Annex 22a – Methodologies and assumptions for GHG calculations

I) Estimation of abatement factors for investments and value chains considered in the Feasibility Study (Annex 2) and Economic Model (Annex 3)

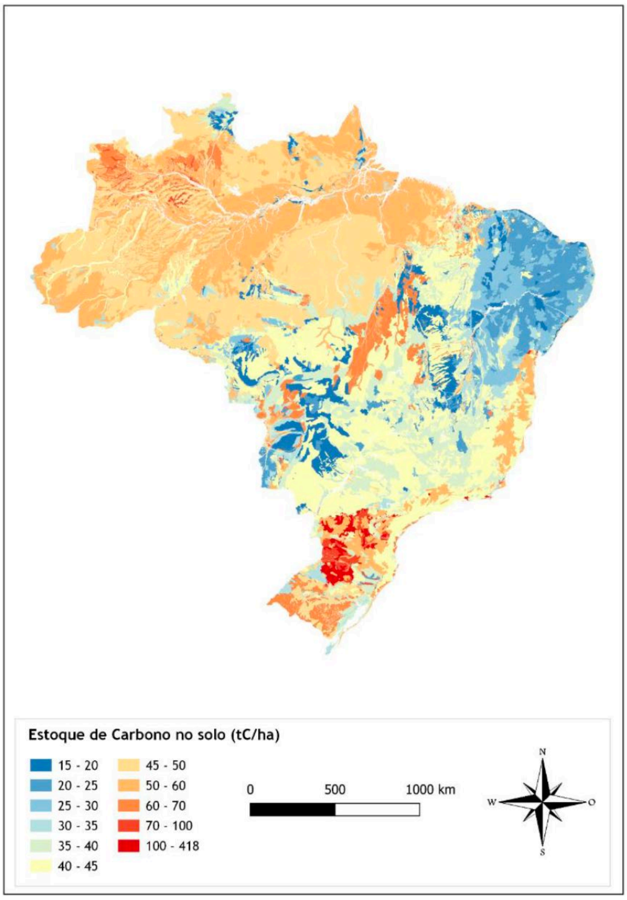
The impact of the activities 1-6 on the GHG emissions were estimated by using the EX-ACT (EX-Ante carbon balance Tool) tool. EX-ACT is a tool developed by the FAO to provide ex-ante estimates of the impact of agriculture and forestry development projects on carbon sequestration and GHG emissions, indicating its effect on the carbon balance. The tool is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[1], the 2014 supplement for wetlands and the 2019 refinement[2], and provides EX-ACT with recognized regional default values for emission factors and carbon values, i.e., the Tier 1 level of precision[3]. It is a renowned tool for this kind of estimation and accepted by institutions like the Global Environment Facility (GEF) and KfW, among others.

In addition to soil type, climate information, and the use of fire for the conversion of land, the following inputs were required to estimate the impact of the activities below on GHG emissions: a) duration of the project (implementation- and capitalization phase), b) the initial land-use and c) the final land-use. The soil type and climate information inputs were obtained by using the IPCC climate and soil classification that is embedded in the tool. For activities 1-6 this was found to be "low activity clay soil" with a reference soil carbon stock of 47 tC/ha. This value seems credible and representative when crosschecking with the national GHG inventory of Brazil. The 4th national GHGI of Brazil (2020) includes a soil map reproduced below, which makes an association between vegetation and soil type. It indicates that soil carbon stocks in the Amazon basin are in the range of 47 tC/ha or higher.

---

1 https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/
2 https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/
3 http://www.fao.org/3/i8075e/i8075e.pdf

Figura 13. Estoque de carbono (tC/ha) nos solos do Brasil, adaptado de Bernoux *et al.* (2002).



The climate of “tropical wet” is considered appropriate and applicable for the Amazon basin. For all activities, we assumed that there was no fire in use for the conversion of land.

The GHG emissions impact of other activities were estimated based on project benchmarks, as explained below.

The inputs for activities 1-6 are defined as follows:

1. Acai (EX-ACT) 6.1 tCO_2e/ha/annum net sequestered/avoided in project scenario.
    - Intervention: Poorly managed Acai systems are to be intensified and improved (irrigation). This leads to a higher carbon stock in biomass and soil carbon stocks.
    - Carbon Monitoring: height of palms and stand density should be monitored in intervals of 1-5 years
    - Baseline: It is assumed that the baseline is a suboptimal Acai system with slightly degraded soil carbon stocks of 35 tC/ha and reduced growth of 0.5 tC/ha/annum. This will be the benchmark and is thus considered a zero-baseline → baseline sequestration rate: 0 tCO_2e/ha/annum
    - Project: This Acai system is converted to a productive Acai system, improving soil beyond the average up to 52.5 tC/ha. Tillage and input factors were assumed at 1 and a biomass growth rate of 0.91 tC/ha/annum is used for biomass growth, which is a standard agroforestry factor used in the 4th national inventory report by Brazil → project sequestration rate 6.1 tCO_2e/ha/annum

    a. Implementation phase: 3 years, capitalization phase: 17 years

2. Aquaculture: an initial modelling of aquaculture-related GHG emission reductions was done to develop an indicative sense for the range and order of magnitude of potential mitigation benefits associated to this value chain. Based on such modelling, a net abatement factor of 14.4 tCO2e/ha/annum was estimated for the project scenario, where improved productivity and expansion of aquaculture production is expected to result in some degree of reduced beef production. The project team, however, is not aware as of the date of this analysis of the availability of any internationally validated methodology to assess the displacement of beef production/consumption (and therefore cattle expansion-induced deforestation) based on increased fish production from aquaculture. As a result, to be conservative and in spite of the modelling work conducted and mentioned above, no GHG emission reductions are counted towards projected economic benefits of the Programme from the share of investments estimated to support the aquaculture value chain. In both the economic model (Annex 3a) and the calculations of Annex 22b the GHG emission reductions from aquaculture are considered / valued as 0 and presented as N/A. During the Programme implementation stage IDB will continue to monitor developments around international validation of related methodologies; and in case adequate methodologies become available it will consider them for assessing mitigation benefits of aquaculture projects.

3. Cacao improved (EX-ACT): 4.3 tCO2e/ha/annum net sequestered/avoided in project scenario.
    - Intervention: Low productivity cacao is improved towards a productive cacao system. This leads to a higher carbon stock in biomass and soil carbon stocks. As a proxy land use the option "Agro-forestry" was selected to reflect Cocoa agroforestry.
    - Carbon Monitoring: Tree diameter, height, and stand density should be monitored in intervals of 1-5 years
    - Baseline: It is assumed that low productivity cacao with low C inputs is the baseline land use: Tillage factor 1, input factor 0.92. The aboveground and belowground biomass growth is assumed to be 20% below the IPCC default due to suboptimal management → baseline sequestration rate: 7.2 tCO2e/ha/annum
    - Project: Through improved inputs and better soil management the system moves towards more productive cacao with higher biomass (similar to IPCC default). Tillage factor 1.1, input factor 1 → project sequestration rate 11.5 tCO2e/ha/annum
    - Implementation phase: 3 years, capitalization phase: 17 years.

4. Cacao on degraded land (EX-ACT): 15.2 tCO2e/ha/annum net sequestered/avoided in project scenario.
    - Intervention: Cacao plantations are established on degraded land. This increases the carbon stock in biomass and soil.
    - Carbon Monitoring: Area of established plantation, survival rate, tree diameter, height, and stand density should be monitored in intervals of 1-5 years
    - Baseline: It is assumed that the baseline scenario is degraded land according to IPCC definition with a soil carbon stock of 17.2 tC/ha and biomass growth of 1 tC/ha/annum. This will be the benchmark and is thus considered a zero-baseline → baseline sequestration rate: 0 tCO2e/ha/annum
    - Project: As a proxy land use the option "Agro-forestry" was selected to reflect cacao agroforestry with a growth of 2.6 tC/ha/annum and a final soil carbon stock

of 52,5tC. Trees are not harvested. Tillage and input factors were assumed to be 1. → project sequestration rate 15.2 tCO_2e/ha/annum
- Implementation phase: 3 years, capitalization phase: 17 years.

5. Coffee improved (EX-ACT): 4.3 tCO_2e/ha/annum net sequestered/avoided in the project scenario.
    - Intervention: Low productivity coffee is improved towards a productive coffee system. This leads to a higher carbon stock in biomass and soil carbon stocks. As a proxy land use the option "Agro-forestry" was selected to reflect Coffee agroforestry.
    - Carbon Monitoring: Tree diameter, height, and stand density should be monitored in intervals of 1-5 years
    - Baseline: It is assumed that low productivity coffee with low C inputs is the baseline land use: Tillage factor 1, input factor 0.92. The aboveground and belowground biomass growth is assumed to be 20% below the IPCC default due to suboptimal management →baseline sequestration rate: 7.2 tCO_2e/ha/annum
    - Project: Through improved inputs and better soil management the system moves towards more productive coffee with higher biomass (similar to IPCC default). Tillage factor 1.1, input factor 1 → project sequestration rate 11.5 tCO_2e/ha/annum
    - Implementation phase: 5 years, capitalization phase: 15 years.

6. Coffee on degraded land (EX-ACT): 15.2 tCO_2e/ha/annum net sequestered/avoided in project scenario.
    - Intervention: Cacao plantations are established on degraded land. This increases the carbon stock in biomass and soil.
    - Carbon Monitoring: Area of established plantation, survival rate, tree diameter, height, and stand density should be monitored in intervals of 1-5 years
    - Baseline: It is assumed that the baseline scenario is degraded land according to IPCC definition with a soil carbon stock of 17.2 tC/ha and biomass growth of 1 tC/ha/annum. This will be the benchmark and is thus considered a zero-baseline → baseline sequestration rate: 0 tCO_2e/ha/annum
    - Project: As a proxy land use the option "Agro-forestry" was selected to reflect cacao agroforestry with a growth of 2.6 tC/ha/annum and a final carbon stock of 52.5tC. Tillage and input factors were assumed to be 1. → project sequestration rate 15.2 tCO_2e/ha/annum
    - Implementation phase: 3 years, capitalization phase: 17 years.

For the activity 7, a timber growth model and a long-term average approach was used to calculate the emission reductions.

7. Timber-Parica: 6.5 tCO_2e/ha/annum net sequestered/avoided in project scenario.
    - Intervention: Afforestation of degraded land leading to higher carbon stocks in biomass and soil
    - Monitoring: Typical forest monitoring of area of afforestation, survival rate, tree diameter, height, stand density, etc.
    - Baseline: It is assumed that low productivity degraded land is the baseline scenario. This will be the benchmark and is thus considered a zero-baseline → baseline sequestration rate: 0 tCO_2e/ha/annum

- Project: planting of timber plantation with mean annual increment of 20 m3/ha/a, with 3 thinnings and rotation of 20 years, afforestation of non-forest land and a growth in soil carbon stock of 1.7 tCO_2/ha/annum. Conservatively, there is no accounting of harvested wood products. → project sequestration rate 6.5 tCO_2e/ha/annum
- Implementation phase: 7 years, capitalization phase: 13 years.

Activity 8 on NTFP used an example of similar interventions in Peru as certified in a voluntary carbon project (https://registry.verra.org/app/projectDetail/VCS/868) to derive a GHG estimate.

8. NTFP (Brazil nut): 1.4 tCO_2e/ha/annum net sequestered/avoided in project scenario.
   - Intervention: Protection of forest through intensification of forest-based NTFP value chain utilizing Brazil nut enrichment and other measures. This shall provide an income from forest and address drivers of deforestation (cattle, charcoal, etc.)
   - Monitoring: Should be linked to NFMS and utilize typical REDD+ monitoring approaches
   - Baseline: Degradation or underutilization of NTFP value chain leads to long-term deforestation. Based on the example project in Peru, this leads to net emissions of 2.87 tCO_2e/ha/annum. As shown in the figure below on Benchmarks for AUDD this lies within a credible range. For conservativeness, we apply a margin of safety of ca. 50% → baseline emission rate 1.4 tCO_2e/ha/annum
   - Project: Through enrichment planting and NTFP intensification deforestation can be prevented. Note: This is a simplified demonstration. Normally, deforestation can only be reduced but not prevented. However, this is already considered in the net value. On top, the feasibility study indicated in its modelling depending on already existing degradation the intervention could lead to a sequestration of 5tCO_2e/ha/annum. This will be conservatively excluded to also account for intervention areas with lesser degradation levels → project emission rate 0 tCO_2e/ha/annum

Abatement of value chain 9 (community tourism) was estimated based on reducing deforestation at the rate of a reference carbon forestry project. The project team compared this reference project to a global benchmark (see Figure 1). The value used in the calculations for the GCF proposal (1.87 tCO_2e/ha/annum) are conservative compared to global benchmarks (2.4 tCO_2e/ha/annum). A quick summary of the reference project applied can be found in Table 1. The monitoring should be linked to the particular NFMS similar to the approach used in the reference project.

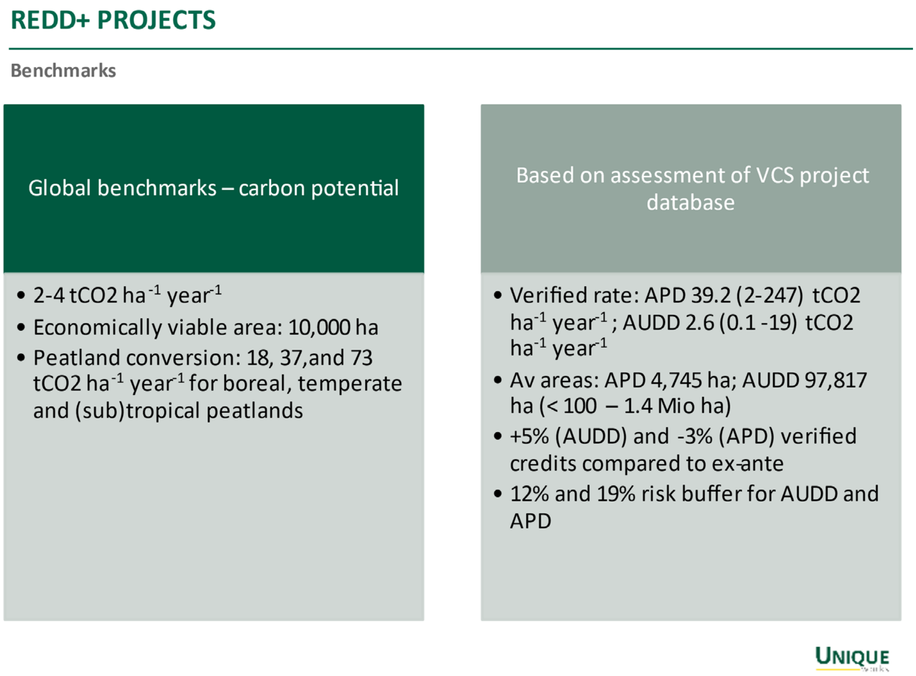


Figure 1: Global benchmarks for REDD+ project

9. Community tourism: 1.87 tCO_2/ha/annum net sequestered/avoided in project scenario.
    - Assumption that community tourism is reducing deforestation.
    - Based on verified credits generated by CIMA reference project in Peru.[4]

Table 1 – Summary of reference project used for value chain 9

CIMA Project – Key parameters

- Developed in the Cordillera Azul National Park extends into the Peruvian Amazon, in the north-east of Peru, in the Amazonian regions of Loreto, San Martín, Huánuco and Ucayali.
- Deforestation is driven by subsistence farming (grassland and agriculture).
- The project area is 1,351,963 hectares.
- The park’s buffer zone was officially recognized by the Peruvian government in a Supreme Decree establishing the park. In 2007 the buffer zone was expanded by legislation, resulting in an area of 2,301,117 hectares.
- Under VCS, the project is using VM0007 REDD Methodology Modules (REDD-MF) for un-planned frontier deforestation for carbon stock and avoided emissions assessment. The sign-ing of the 20-year management contract in 2008 served as the start of the carbon project.
- The project’s primary objective is to prevent deforestation in PNCAZ by protecting the park, capacity building for sustainable land use, strengthening relationships with local, regional and national government agencies.
- This project is a conservation project designed to maintain the project area’s High Conserva-tion Values (HCVs). The project falls within the Un-planned Deforestation, as the baseline con-templates the conversion of forest land to non-forest land primarily for Agriculture and Pas-ture, due to unauthorized actions by external agents.

---

[4] Centro de Conservación, Investigación y Manejo de Areas Naturales – Cordillera Azul. CORDILLERA AZUL NATIO-NAL PARK REDD PROJECT. Lima, Peru..

▪ The ex-ante projections assume that no deforestation, or other sources of emissions, occurs in the project in the with-project case, i.e. that park protection activities are successful in preventing land clearing within the park boundary. Park protection and border patrolling, as well as community awareness programs, are key components to the project implementation. CIMA has a proven track record from 2003 to 2008, of effective protection work and conflict resolution. ▪ The activities to be implemented are designed to combat the greatest driver of deforestation in the project zone which is the advancement of the agricultural frontier. ▪ The estimates of the areas of Unplanned Deforestation derived from the analysis of remotely sensed data. ▪ Carbon pools included: above and below-ground and deadwood. Litter is not included due to its generally not significant contribution to total carbon stocks; and soil organic carbon not included – it is a conservative approach since under the baseline the emissions from soil are expected to be larger (reduction of soil carbon stock from conversion of forests to agriculture, in particular).

II) GHG calculation approach

Utilizing the per hectare abatement factors estimated in the previous section, GHG emission reduction are calculated in the Economic Model (Annex 3) utilizing the following general approach:

1. Allocation of Programme Capex investment resources (i.e. GCF plus additional investment resources mobilized for CAPEX investment; total of USD 751M) is generally made pro rata with market financial demand, as evaluated in the Feasibility Study (Annex 2).
2. Taking such allocations per value chain, the number of hectares supported by the Programme is calculated for each of them based on average investment per hectare values, based on data gathered in the Feasibility Study.
3. GHG abatement is subsequently calculated by multiplying -for each value chain and type of investment- the relevant number of hectares, the per-hectare/year abatement value and the asset lifetime (years) of each investment.

Annex 22b summarizes these calculations and results, for each value chain.