
Presence of ponds	Filtering Criteria	Grid tiles overlap	Clark Labs dataset (https://clarklabs.org/aquaculture/).
Elevation	Scoring Criteria	High: <= 1.5 m Low: > 2.8 m Weight: 3/12 (25%)	Copernicus GLO-30 DEM
Slope	Scoring Criteria	High: <= 2% Low: > 2.5% Weight: 1/12 (8.3%)	ALOS World 3D - 30m DEM
Storm Surge Height	Scoring Criteria	High: Areas affected by storm surge at alert level 1 Low: Areas without storm surge warning at SSA 1	Project NOAH Storm Surge Advisory Level 1 Hazard Map

		Weight: 2/12 (16.67%)	
Proximity to Existing Mangroves (2020)	Scoring Criteria	High: <= 3 km Low: > 5 km Weight: 3/12 (25%)	Global Mangrove Watch
Proximity to Historical Mangroves (1999 - 2019)	Scoring Criteria	High: <= 3 km Low: > 5 km Weight: 2/12 (16.67%)	Global Mangrove Watch

Tool applied in the platform Climate Smart Shrimp Tool. https://ci-aquafarm-mapping.web.app/

Appendix 9: Business plan overview

- Executive summary: This section details how climate smart shrimp will be implemented in the farm and what it wants to accomplish. It includes the mission statement and information about the leadership, employees, operations, location and environmental goals of the operation.

- Farm description: This overviews the business's plan and vision. It will include the company's name, business structure, and an overview of the target market. It also should state the number of hectares and other information related to the portion of the market that it will attend. It should also include a section that outlines the company's history and evolution.

- Market analysis: The market analysis includes details of the competition and plans on how the climate smart shrimp differentiate. It also explains how the company fits in with the industry and details its strengths and weaknesses. This section details the target market, the marketing channels and the expected consumer demand for the product or service. Research should also show how easy or difficult it will be to increase market share.

- Service or products: This section details the products and services offered. It can include pricing, product lifespan, benefits, and similar products and competitors. You want to show the difference between your product or service and how it will rise above the competition. Other topics in the section can include production and manufacturing processes, research and development, company patents, and proprietary technology.

- Marketing and sales: This part explains how the company plans to attract and retain customers, it outlines a clear distribution channel, and defines planned advertising and marketing strategies. It can also describe the types of media used for those strategies and campaigns.

- Financial projections: Includes the company's financial planning and financial statements, balance sheets, and other documents. New businesses can include targets and estimates for the first years of the change in the operation, including the CSS practices. It can also outline the company's potential investors and what financial assistance the company may need. Also, this section includes the budget, with detail staffing, development, manufacturing, and marketing costs.

- Appendices

Appendix 10: Criteria to Select Universities for Evaluation and Strengthening Capacity to Generate Climate Risks Information, Including Mangrove Cover Monitoring

The following is a list of suggested criteria to help CI-Ecuador to select universities that would generate climate risks information.

Expertise in climate risk: Strong departments or faculties specializing in climate risk (hazard, vulnerability, and exposure) analysis. Faculty and students from these units and disciplines would have a solid foundation for conducting analysis based on information on current and future hazards and risks already available in key sources of climate information such as IPCC reports, NAPAs/NAPs, National Communications to the UNFCCC and other sources.

Data Management and Analysis Skills. Strong capabilities in data management and analysis, including proficiency in data cleaning, data entry, data coding, and statistical analysis using software such as SPSS, STATA, or R. Individuals with data visualization, detail-oriented, and capable of managing large datasets efficiently are desirable.

Risk disaster reduction: Relevant experience in the design and implementation of disaster risk reduction and/or climate change adaptation at the local level.

Geographic Information System (GIS) Specialists. Faculty and students who can analyze and visualize geospatial data are desirable. These skills are essential for mapping, spatial analysis, and data visualization to enhance the understanding of the project's spatial dynamics and contribute to decision-making processes.

Geographic and Ecological Understanding. Priority will be given to university faculty and students with a good understanding of the local geography, climate information and ecosystems along Ecuador's coastlines. Having this knowledge can contribute to better contextualization of the project objectives, and reasons for data collection, and enable the identification of relevant socioeconomic and environmental variables for analysis.

Community Engagement and Capacity Building. This project has strong community engagement and capacity-building components, as such, University Units and Faculty who are willing to engage in training local field assistants and local governments representatives involving local governmental members in the process, and promoting participatory approaches to research is desirable.

Multidisciplinary Approach. We value and encourage multidisciplinary collaborations across various fields, including natural sciences, environmental studies, climate change, and policy. Faculty and students with multidisciplinary, transdisciplinary, or interdisciplinary approaches can provide a more holistic understanding of the project's objectives and facilitate integrated data analysis.

Appendix 11: Criteria to Select Universities for Bluecarbon analysis

The following is a list of suggested criteria to help CI-Ecuador to select universities that would implement the bluecarbon analysis.

E**xpertise in Mangrove Ecology**: Senior staff with experience in mangrove ecology and ecosystem-level carbon estimation. Faculty and students from these units and disciplines would have a solid foundation for conducting research in different strata of mangrove ecosystems.

Field Research Experience: Previous experience in conducting forest inventories and carbon measurements in mangrove ecosystems. Teams with academic publications that report on carbon, in particular in mangrove ecosystems, will be highly considered.

Expertise in logistics capacity: Previous experience to execute forest carbon inventories in the Gulf of Guayaquil.

Community Engagement and Capacity Building. This project has strong community engagement and capacity-building components, as such, university units and faculty who are willing to engage in training local field assistants, involving community members in the data collection process, and promoting participatory approaches to research is desirable. Experience working with local communities and mangrove ecosystems in the Gulf of Guayaquil will be highly considered.

Laboratory facilities: Access to analytical laboratory facilities to analyze for total carbon (and nitrogen) in soils and plant tissue samples through the dry combustion method.

Data Management and Analysis Skills. Strong capabilities in data management and analysis, including proficiency in data cleaning, data entry, data coding, and statistical analysis using software. Individuals with data visualization, detail-oriented, and capable of managing large datasets efficiently are desirable.

Geographic Information System (GIS) Specialists. Faculty and students who can analyze and visualize geospatial data are desirable. These skills are essential for mapping, spatial analysis, and data visualization to enhance the understanding of the project's spatial dynamics and contribute to decision-making processes.

Appendix 12: Socio Manglar subaccount information

Background

In 2008, Ecuador's Ministerio del Ambiente, Agua y Transición Ecológica (MAATE) created the **Socio Bosque** Program whose main objective is the conservation of native forests and moorlands in Ecuador. Socio Bosque provides economic incentives to farmers and Indigenous communities that voluntarily commit to the conservation and protection of their native forests, moorlands or other native vegetation. The Socio Bosque Program is supported financially by the government of Ecuador and donors. Long-term annual funding is also provided for the Socio Bosque Program from the Socio Bosque Fund, which is managed by Fondo de Inversion Ambiental Sostenible (FIAS)[46].

FIAS is a private, non-profit entity that focuses on the management, mobilization, investment, and implementation of public and private funds to finance conservation of natural resources and biodiversity, mitigation and adaptation to climate change and environmental quality, complementing the efforts of the Government of Ecuador. FIAS began operations in 2000 and, as of September 2021, was managing USD 122.6 million[47] in Funds and projects. The Funds managed by FIAS are:

- Protected Areas *Fund (Fondo de Áreas Protegidas)*
- Socio Bosque Fund *(Fondo Socio Bosque)*
- Social Responsibility and Sustainability Fund *(Fondo de Responsabilidad Social y Sostenibilidad)*
- Wildlife Fund *(Fondo de Vida Silvestre)*
- Galapagos Invasive Species Fund *(Fondo de Especies Invasoras de Galápagos)*
- Galapagos Fund (*Fondo Galápagos)*
- Bioeconomy Technical Assistance Fund *(Fondo de Asistencia Tecnica Bioeconomia)*
- Zero Carbon Fund (*Fondo Carbono Cero)*

Contributors to funds or programs administered by FIAS include the governments of Ecuador, France, Germany, Italy, Norway, as well as global NGOs and the private sector.

Conservation International (CI) has contributed to three of the FIAS funds:

1. *Ecuador Azul* subaccount of the **Protected Area Fund** (*Fondo de Areas Protegidas* (FAP)): Capitalized with US$2 million from the Global Environmental Fund (GEF) and US$4 million from CI and the Walton Family Foundation to support Marine Protected Areas. The subaccount is currently providing financial resources to seven Marine Protected Areas to support ongoing management costs.

[46] www.fias.org.ec/en/home
[47] FIAS 2022. Fondo de Inversión Ambiental Sostenible. Brochure Institucional. https://fias.org.ec/wp-content/uploads/2022/02/Brochure_FIAS2022_compressed.pdf ; accessed May 2023.

2. Fund for the control of **Invasive Species** in Galapagos, (*Fondo para el Control de las Especies Invasoras de Galagapos* (FEIG)): Created in 2007 and starting operations in 2012, FEIG contributes to the prevention, control and eradication of introduced species to preserve the ecosystem, the environmental and economic viability of the production systems of the Galapagos Archipelago.

3. **Socio Bosque Fund:** Created in 2012 as a sustainable financing strategy to support the "*Socio Bosque*" Forest Protection Program. This Fund includes five different 'windows':

    - The **Socio Bosque sinking fund** component started with the support of KfW with an initial investment of US$5,463,256 and in 2014 expanded by US$5,405,780 to support conservation areas in Yasuni Biosphere Reserve. Later that year through the KfW, the governments of Norway and Germany provided additional support of US$12,740,642 for the implementation of the project REDD+ Early Movers (REM). In 2017, the GCF project FP019 invested US$2,568,159 for direct payments to Socio Bosque agreements with Indigenous communities to be implemented until 2022.
    - **Paramo subaccount** created in 2020 with the contribution of Produbanco to support three paramo communities. Produbanco has provided US$200,000 to the subaccount.
    - **The Chachi-Kofán sub-account** is aimed at conservation projects and integrated forest management in Chachi and Kofán communities. Funding for this endowment fund comes from CI. The current balance of this subaccount is approximately US$1 million.
    - **Achuar subaccount**, created in 2021 and received US$347,160 from projects financed by the government of France. This subaccount was created to co-finance the Socio Bosque incentives in the Achuar Territory to support strengthening the governance and decision-making of the Achuar nationality.
    - **Socio Manglar subaccount**: Created in 2021 with initial contributions of US$100,000 from CI and US$50,000 from Ecuador's Aquaculture Stewardship Council (ASC). This subaccount is to provide incentive payments for the Socio Manglar Program, which focuses on management of mangroves.

Socio Manglar subaccount

Summary of the subaccount

The purpose of the subaccount is to contribute to the financing of incentives paid to community groups as part of the Socio Manglar Program. The program provides incentive payments to community groups with management responsibility for mangroves. Under the Socio Manglar Program, this responsibility is governed by agreements signed between AUSCEM community associations and MAATE. Increasing the coverage of mangroves that are managed under AUSCEMs and building the capacity of community associations with AUSCEM agreements is the primary focus of Component 1 of the GCF project.

Contributions to the Socio Manglar subaccount may be endowment contributions or sinking funds and will be managed by FIAS in the FIAS Mercantile Trust in Quito, in accordance with the general practices established by the FIAS Investment Committee. In the case of endowment contributions, only the net

returns generated from investments of the capital will be used by the Socio Manglar Program. The capital of the Socio Manglar subaccount will be preserved and increased to guarantee the continuous flow of resources in the long term.

As part of the proposed GCF project, US$4 million would be added to the capital of the subaccount (currently approximately US$162,000 including investment returns on the original US$150,000). The GCF funds will be provided by CI as a grant and an endowment contribution, and held in an interest-bearing account with only the interest used for the Socio Manglar Program. If the interest payments are not needed for use in a particular year, they will remain in the interest-bearing account. . Funds contributed by contributors other than the GCF will be managed according to the investment policy set by the FIAS investment committee. Hence the subaccount will have at least two separate bank accounts: one interest-bearing account for the GCF funds and one investment account for funds from other contributors that are invested in accordance with the FIAS investment policy.

To support the Socio Manglar Program, the Government of Ecuador and the REM[48] program currently provides US$449,000 per year in incentive payments to community organizations involved in mangrove protection as part of the Socio Manglar Program. These direct payments will continue from the Government during the period of the GCF project alongside payments made from the Socio Manglar subaccount.

Socio Manglar subaccount Operations

The operation of the Socio Manglar subaccount will follow operating procedures described in Appendix 13. Key points are summarized as follows.

Fund management for the non-GCF resources

Investment policies are established by the Investment Committee that supports the FIAS Board (see Appendix 13). For endowment contributions, capital may not be used and only the net income generated by the capitalization of such endowment contributions may be used. The principal of the Socio Manglar subaccount must be preserved and increased to guarantee the continuous flow of resources in the long term. It is estimated that the Socio Manglar subaccount will grow between 6-7% each year, depending on the decisions of the FIAS Investment Committee (see Appendix 13). If returns exceed 7%, a portion of the returns in excess will be recapitalized for the purpose of increasing the Socio Manglar subaccount capital. In the case of sinking fund resources, these will be invested according to their specific grant agreement.

When the Socio Manglar subaccount does not generate net returns of at least 6%, all returns will be allocated to co-finance the incentives of Socio Manglar agreements. In the event that the execution of the annual budget is less than the approved budget, the Technical Committee may recommend to the Socio Bosque Fund Board that these funds be transferred to the following year's budget or be capitalized.

[48] https://prem.fias.org.ec/en/home/

The costs of managing the investments in Ecuador shall be financed by the net yields of the Socio Manglar subaccount. These costs will depend on what has been agreed by FIAS for the general management of funds according to the general practices established by the FIAS Investment Committee and those applied for other funds abroad and those established in the Socio Bosque Fund agreement and its Procedures Manual.

Technical Committee

The Technical Committee of the Socio Manglar subaccount is constituted by the following members:

- the Manager of the Socio Bosque Project or their delegate, who chairs the Committee;
- the Executive Director of CI-Ecuador or their delegate, who shall act as Secretary of the Committee and prepare the minutes of the Committee's meetings;
- one representative for each additional contributor;
- the Executive Director of FIAS or their delegate, with voice, but without vote.

Decisions in the Committee shall be made by absolute majority, which means with half plus one of the votes of those attending the Committee. The Committee's recommendations and decisions shall be duly recorded in meeting minutes and kept on file. The preparation and management of the committee meeting minutes is the responsibility of CI-Ecuador as the Committee's Secretariat.

The powers and responsibilities of the Committee are:

(i) Review and approve FIAS reports on the administrative and financial management of the Mangrove Subaccount.
(ii) Request to the Socio Bosque Fund Board the approval of the Operational Annex of the Socio Manglar subaccount, as well as the amendments to the same.
(iii) Approve the activities that are considered a priority and that could be supported with the net income generated by the Socio Manglar subaccount and prepare the Annual Work Plan (AWP) and its respective budget.
(iv) Present the AWP with its corresponding budget to the Socio Bosque Fund Board for approval.
(v) Once the AWP and its respective budget have been approved by the Socio Bosque Fund Board, send instructions to FIAS to make the respective disbursements.
(vi) Evaluate the technical follow-up and monitoring reports prepared by the Socio Bosque Program of the activities co-financed by the Socio Manglar subaccount and approve such reports.
(vii) Review and approve the previous year's execution reports, financial returns obtained in the previous year and availability for execution in the current year, presented by FIAS.
(viii) Review and approve the settlement report of the Accession Agreement prepared by the Socio Bosque Program if required.

Payments

Disbursements will be made directly by FIAS to the beneficiaries (community associations managing mangroves under AUSCEM agreements) selected by the Socio Manglar subaccount Technical Committee.

GCF Project: Contractual Relationship and Flow of Funds

CI, through its country office in Ecuador (EE), will enter into a sub-grant agreement with FIAS that is compliant with CI and GCF requirements. Signature of the agreement between CI and FIAS is scheduled in the project implementation timetable (Annex 5) for Q4 of year 1.

The EE will disburse US$4 million of GCF funds to FIAS at the beginning of Year 2 of the project.

Projections of costs, income, yield and subaccount balance

Projections for the growth of the Socio Manglar account are provided in Figure 39 and Figure 39. These projections are based on the following default assumptions:

Cost assumptions

- Growth in the Socio Manglar program is based on the assumptions made in the GCF project about growth in the number of communities managing mangroves through AUSCEM agreements and receiving Socio Manglar incentive payments. These assumptions include some further growth of the Socio Manglar program beyond the end of the GCF project implementation period.
- No change is assumed in the current method for calculating the value of Socio Manglar incentive payments (except for increased cost in line with inflation – see point below).
- Costs are subject to an assumed annual increase of 2% due to inflation (annual average inflation from 2013 to 2022 was 1.8%; consumer price index inflation is projected by the World Bank to remain below 2% until 2026[49]).

Income assumptions

- The Government of Ecuador (through MAATE) continues to directly support the costs of Socio Manglar for an amount equivalent to its current contributions during the GCF project. Beyond the current project (Year 7 onwards), the contributions increase in line with the assumed inflation rate. MAATE's own costs for administration and monitoring related to its current contributions continue to be covered from its own budget and increase in line with inflation.
- Existing and anticipated funding from CI that contributes to the Socio Manglar Program continues in the early years of the project (indicated in the table as the Time CO_2 funding).
- Funding from MAATE's planned Carbon Zero program (PECC) starts to contribute to the Socio Manglar Program in Year 2 of the GCF project. Contributions in Year 2 and 3 are assumed to be US$150,000 and then rise to US$300,000 in Year 4. These contributions are then assumed to remain constant and rise in line with inflation. An assumption is introduced that the private sector contributions will decline a few years after the project ends. This is introduced into the model as a halving of support in year 11 and then continued support at that level up to year 20 (but assuming annual increases in line with inflation).
- Investment returns generated from the investment account portion of the Socio Manglar subaccount (i.e. the non GCF portion) is assumed to be available for programming based on interest generated in the previous year and starting in Year 1. A net investment return of 6.5% is

[49] https://thedocs.worldbank.org/en/doc/e408a7e21ba62d843bdd90dc37e61b57-0500032021/related/mpo-ecu.pdf. Accessed May 2024

assumed to be available (net of FIAS costs). The 6.5% figure is based on the stated objective of achieving returns of 6 to 7% annually. For comparison, between 2019 and 2023 the actual investment return of the Socio Bosque Fund, of which the Socio Manglar subaccount is part, was between 7.3% and 8.6% annually.

- Interest generated from the $4 million of GCF funds is assumed to achieve an average interest rate of 3.5%. Current rates available from banks in Ecuador are significantly higher than this but it is assumed they will reduce over time.

Assumptions about direct contributions to the Socio Manglar subaccount

- Any income from private sector contributions (e.g. the Carbon Neutrality program) and the returns from the Socio Manglar account that is not needed to cover costs in a particular year is assumed to be reinvested into the capital of the Socio Manglar subaccount (investment portion).
- Any income from interest earned on the interest-bearing account (i.e. the GCF proceeds) is used for incentive payments, or, if any portion of it is not needed in a particular year, then the remaining GCF proceeds are returned to (or remain in) the interest-bearing account. For the avoidance of doubt, there should be no investment of GCF Proceeds and interest earned on GCF Proceeds should be only generated from holding GCF Proceeds in the interest-bearing account.
- US$4 million from the GCF project contributes to the Socio Manglar subaccount capital at the start of Year 2 of the proposed GCF project, thereby generating a full year of interest in Year 2 that becomes available to use in year 3.
- US$1 million is raised from ASC partners over the course of the GCF project. The model assumes this will be added to the subaccount capital in payments of US$250,000 each year for project Years 2 to 5.

An additional important assumption is that the strategy for growth of the Socio Manglar subaccount will be revisited regularly (at least annually) to update projected costs, income and contributions to the subaccount. The long-term objective is that the combination of interest and investment income generated from the subaccount and ongoing government payments based on current amounts (adjusted for inflation) are able to cover all the incentive payments needed by the Socio Manglar Program. Changes to any of the assumptions mentioned above will affect the projections presented here. As shown in Figure 39, the costs are covered during the first ten years and the Socio Manglar subaccount would still be growing although this growth would be slowing by year 10. Figure 40 shows that under current assumptions the Socio Manglar costs are also covered after 20 years. However, the longer-term projections are highly variable to changes in assumptions including those about growth of the Socio Manglar Program (i.e number of communities involved and the size of areas they are managing), inflation rate, investment performance, direct contributions from government and the carbon zero program (PECC) and the timing and value of contributions into the Socio Manglar subaccount. Regular revisiting of the assumptions and revision of the projections and strategy for attaining the long-term objective of covering Socio Manglar costs is therefore essential.

Figure 39. Projected costs, income, Socio Manglar subaccount balance and funds available for programming for the first 10 years of operation

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Project year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Costs											
Direct incentives payments	449,000	449,000	449,000	497,412	565,380	640,895	715,023	766,161	807,929	841,881	882,783
Inflation on incentives			8,980	8,980	9,948	11,308	12,818	14,300	15,323	16,159	16,838
Admin support (including inflation)	9,160	9,160	9,160	10,147	11,534	13,074	14,586	15,630	16,482	17,174	18,009
Monitoring + tech support (Including inflatic	91,596	91,596	91,596	101,472	115,337	130,743	145,865	156,297	164,817	171,744	180,088
Total financial needs	**549,756**	**549,756**	**558,736**	**618,012**	**702,199**	**796,020**	**888,292**	**952,388**	**1,004,551**	**1,046,958**	**1,097,717**
Direct Income											
GoE incentives	449,000	449,000	449,000	449,000	449,000	449,000	449,000	457,980	467,140	476,482	486,012
Carbon Neutrality program			150,000	150,000	300,000	306,000	312,120	318,362	324,730	331,224	337,849
GoE admin + monitoring	100,756	100,756	100,756	111,619	126,871	143,817	160,451	171,926	181,299	188,918	198,097
GCF - sinking fund											
CI private donor (TIME CO2)	7,404	7,404									
Investment return from the GCF interest bearing account available for SM program				140,000	142,891	143,471	143,471	143,471	143,471	143,471	143,471
Investment return from the SM subaccount available for SM program		10,530	11,214	37,360	65,788	105,814	144,950	165,860	185,699	205,055	224,438
Total	**557,160**	**567,690**	**710,970**	**887,979**	**1,084,551**	**1,148,102**	**1,209,992**	**1,257,600**	**1,302,338**	**1,345,151**	**1,389,866**
Net Benefit (i.e available for reinvestment)		**17,934**	**152,234**	**269,967**	**382,352**	**352,083**	**321,700**	**305,212**	**297,787**	**298,193**	**292,149**
Socio Manglar Subaccount contributions (with GCF interest being spent or reinvested)											
ASC	50,000										
CI	100,000										
2023 interest on ASC and CI contribution	12,000										
ASC partners			250,000	250,000	250,000	250,000					
Reinvestment		10,530	152,234	187,360	365,788	352,083	321,700	305,212	297,787	298,193	292,149
Unused interest from the interest-bearing account that remains in account			-	82,608	16,563	-	-	-	-	-	-
GCF interest-bearing account contribution			4,000,000								
Anual contributions	**162,000**	**10,530**	**402,234**	**437,360**	**615,788**	**602,083**	**321,700**	**305,212**	**297,787**	**298,193**	**292,149**
Invested portion balance	162,000	172,530	574,764	1,012,124	1,627,912	2,229,995	2,551,695	2,856,907	3,154,694	3,452,887	3,745,036
GCF interest bearing acct balance	-	-	4,000,000	4,082,608	4,099,171	4,099,171	4,099,171	4,099,171	4,099,171	4,099,171	4,099,171
Socio Manglar subaccount balance	**162,000**	**172,530**	**4,574,764**	**5,094,732**	**5,727,083**	**6,329,166**	**6,650,866**	**6,956,078**	**7,253,865**	**7,552,058**	**7,844,207**
Interest from GCF interest bearing account available for SM program				**140,000**	**142,891**	**143,471**	**143,471**	**143,471**	**143,471**	**143,471**	**143,471**
Investment return from the SM subaccount available for SM program		10,530	11,214	37,360	65,788	105,814	144,950	165,860	185,699	205,055	224,438

Figure 40. Summary of 20-year projection for the costs, income and subaccount balance

	2024	2029	2034	2039	2044
Project year	**0**	**5**	**10**	**15**	**20**
Costs					
Direct incentives payments	449,000	640,895	882,783	1,030,420	1,135,523
Inflation on incentives		11,308	16,838	20,212	22,274
Admin support (including inflation)	9,160	13,074	18,009	21,021	23,165
Monitoring + tech support (Including inflatic	91,596	130,743	180,088	210,206	231,647
Total financial needs	**549,756**	**796,020**	**1,097,717**	**1,281,858**	**1,412,608**
Direct Income					
GoE incentives	449,000	449,000	486,012	536,597	592,446
Carbon Neutrality program		306,000	337,849	186,506	205,918
GoE admin + monitoring	100,756	143,817	198,097	231,226	254,811
GCF - sinking fund					
CI private donor (TIME CO2)	7,404				
Investment return from the GCF interest bearing account available for SM program		143,471	143,471	143,471	143,471
Investment return from the SM subaccount available for SM program		105,814	224,438	269,342	296,564
Total	**557,160**	**1,148,102**	**1,389,866**	**1,367,142**	**1,493,210**
Net Benefit (i.e available for reinvestment)		**352,083**	**292,149**	**85,284**	**80,602**
Socio Manglar Subaccount contributions (with GCF interest being spent or reinvested)					
ASC	50,000				
CI	100,000				
2023 interest on ASC and CI contribution	12,000				
ASC partners		250,000			
Reinvestment		352,083	292,149	85,284	80,602
Unused interest from the interest-bearing account that remains in account		-	-	-	-
GCF interest-bearing account contribution					
Anual contributions	**162,000**	**602,083**	**292,149**	**85,284**	**80,602**
Invested portion balance	162,000	2,229,995	3,745,036	4,229,013	4,643,119
GCF interest bearing acct balance	-	4,099,171	4,099,171	4,099,171	4,099,171
Socio Manglar subaccount balance	**162,000**	**6,329,166**	**7,844,207**	**8,328,184**	**8,742,290**
Interest from GCF interest bearing account available for SM program		**143,471**	**143,471**	**143,471**	**143,471**
Investment return from the SM subaccount available for SM program		105,814	224,438	269,342	296,564

Risk factors and mitigation measures to reduce risk in the assumptions of the financial analysis.

The projections in the financial analysis for the Socio Manglar subaccount include risks and possible variations. The main risks are:

Risk	Mitigation measure
Reduced political support for the implementation of the PECC initiative during changes in administration	There is a growing interest of Ecuadorian and transnational companies in the program. There are currently 50 companies that signed the commitment agreement and are requesting the Ministry to go forward. Supporting these initiatives and pressure is important. CI-E is part of several business alliances that are committed to reduce environmental impacts. CERES (Corporación Ecuatoriana para la Responsabilidad Social & Sostenibilidad) and WBCSD Ecuador - CEMDES (World Business Council for Sustainable Development) are examples of that.
Return on the investment that may reduce in the following years.	We have conservatively used a 6.5% rate for estimating the investment return on the invested portion of the Socio Manglar subaccount. For comparison, between 2019 and 2023 the actual investment return of the Socio Bosque Fund was between 7.3% and 8.6% annually despite significant volatility in financial markets during that period. For the interest-bearing account we assume an interest rate of 3.5%, which is at the lower end of the range of deposit interest rates that have been available in Ecuador between 2008 and 2022[50]. Higher rates are available currently.
Government support for Socio Manglar.	The current administration has committed to continue with the Socio Bosque Program (PSB) and also expand it. This commitment is reflected in the co-financing letter from MAATE. If this changes in the next administrations and the government stops supporting PSB, then CI would make conservation agreements directly (AUSCEMs-CI) with “results-based incentives” if funding could be secured.
Change in the current method for calculating the value of Socio Manglar	Costs are linked with the number of hectares included in Socio Manglar and we are not expecting changes in the method for calculation of payments. In the financial model we conservatively assume an annual increase in incentive

[50] https://data.worldbank.org/indicator/FR.INR.DPST?locations=EC

	payments in line with inflation although this is not typically practiced by MAATE. Recent changes in the regulation of the Socio Bosque Program are related to the number of years of the agreements, so this initiative is a way to give permanent support to the areas.
US$1 million is raised from ASC partners over the course of the GCF project	If the project partners (CI, MAATE, FIAS) are not successful in raising the assumed US$1 million , we may have to reduce the number of hectares included in the Socio Manglar program, particularly over the longer term. Note that the financial model assumes some additional expansion of community mangroves beyond what is planned in the GCF project.

Appendix 13: Operational Annex: Regulations for the administration and operation of the Socio Manglar subaccount *(Unofficial English Translation)*

PRESENTATION

In accordance with the provisions of the Resource Management Agreement of the Socio Bosque Special Contribution Fund (the "Management Agreement"), the Socio Bosque Special Contribution Fund ("FSB") may receive resources from any contributor through an adhesion agreement, which may include specific procedures for the operation of the resources it receives, as long as they do not affect its general purpose. Conservation International Foundation Ecuador (CI-Ecuador), with the support of the Aquaculture Stewardship Council (ASC), has committed to contribute with an endowment contribution to the FSB for the creation of the Mangrove Subaccount (the "Socio Manglar Subaccount"), as a mechanism to co-finance the incentives of the Socio Bosque Project (PSB), whose yields contribute to the payment of incentives to the organizations that participate in the Mangrove Chapter (Socio Manglar) of the SBP.

This operational annex shall also apply to future donors to the Mangrove Subaccount.

Quito, April 13th, 2021.

1. OBJECTIVE OF THIS OPERATIONAL ANNEX

To regulate the administration and operation of the Mangroves Subaccount within the SBF according to the Administration Agreement and the Accession Agreement to the SBF signed between the SBP, CI-Ecuador and FIAS. These regulations shall apply to all accession agreements signed for the purpose of contributing to the Mangrove Subaccount.

2. POLICIES FOR THE ADMINISTRATION OF THE MANGLARES SUB-ACCOUNT

Contributions to the Mangrove Subaccount may be capitalization or extinguishable contributions and will be managed by FIAS in the FIAS Commercial Trust in the city of Quito, in accordance with the general practices established by the FIAS Investment Committee for investments in Ecuador. Therefore, the policies detailed below will be automatically modified when the FIAS Investment Committee changes them. FIAS will inform the FSB Board of Directors, the Technical Committee and the contributors to the Mangrove Subaccount immediately of any changes. The investment policies of FIAS in Ecuador are attached as Annex 1 to this Operational Annex.

In the case of endowment contributions, its capital may not be used and only the net income generated by the capitalization of such endowment contributions may be used. The capital of the Mangroves Subaccount must be preserved and increased to guarantee the continuous flow of resources in the long term. It is estimated that the Mangrove Subaccount will grow between 6-7% (net yield) each year, depending on the decisions of the FIAS Investment Committee.

If the Mangrove Subaccount generates net returns of more than 7% of the total value of the Mangrove Subaccount as of December 31 of each year, at least part of the return in excess of 7% (net return) will be recapitalized for the purpose of increasing the Mangrove Subaccount equity.

In years when the Mangroves Subaccount does not generate net returns of at least 6%, all returns generated by the Mangroves Subaccount will be allocated to co-finance the incentives of the PSB agreements, selected jointly with the contributors.

In the event that the execution of the annual budget is less than the approved budget, the Technical Committee may recommend to the FSB Board that these funds be transferred to the following year's budget or be capitalized.

The costs of managing the investments in Ecuador shall be financed by the net yields of the Mangrove Subaccount. These costs will depend on what has been agreed by FIAS for the general management of funds according to the general practices established by the FIAS Investment Committee and those applied for other funds abroad and those established in the Socio Bosque Fund agreement and its Procedures Manual.

In the event of termination of the adhesion agreement signed with CI-Ecuador or another donor of the Mangroves Subaccount, the equity contributions will remain in the FSB and their net income must be used exclusively for the co-financing of the incentives of the PSB agreements, selected jointly with the contributors.

3. THE MANGROVE SUBACCOUNT TECHNICAL COMMITTEE

3.1 Creation of the Technical Committee

For the execution of the Accession Agreement, the Technical Committee of the Mangrove Subaccount is created, which will be constituted by the following members:

a. The Manager of the Socio Bosque Project or his delegate, who chairs the Committee,
b. The Executive Director of CI-Ecuador or his delegate, who shall act as Secretary of the Committee and prepare the minutes of the Committee's meetings,
c. One representative for each additional contributor,
d. The Executive Director of FIAS or his delegate, with voice, but without vote.

The members of the Technical Committee shall not receive remuneration or compensation for travel expenses.

3.2 Meetings

The Committee shall meet ordinarily at least two (2) times a year, and the first meeting shall be held within the first quarter of the year, based on the proposed date submitted for such purpose by the Chairman, and extraordinarily when two (2) of its members so request.

3.3 Solicitation

Once the date for the ordinary meeting has been set, the members of the Committee shall be notified in writing by the Secretariat of the Technical Committee at least ten (10) calendar days prior to the date set. Extraordinary meetings shall be called by the Chair at the request of at least two (2) of its members. The calls for extraordinary meetings shall be made by the Secretariat, which shall be notified in writing, attaching the agenda, at least ten (10) calendar days prior to the date of the meeting.

3.4 Headquarters

The meetings shall be held at the FIAS offices located in the city of Quito and by exception, raised by the Chair of the Committee or two (2) members, they may be held in other locations or through virtual platforms.

4. RULES OF PROCEDURE

4.1 Agenda of the Committee's meetings

The agenda shall be defined by the Chair, after taking into account the criteria of the members of the Committee. The agenda shall be subject to the general interests for the efficient operation and execution of the Mangrove Subaccount, in accordance with the Accession Agreement, and shall always be attached to the respective meeting notices.

In the event that one or more of the members of the Committee deem it necessary to include a matter in the agenda, not previously considered, and which should, due to its importance, be considered by the Committee, it may be included, provided that it has been submitted to the Chairman for approval at least five (5) days prior to the meeting. The Chair shall decide on its acceptance or rejection at least two (2) days prior to the meeting and shall immediately notify the other members of the Committee of the new matter.

4.2 Information for Committee Members

Preparatory material. For the proper exercise of their functions, the members of the Committee shall have access at least five (5) days in advance to the information that is relevant for decision making, except for emergency situations that prevent them from complying with this term. The preparation of such information shall be the responsibility of the Committee's Secretariat.

The information will be available to Committee members at the FIAS and CI-Ecuador offices and will also be sent by e-mail or by any other suitable means to facilitate its review and availability.

4.3 Acts

The minutes of the meetings shall be kept by the Secretary of the Committee, who shall record the matters discussed, the decisions adopted, the votes and everything related to the agenda. The minutes shall be signed by the Committee members present.

The following original copies of the minutes shall be made and delivered as follows:

- One copy for each additional contributor,
- A copy for FIAS,
- One copy to MAAE-PSB, and
- One copy for CI-Ecuador.

4.4 Recommendations and decisions

The Committee's recommendations and decisions shall be duly numbered and kept on file; the preparation and management of this file is the responsibility of CI-Ecuador as the Committee's Secretariat.

Decisions in the Committee shall be made by absolute majority, which means with half plus one of the votes of those attending the Committee.

5. POWERS AND RESPONSIBILITIES OF THE MANGROVE SUBACCOUNT TECHNICAL COMMITTEE

The powers and responsibilities of the Committee are as follows:

a. To review and approve FIAS reports on the administrative-financial management of the Mangrove Subaccount.
b. To know and request to the FSB Board the approval of the Operational Annex of the Mangroves Subaccount, as well as the amendments to the same.
c. Approve the activities that are considered a priority and that could be supported with the net income generated by the Mangroves Subaccount, and prepare the Annual Work Plan (AWP) and its respective budget.
d. Present the AWP with its corresponding budget to the FSB Board for approval.
e. Once the AWP and its respective budget have been approved by the FSB Board, send instructions to FIAS to make the respective disbursements.
f. Evaluate the technical follow-up and monitoring reports prepared by the PSB of the activities co-financed by the Mangroves Subaccount and approve such reports.

g. To review and approve the previous year's execution reports, financial returns obtained in the previous year and availability for execution in the current year, presented by FIAS.

h. To review and approve the report on the settlement of the Accession Agreement prepared by the PSB.

6. OPERATING CYCLE OF THE MANGROVES SUBACCOUNT

6.1 Mangroves Subaccount Annual Budget

The Technical Committee will present to the FSB Board of Directors the annual budget and the AWP based on the financial projection of the Mangrove Subaccount yields.

6.2 Objectives of the Mangroves Subaccount and Activities to be financed with the net income of the Mangroves Subaccount

6.2.1 General Purpose:

- The Parties agree to contribute to the conservation and sustainable use of Ecuador's mangroves, through the creation of the Mangroves Subaccount in the Socio Bosque Special Contribution Fund with the purpose of contributing to the co-financing of the incentives for the conservation of Ecuador's mangroves provided by the MAAE, within the framework of the Socio Bosque Project.

In the case of extinguishable contributions, FIAS will use them for the payment of incentives to the selected organizations jointly with the contributors.

In the case of endowment contributions, the returns of the Mangrove Subaccount may be used to finance incentive payments and other activities agreed upon by the Mangrove Subaccount Technical Committee.

6.3 Disbursements

Disbursements will be made directly by FIAS to the beneficiaries selected by the Mangrove Subaccount Technical Committee.

7. MONITORING AND TECHNICAL SUPERVISION

The organizations supported by the Mangroves Subaccount shall be monitored technically and financially according to the periodicity established in the Socio Bosque Project Manual. The Technical Committee will be responsible for evaluating the technical monitoring reports of the performance of the Mangroves Subaccount and will determine the success of the activities supported with the returns from the Mangroves Subaccount.

FIAS must submit to the FSB Board, the Mangrove Subaccount Technical Committee and the Mangrove Subaccount contributors the financial and accounting follow-up reports of the Mangrove Subaccount incentives paid and the administration costs.

The Technical Committee shall analyze the reports submitted by FIAS and request additional information if deemed appropriate. The analysis of the reports may generate a request for clarification or expansion of the reports received.

Committee members may also make on-site monitoring visits to the agreements for which incentive funding was approved to check the conservation status of the area under conservation. The cost of these visits may be funded by the Mangroves Subaccount if approved by the Technical Committee.

8. APPLICABLE COSTS FOR THE MANAGEMENT OF THE FSB'S MANGROVE SUBACCOUNT BY FIAS

The compensation for administrative costs of FIAS established in the FSB Accession Agreement between the MAAE, CI-Ecuador and FIAS include:

a. For patrimonial contributions, the provisions of the FSB Procedures Manual shall apply.
b. For extinguishable contributions, a percentage of 5% (five percent) will be applied on the amounts administered during the year.

9. SCHEDULE OF MEETINGS AND DISBURSEMENTS

Activities	Quarter 1	Quarter 2	Quarter 3
The Technical Committee evaluates the final reports on the execution of resources and projects for the previous year. Evaluates next year's AWP and budget, ensuring complementarity with PSB investments. Approves activities to be funded and submits AWP and budget to the FSB Board for approval.			
The FSB Board approves the AWP and budget.			
FIAS executes the respective disbursements.			
The activities are executed.			
The organization sends the financial information to FIAS six (6) months after signing the agreement. And at the end of the fiscal period (January-December of each year), in the established formats.			
The organization holds meetings with CI-Ecuador and/or PSB to report on the execution of activities six (6) months after implementation.			
The beneficiary organizations send the financial information to FIAS and make the final technical report to the PSB on the investment made during the year.			