
ANNEX 22. Carbon Estimates

Basin Approach for Livelihood Sustainability through Adaptation Strategies (BALSAS)

April 2024

Estimate of the GHG mitigation potential

1. Background

The objective of the project is to reduce the vulnerability to climate change of the rural population, ecosystems and production systems and promote the transformation towards sustainable models low in greenhouse gas emissions in the Balsas Basin. The project will be co-financed between IFAD, the GCF and the GdM. IFAD will be the Accredited Entity before the GCF. The project proposes intersectoral coordination and convergence of actions of the Ministry of the Environment and Natural Resources (SEMARNAT), which includes the National Forestry Commission (CONAFOR), the National Water Commission (CONAGUA), the Mexican Institute of Water Techniques (IMTA) and other institutions involved in rural development such as the Ministry of Agriculture and Rural Development (SADER, the Ministry of Welfare, the National Institute of Indigenous Peoples (INPI), and the national development banks, as well as the state governments of the territories covered by the project. Through the project, the integration and implementation of the main climate public policy instruments of Mexico will be promoted, this being a strategic aspect of the intervention, by promoting coordinated actions in the territory for the mitigation and adaptation to climate change.

The typology of interventions proposed have mitigation co-benefits. In this context, the quantification of GHG emission is an important step to highlight this benefit. It also offers an opportunity to identify how the project actions provide win-win situations in delivering both adaptation and mitigation objectives which are equally important considering the climate change context.

2. Methodology

- A. Methodology for accounting for Greenhouse Gases with the use of the Ex-Ante Carbon Balance Tool (EX-ACT) and the modeling tool for increases in Carbon stocks derived from Sustainable Forest Management (Model+MFS).

The 2030 Agenda and Paris Agreement tied the knot between sustainable economic development and a climate-resilient, low greenhouse gas (GHG) emissions future. Moving forward, accounting for potential changes in GHG emissions will be a vital component of any agricultural investment, project, or policy proposal under consideration by any country, institution, or organization. To support the international community's efforts with quantifying changes in GHG emissions, the Food and Agriculture Organization of the United Nations (FAO) developed the EX-Ante Carbon-balance Tool (EX-ACT¹). Based on the Intergovernmental Panel on Climate Change (IPCC) methodology, EX-ACT provides its users a consistent way of estimating and tracking the impact of agricultural, forestry, and other land-use (AFOLU) investments and policies on GHG emission levels. EX-ACT is a free, open-source, Excel-based model and is available in all UN languages. GHG accounting has become a common practice for many international financial institutions as part of their project preparation. EX-ACT is widely used to assess the impact of agricultural and forestry projects on GHG

¹ http://www.fao.org/fileadmin/templates/ex_act/pdf/Technical_guidelines/EX-ACT_technicaldescription_EN_v7.pdf

emission and carbon sequestration. Its use includes ex-ante assessments of GEF projects, forestry and agricultural investment projects at the World Bank, Development Banks among others.

The tool calculates carbon stock changes and GHG emissions, including carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), which once converted to CO₂ equivalent are used to derive the carbon balance that indicates the impact of the project. A positive result in the carbon balance indicates that the project generates higher emissions, while a negative result in the carbon balance indicates that the project contributes to the reduction of emissions.

EX-ACT analysis assesses how the impacts of an intervention compare to the business-as-usual (BAU) scenario. The calculator requires data for 3 specific points in time: initial situation, scenario with project and scenario without project or BAU. In preparing this data, work is required in advance to determine the appropriate use of activity/intervention data in the tool. This takes into consideration technical specifications, discussions with national staff to determine current and future projections, and review of secondary sources to assess the availability of Tier 2 or Tier 3 coefficients to improve assessment accuracy. Once all this information is collected, a plan is generated based on technical experience on how to best model the intervention in the tool along with the assumptions made. This is a crucial step, because it is what really determines the impact measurement.

The Sustainable Forest Models (Model+MFS) tool was created by the National Forestry Commission (CONAFOR), with the support of FAO and the World Bank in 2019. This tool serves to facilitate the modeling of increases in Carbon stocks derived from Sustainable Forest Management, as a result of the implementation of programs and projects focused on timber harvesting (and its improvement), within the framework of climate change mitigation actions developed by CONAFOR.

Model+ MFS is designed for national or subnational programs and projects that implement actions related to CONAFOR's Community Forest Management program. Model+ MFS is a simplified tool based on the characteristics of the Mexico Forestry Development Method. An important part of the data considered in this tool comes from the National Monitoring, Reporting and Verification System for REDD+ operated by CONAFOR and the National Network of Permanent Monitoring Systems in Productive Forest Landscapes of Mexico, as well as default information from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Its main characteristics are: (a) Flexibility to enter inputs from different sources, (b) Results for biomass, carbon and carbon dioxide, (c) Spatially referenced results and (d) Two models for two cutting cycles. It is important to note that if you want to analyze other silvicultural systems than the MDS, Model+ MFS should be modified. The first version of this tool was made in 2019, in March 2022 the tool was updated and several assumptions were changed, so it is believed that it is now a slightly more realistic version that tries to represent the difference in biomass growth of unmanaged forests Vs under sustainable forest management.

3. Project scope and data sources

Project objective: “Contribute to the reduction of vulnerability to climate change of the population, ecosystems and productive systems in the Balsas Basin.”

Project management:

The estimate for this project considers the sequestration, reduction and/or avoidance of emissions resulting from the implementation of the activities of component two of the project, which represent the investments that will be made at the level of forest areas and agricultural plots.

- Payment for Environmental Services
- Forest Restoration
- Commercial Forest Plantations
- Community Forest Management and Value Chains

These summarized activities are described in Table 1.

Table 1: Project activities considered for the EX-ACT analysis

Component 2			CONAFOR
ROP	Model	Unit of measure	Total hectares
Community Forest Management and Value Chains			
D. Activity 2.3.1 Sustainable Forest Management adapted to climate change, inclusion and access to markets	Sub-activity 2.3.1.1 Manage forests sustainably adapted to climate change (MFCCV.1)	hectare	120,487/ 48,195
Commercial Forest Plantations			
C. Activity 2.2.2 Forest Plantations Adapted to Climate Change	Sub-activity 2.2.2.1 Establish climate adapted planted forests (PFC 1)	hectare	4,353
	Sub-activity 2.2.2.2 Establish silvopastures (PFC 2)	hectare	1,500
Forest Restoration			
B. Activity 2.2.1 Restoration of Forest Landscapes adapted to climate change (RFM)	Sub-activity 2.2.1.1 Establish climate resilient agroforestry systems	hectare	2,000
	Sub-activity 2.2.1.2 Establish agave – forest water / soil retention terraces	hectare	1,000
	Sub-activity 2.2.1.3 Establish forest – pasture water / soil retention terraces	hectare	1,400
Payment for Environmental Services			
A. Activity 2.1.1 Payment of environmental services	Sub-activity 2.1.1.1 PDFS PES projects are approved and financed	hectare	193,838

EX-ACT distinguishes between two time periods: the project execution phase and the capitalization phase. The execution phase is the period during which the project activities are carried out. However, the period covered by the analysis does not necessarily end with the end of the project's active intervention. Further changes may occur as a result of interventions (project activities), such as changes in soil carbon content or biomass. This period defines the compounding phase. In this analysis, following the IPCC recommendations, we consider a global period of 20 years for the implementation and capitalization phase. The implementation phase lasts 8 years, the benefits generated by the project will continue to be capitalized for another 12 years until reaching the 20-year period.

The estimates focus on some of the activities of component 2 of the project, which are broken down as shown in Table 1 and the calculations for each activity are described below.

2.1.1 Payment for environmental services (PES)

One of the project objectives is to support 193,838 hectares for payment for environmental services. Thanks to information shared by the National Forestry Commission (CONAFOR), it is known that the difference between deforestation rates between a forest under payment for environmental services vs. a forest without PES is 0.3% at the national level, so it is assumed that if This activity will not be carried out, there would be a felling of 0.3% of the 193,838 hectares supported. As a result of this activity, deforestation of the forests is avoided.

For purposes of this estimate, it was considered that this type of ecosystem and climate occur in the project area in the following proportion: 70% dry tropical forests (dry tropical climate) and 30% temperate forests (humid warm temperate climate). In each ecoregion, once there is deforestation, land use changes occur in the proportion shown in Table 2. This information is important for the situation without a project, which must be declared in the EXACT tool.

Table 2: Land use changes proportion after deforestation.

Ecoregion	% FL - GL	% FL - CL
Jungles Warm - Dry	61%	39%
Warm Temperate mountains	82%	18%
*FL = Forest Land, GL = Grassland, CL = Cropland		

According to the above information, the information that is declared in the tool in the land use change section is as follows, of the 193,838 ha:

-58 151.4 hectares (30% of the total) are assumed to enter the PES program in dry forest areas with a tropical climate, so it is assumed that the project will prevent deforestation of 1395.63 ha in this area (851.33 ha converted to pasture and 544.29 ha converted to annual crops). They were declared in EX-ACT as Tropical Dry Forest, because due to its characteristics it is considered that it is the one

that best represents the characteristics of the ecosystem in Mexico. The conversion would take place without the use of fire.

-135 686.6 hectares (70% of the total) are assumed to enter the PES program in warm temperate dry areas, so it is assumed that the project will prevent deforestation of 3256.47 ha in this area (2670.31 ha converted to pasture and 586.16 ha converted to annual crops). They were declared in EX-ACT as subtropical mountain system, because due to its characteristics it is considered that it is the one that best represents the characteristics of the ecosystem in Mexico. The conversion would take place without the use of fire.

2.2.1 Restoration of Forest Landscapes adapted to climate change (RFM)

These activities aim to transform areas with a certain degree of degradation or abandoned areas into productive areas.

2.2.1.1 Establish climate resilient agroforestry systems

The purpose of this activity is to transform abandoned areas into productive agroforestry areas. This action aims to intervene in 2000 ha in areas with a temperate warm dry climate. They were declared in EX-ACT as a land use change, from annual fallow to Agroforestry system (default) and it was used a Tier 2 factor of above ground biomass of 2.34 TC/ha/year. The Tier 2 value was obtained from the average of different secondary sources of case studies in Latin America that declared the capture in TC/ha/year in shaded coffee plantations.²

2.2.1.2 Establish agave – forest water / soil retention terraces

The purpose of this activity is to transform areas with a certain degree of degradation into multipurpose production areas. This action aims to intervene in 1000 ha in areas with a subtropical dry climate. They were declared in EX-ACT as a land use change, 80% of the total area from annual fallow to Agroforestry system (default) and 20% from degraded land to Agroforestry system (default). It is assumed that there will be a density of 700 plants per ha of agave and that the natural regeneration of woody trees will be promoted, it was used a Tier 2 factor of above ground biomass of 7.80 TC/ha/year.³

2.2.1.3 Establish forest – pasture water / soil retention terraces

The purpose of this activity is to transform areas with a certain degree of degradation into better managed community use areas through the division of strips of multipurpose planted forests that include native species for timber and useful as a source of food and protein for livestock. This action aims to intervene in 1400 ha, 80% of the total area in areas with a subtropical dry climate and 20% of the total area in areas with a temperate warm dry climate. They were declared in EX-ACT as a

² Andrade, Hernán J.; Marín, Lina M.; Pachón, Diana P. Fijación de carbono y porcentaje de sombra en sistemas de producción de café (*Coffea arabica* L.) <https://www.redalyc.org/pdf/857/85731100008.pdf>

Avila Vargas, Gabriela; Fijación y almacenamiento de carbono en sistemas de café bajo sombra <https://repositorio.catie.ac.cr/bitstream/handle/11554/10006/tesis%20gabriela.pdf?sequence=1&isAllowed=y>

³ Modelo Agroforestal de agave <https://www.oaxacabajoenemisiones.mx/?P=Agave>

land use change 238 ha from annual fallow to silvopasture system (default) and 42 ha from degraded land to silvopasture system in the temperate zone, and 952 ha from annual fallow to silvopasture system (default) and 168 ha from degraded land to silvopasture system in the subtropical dry climate.

2.2.2 Forest Plantations Adapted to Climate Change

2.2.2.1 Establish climate adapted planted forests (PFC 1)

The objective of this activity is to increase forest carbon stocks through the implementation and development of Commercial Forest Plantations on land suitable for forestry. This action aims to intervene in 4353 ha in areas with a temperate warm dry climate. They were declared in EX-ACT as planted subtropical dry forest, 80% of land use prior to planting is pasture and 20% is annual crops. The species that were considered for these plantations by the region were *pinus pseudostrobus* and *pinus patula* with an average tier 2 value of 2.5 TC/ha.

2.2.2.2 Establish silvopastures (PFC 2)

The purpose of this activity is to transform of grasslands with a degree of degradation to silvopastoral systems. This action aims to intervene in 1500 ha in areas with a subtropical dry climate. They were declared in EX-ACT as a land use change from grassland to silvopasture. Currently they are overgrazed areas, without the project they became degraded areas, with the project we seek to improve the condition.

2.3.1 Sustainable Forest Management adapted to climate change, inclusion and access to markets

2.3.1.1 Manage forests sustainably adapted to climate change (MFCCV.1)

The objective of this activity is the incorporation of areas to forest management. As a result of the incorporation to sustainable forest management, two benefits are accounted for, the avoidance of deforestation in the areas where management occurs and the increases in biomass in the hectares that are incorporated for the first time into sustainable forest management. Due to this, deforestation of 0.3% is avoided in 120,487ha where management occurs. They were declared in EX-ACT as avoided deforestation.

For areas that are incorporated into sustainable forest management for the first time, it is assumed that the project will support approximately 48,195 hectares. To estimate the benefits in biomass increases, the model+ MFS tool is used. The variables and inputs used in this tool are shown in the following table 3.

Table 3. Information entered into Model+MFS for projects that are incorporated into MFS for the first time.

Information	with project	
Authorized Surface	6024	ha
Area per annuity	602	ha
Annuities	10	
Average existence in M3/ha	211.32	m3/ha
Authorized extraction volume per annuity	3.80	m3/ha
Starting ICA	5.1394	m3/ha/año
Information	Without project	
Authorized Surface	6024	ha
Area per annuity	602	ha
Annuities	10	
Average existence in M3/ha	211.32	m3/ha

It is important to mention that the version of Model+MFS used in this estimation is version 2, updated in March 2022, but this tool designed by CONAFOR with support from the World Bank and FAO still needs to be validated within the National Forestry Commission.

Final results:

The mitigation potential for the project in a total of **324,578 hectares intervened** with the activities described above of component 2 is:

- After **8 years** of implementation it is **-1,644,348.5 tCO₂eq**
- After **20 years** (8 of implementation and 12 of capitalization) it is **-3,926,876.41 tCO₂eq**

Table 4 shows the final results of the mitigation potential of the different activities of component 2.

Table 4. Final results by component

Component 2			CONAFOR				Total at 4 years	Total at 8 years	Total at 20 years
ROP	Model	Unit of measure	Total hectares	Total hectares	Ton CO2eq/year	Ton CO2eq/ha/year	Ton CO2eq	Ton CO2eq	Ton CO2eq
Community Forest Management and Value Chains									
D. Activity 2.3.1 Sustainable Forest Management adapted to climate change, inclusion and access to markets	Sub-activity 2.3.1.1 Manage forests sustainably adapted to climate change (MFCCV.1)	hectare	120,487	48,195	-52392.14	-0.87563185	-113721.59	-419137.1	-863848
Commercial Forest Plantations									
C. Activity 2.2.2 Forest Plantations Adapted to Climate Change	Sub-activity 2.2.2.1 Establish climate adapted planted forests (PFC 1)	hectare	4,353		-50611.32684	-20.08138	-202445.31	-404890.6	-1012226.54
	Sub-activity 2.2.2.2 Establish silvopastures (PFC 2)	hectare	1,500		-19875.74129	-13.25049419	-79502.965	-159005.9	-397514.8
Forest Restoration									
B. Activity 2.2.1 Restoration of Forest Landscapes adapted to climate change (RFM)	Sub-activity 2.2.1.1 Establish climate resilient agroforestry systems	hectare	2,000		-11694.00	-5.8	-46776	-93552	-233880
	Sub-activity 2.2.1.2 Establish agave – forest water / soil retention terraces	hectare	1,000		-26235.35	-26.2	-104941.41	-209882.8	-524707.1
	Sub-activity 2.2.1.3 Establish forest – pasture water / soil retention terraces	hectare	1,400		-20548.00	-27.7	-82192	-164384	-410960
Payment for Environmental Services									
A. Activity 2.1.1 Payment of environmental services	Sub-activity 2.1.1.1 PDFS PES projects are approved and financed	hectare	193,838		-24187.00	-0.224413252	-96748	-193496	-483740
				Total	-205543.56	-753.34	-726327.28	-1644348.50	-3926876.41

