Food and Agriculture Organization of the United Nations

FUNDING PROPOSAL TO THE GREEN CLIMATE FUND

-IRES-CUBA-

INCREASED CLIMATE RESILIENCE OF RURAL HOUSEHOLDS AND COMMUNITIES THROUGH PRODUCTIVE LANDSCAPE RESTORATION IN SELECTED LOCALITIES OF THE REPUBLIC OF CUBA

ANNEX 2. FEASIBILITY STUDY

October 2019

Republic of Cuba

EXECUTIVE SUMMARY

The Government of the Republic of Cuba (GoC) – through its Ministry of Agriculture (MINAG) and with support from its National Designated Authority (NDA), and the Ministry of Science, Technology and Environment (CITMA) – requested FAO's support to help formulate a funding proposal for the project "Increasing climate resilience of vulnerable rural households and communities through rehabilitation of productive agroforestry landscapes in selected locations in the Republic of Cuba" to be presented to the Green Climate Fund.

Climate change projections indicate Cuba will experience increased temperatures and shifts in precipitation patterns. Given the dependency of the poorest communities on water supply for their livelihoods, the impact of climate change will affect the food and income security of an already vulnerable population.

A significant determinant of Cuba's ability to improve economic growth and reduce poverty and inequality is its ability to adapt agroforestry-based livelihoods to the adverse effects of climate change. The Cuban government has invested significantly in adaptive agricultural practices. However, gaps remain in service delivery to smallholders to increase their capacities, resources and information access related to climate risk management. Efforts have not taken into consideration all elements of a holistic, climate resilience approach to achieve transformational change at scale.

Due to their vulnerability, seven municipalities in three selected provinces in the Central and Eastern regions were prioritized for adaptive measures. These included the municipality of Los Arabos in Matanzas province and the municipalities of Corralillo, Quemado de Güines, and Santo Domingo in the province of Villa Clara (Las Villas), all in the Central region; and in the Eastern region, the municipalities of Amancio Rodríguez, Colombia and Jobabo in the province of Las Tunas. The project aims at increasing the adaptive capacity of rural households and communities affected by climate change by: 1) implementing agroforestry and forestry systems; 2) strengthening institutional and farmer capacities to enhance climate resilience of production landscapes through agroforestry and forestry systems and improved ecosystem services; and 3) enhancing governance to support climate-resilient production systems and ecosystem services.

The project was designed through engagement with the NDA and stakeholder consultations, including civil society and government entities at the national, regional and local levels. Sustainability of the proposed interventions can be assured by: a) ensuring participation of all relevant stakeholders in activities with emphasis placed on strengthening women's and other disadvantaged groups' capacities and leadership capabilities to address social disparities; b) building upon local institutional structures; and c) promoting learning, adaptive management, and dissemination of knowledge.

The project will contribute to the GCF's Fund-level impacts of reduced emissions from forestry and land use; increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions; and increased resilience of ecosystem and ecosystem services. In addition, the proposed project will help achieve the climate priorities outlined in Cuba's Nationally Determined Contributions (NDC) and *Tarea Vida* (state plan on climate change).

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Abbreviations

ANAP	National Association of Small Farmers
CA	Conservation agriculture
CC	Climate change
CCS	Credit and Service Cooperatives
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIMMYT	Centro Internacional de Mejoramiento Maíz y Trigo [International Maize and Wheat Improvement Centre]
CITMA	Ministry of Science, Technology and Environment
CMIP	Coupled Model Intercomparison Project
CN	Concept note
CP	Consejo Popular [Popular Council]
CRIDF	Climate Resilience Infrastructure Development Facility
CRA	Climate-resilient agriculture
CUP	Cuban pesos
FAO	Food and Agriculture Organization [of the United Nations]
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environmental Facility
GESI	Gender equality and social inclusion
GHG	Greenhouse gas
GNI	Gross national income
GoC	Government of Cuba
HHD	High Human Development
IFAD	International Fund for Agricultural Development
INDC	Intended nationally determined contribution
IPPC	Intergovernmental Panel on Climate Change
MINAG	Ministry of Agriculture
PECC	Programa de Enfrentamiento al Cambio Climático [Program to Confront Climate Change]
PIA	Project intervention area
NAMAs	Nationally appropriate mitigation actions

NAPAS	National action plan for adaptation
NDCs	Nationally determined contributions
NGOs	Nongovernmental organizations
RCP	Representative Concentration Pathway
REDD	Reducing emissions from deforestation and forest degradation in developing countries
SIDS	Small island developing state
SMME	Small, micro, and medium-sized enterprises
SNC	Second National Communication to the UNFCCC
SPI	Standardized Precipitation Index
UEBIST	Base Enterprises for Integrated Technical Services
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

(PECC)

INTRODUCTION

This feasibility study is an assessment of key climate change risks and impacts on water security and productivity in Cuba's Central and Eastern regions. It analyses and determines the feasibility of interventions to improve climate resilience of rural households and communities through rehabilitation of productive agroforestry landscapes.

The study began with an in-depth review of related projects as well as consultations with government and non-government stakeholders. Technical studies also were conducted to identify vulnerabilities and risks to climate change impacts and needs to increase the adaptive capacity of households and communities. All studies are included in this document as Appendixes for full reference.

In 2017, the Government of Cuba (GoC) requested the FAO Representative in the country to prepare a proposal for a GCF project to increase resilience of rural households and communities through rehabilitation of productive agroforestry landscapes in selected localities. The project formulation was based on discussions held with the government's National Designated Authority (NDA) for the GCF within CITMA (Ministry of Science, Technology and the Environment).

In July 2017, with the government's no-objection letter, FAO sent the Project Preparation Facility (PPF) to the GCF to prepare the proposal. GCF's comments arrived at the end of 2017, however, the government of Cuba and FAO decided to prepare the NC with funds from the accredited agency.

In November 2018, the Concept Note (CN) "IRES – Cuba: Increased climate resilience of rural households and communities through productive landscape restoration in selected localities of the Republic of Cuba" was sent to the GCF. The CN was based on studies and missions carried out by a team of national consultants and FAO. Studies included: Baseline Vulnerability to Climate Change, Socioeconomic Characterization, Identification and Prioritization of Adaptation Modules, Institutional Analysis, Analysis of Relevant Initiatives, and Gender Analysis. GCF's comments on the CN were received on 10 December 2018.

In December 2018 and March 2019, two technical missions made field visits to meet the NDA and government team. A team of FAO specialists and external consultants was comprised to help formulate the funding proposal.

This feasibility study comprises an overview of Cuba's climate risk profile, including: current climate-change scenarios, climate-change projections, methodology used for selection of project implementation areas (PIA) and expected impacts on the PIA, the policy and institutional framework, an overview of related / complementary past and ongoing projects, main gaps and barriers that impede the GoC's achievement of a climate change adaptation / mitigation strategy in the project-targeted regions, and recommendations. The "Recommendations" section presents project activities with details of outputs, followed by an economic / financial analysis and carbon estimates, the project's institutional and implementation arrangement, and an overview of the gender and sustainability approaches adopted in the proposal.

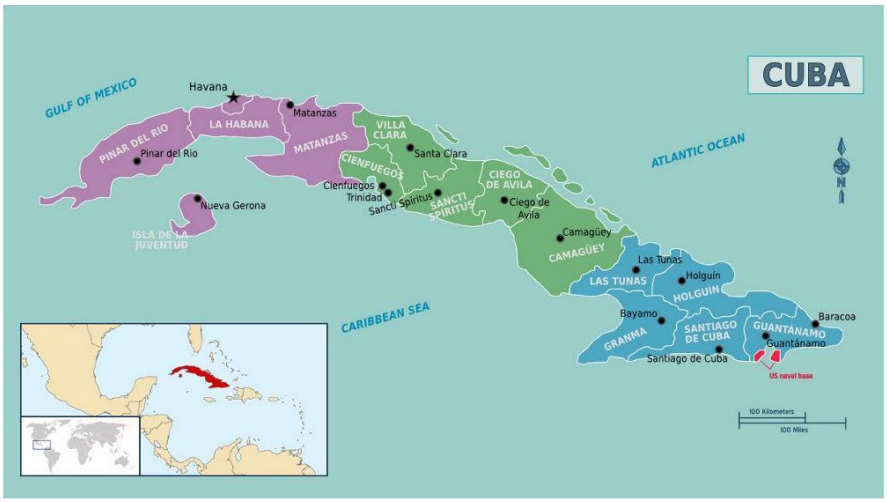
PART 1. Context analysis: climate-risk profile

1.1 Country context and challenges

1.1.1 Country overview

1. Cuba is a small-island developing state (SIDS). The Cuban archipelago consists of the island of Cuba, Isla de la Juventud [the Isle of Youth], and more than 1600 islands, islets and cays, which altogether cover a surface area of 110,922 square kilometers. From an administrative perspective, the country is divided into 16 provinces and 168 municipalities, including the special municipality of Isla de la Juventud. From the geo-economic perspective, the country is divided into the Western, Central and Eastern regions, as shown in Figure 1 (below).

Figure 1. Regions in Cuba[1]



Western Region
Central Region
Eastern Region

2. Cuba has four mountainous systems occupying 19,594 square kilometers, which accounts for 18% of the total area of the country. The plains cover 82% of the total country area, home to abundant agricultural and forestry activities, in accordance with local potential.

3. Cuba's population in 2013 was 11,239,224 inhabitants, with a density of 102.0 inhabitants per square kilometer (ONEI, 2017);[2] 76.8% lived in urban areas. Likewise in 2013, the total fertility rate dropped to 1.73, below the replacement level; together with a reduction in overall mortality, with a rate of about

[1] https://maps-cuba.com/cuba-regions-map

[2] National Office of Statistics and Information -ONEI (2017): Anuario Demográfico de Cuba 2016. La Havana: Republic of Cuba http://www.one.cu/aec2016/03 Poblacion.pdf

8.3 per thousand; and infant mortality (5.5 per thousand), with a consequent increase in life expectancy (78 years). Thus, compared to 2002, the 0–14-year-old population group decreased by 3.6%; the 15–59-year-old group remained steady; and the >60-years-old group grew (accounting for 18.7% of total population at the end of 2013). These statistics place Cuba among the countries with in Latin America and the Caribbean with the oldest populations (ONEI, 2014)[3].

4. By the end of 2013, growth of Cuba's Gross Domestic Product (GDP) reached 4.5% as result of expansion of public investment and implementation of strategic programs in the multiple sectors: energy, agriculture (with focus on food production), tourism, and transport.[4] Cuba's economy is based on agriculture, industry (where sugar has an important role) and services (mainly tourism). In 2013, total expenditure of the state budget decreased by 3% compared to the previous year. Of the total expenditure of the state budget, 14.9% was allocated to health, 11.1% to social security, and 17.4% to education. The country ranks 44th among those with high human development (HHD), according to the UNDP "Human Development Report 2014." Total net revenues decreased by 4.8% for a negative fiscal balance of 4.5 billion Cuban pesos (CUP), accounting for 4.8% of GDP.

5. The agricultural sector plays a strategic role in Cuba being able to meet its objective of reducing food insecurity in the population. Agriculture accounted for 3.9% of Cuba's GDP in 2013, and 3.8% in 2017.[5] Main products include sugarcane, tobacco, citrus, coffee, rice, potatoes, beans, and livestock. From 1980 through the early 1990s, machinery, fertilizers and other chemical products were used intensively in the sector, with strong negative impact on the natural environment (land and water). Starting in the 1990s, the agricultural sector experienced a deep recession, with a 50% drop in production, as result of the loss of Cuba's main suppliers in Eastern Europe as well as resurgence of the economic/commercial/financial embargo imposed by the United States, which has had a strong impact on the national economy.

6. According to the Second National Communication to the UNFCCC (2015), estimates show a reduction of 32% of land (approximately 800,000 hectares) devoted to production of permanent crops compared to 1998. This decrease is due, in part, to land previously used for food production (cereals and grains), livestock and commercial forests being converted into sugarcane plantations and also to the fragile ecosystem in which the agriculture is inserted in Cuba (mountainous areas with high risk of erosion and coastal zones or plains with risk of salinization).

7. In addition, Cuba is affected by extreme weather events, severe drought, rural fires, earthquakes and tsunamis (SNC, 2015).[6] The Cuban government has incorporated disaster risk reduction into its governmental structures through a Civil Defense system, with national and supra-institutional scope, and a structure based on the country's political-administrative division. This system is responsible for addressing all territorial issues on response strategies, contingency plans and protection of both the country's population and its economic/social/environmental assets.

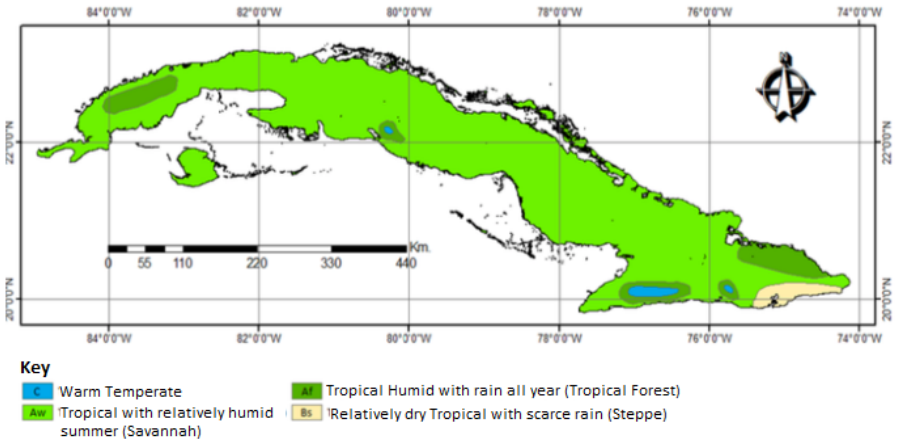
[3] National Office of Statistics and Information ONEI (2014): Anuario Demográfico de Cuba 2013.Havana: Republic of Cuba
[4] Second National Communication to the UNFCCC (SNC). 2015. Havana: Republic of Cuba
https://unfccc.int/sites/default/files/resource/cubnc2.pdf
[5] The world Bank. Agriculture, forestry, and fishing, value added (%of GDP).
https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=CU
[6] Second National Communication to the UNFCCC (SNC). 2015. Havana: Republic of Cuba
https://unfccc.int/sites/default/files/resource/cubnc2.pdf

1.2 Climate change in Cuba: observed and future trends

1.2.1 Climate drivers and extreme events in Cuba

8. Most of Cuba's territory has a tropical climate with a rainy season in summer (Type "Aw," according to Köppen climate classification in Figure 2). Average annual temperatures range from 24°C to 26°C (and higher) in the lowlands and on the Eastern coast, with temperatures below 20°C in the highest parts of the Sierra Maestra. Despite the tropical conditions, some seasonal features are present in its thermal regime, with two well-known seasons: summer or rainy season from May to October (July and August are the warmest months) and winter (less rainy season) from November to April (January and February are the coldest months). The national average rain record is 1 335 mm.

Figure 2. Types of climate in Cuba (Köppen climate classification)



Source: Second National Communication to the UNFCCC–SNC, 2015.[7]

9. Climatic conditions of the Cuban archipelago are determined by its geographical position in the Northern Hemisphere. Cuba receives high levels of solar radiation throughout the year, which conditions the warm character of its climate. In addition, the country's proximity to the Tropic of Cancer impacts the seasonal influence of both tropical and extratropical atmospheric circulation. Relevant factors in modeling climate and its variation include: global atmospheric circulation, sea surface temperature in the North Atlantic Ocean, cold fronts and particular meteorological events such as tropical storms, hurricanes, as well as the incidence of the "El Niño"/Southern Oscillation (ENSO) phenomenon (known as "El Niño" and "La Niña").

10. According to the Vulnerability and Climate Change Adaptation Index in the Latin America and Caribbean region, Cuba is classified as a "high risk" country.[8] Observations show that the country's climate has been changing, and studies conducted under the Second National Communication to the UNFCCC (2015)[9]

[7] Second National Communication to the UNFCCC. 2015. Havana: Republic of Cuba https://unfccc.int/sites/default/files/resource/cubnc2.pdf
[8] Corporación Andina de Fomento, 2014. Índice de vulnerabilidad y adaptación al cambio climático en la región de América Latina y el Caribe
[9] Second National Communication to the UNFCCC. 2015. Havana: Republic of Cuba https://unfccc.int/sites/default/files/resource/cubnc2.pdf

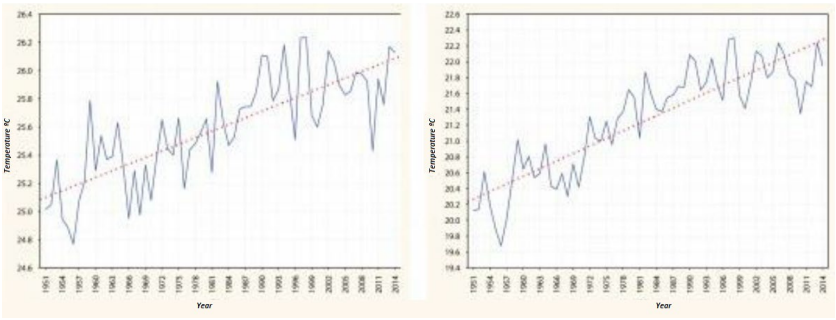
indicate the occurrence of: i) increased temperatures; ii) erratic seasonal rains; iii) greater frequency of long and severe droughts; iv) increased frequency and severity of cyclone activity; and v) moderate and severe coastal flooding.[10]

1.2.1.1. Observed climate trends in Cuba

(i) **Temperature rise**: The surface air temperature has increased by 0.9°C since the middle of last century, conditioned by the increase of 1.9°C in average minimum temperature, thereby producing a decrease in daytime temperature oscillation (see Figure 3).

Figure 3. Cuba, average (a) and minimum (b) temperature (°C); and temperature trends (1951–2014)

a **b**



Source: Planos Gutierrez et al., 2012; in Somoza J. De la Colina A., 2018.[11]

(ii) **Changes in precipitation pattern**: Positive precipitation anomalies increased slightly since the late 1970s with increased rainfall during rainy season (November to April).

11. For precipitation, a positive anomaly value indicates that the precipitation observed was greater than average precipitation in the 1970–1999 period, while a negative anomaly indicates that the precipitation observed was less than the average precipitation from 1970–1999. Although the series of annual precipitation values observed for Cuba from 1961 to 2007 do not show statistical significance, positive anomalies have slightly increased since the late 1970s and especially since the 1990s. In general, the slight increase in annual values is fundamentally conditioned by variations that occurred from November to April (the less-rainy months). In these months, despite the predominance of negative anomalies in recent years, there has been a slight upward trend, observed since the mid-1970s to the present, particularly with the increase in magnitude of positive anomalies in the Central Region (see Table 1).

[10] More information on climate changes observed in Cuba is provided in Appendix 2.4 of this document: Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for implementation of the project*. La Habana, Cuba, 2018.

[11] Planos Gutiérrez, E.O., Rivero Vega, R., Guevara Velazco, V., 2012. Impacto del Cambio Climático y Medidas de Adaptación en Cuba. La Habana: Cuba / *Climate Change Impact and Adaptation Measures in Cuba*. Havana: Cuba.
in. Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project*. La Habana, Cuba, 2018. (Appendix 2.4).

Table 1. Behavioral anomalies in precipitation (Standardized Precipitation Index) in rainy season, less-rainy season, and annually (1961–1979 and 1961–2007).

	CUBA		WESTERN		CENTER		EASTERN	
	1961-79	1961-07	1961-79	1961-07	1961-79	1961-07	1961-79	1961-07
LESS RAINY PERIOD								
MEAN	-0.68	-0.11	-0.58	-0.17	-0.81	0.05	-0.44	-0.15
MEDIAN	-0.67	-0.1	-0.59	-0.27	-0.67	0.03	-0.71	-0.15
STND. DEV	2.15	0.96	2.09	0.94	2.07	2.02	2.22	2.03
VARIANCE	2.33	0.92	2.19	0.88	2.14	2.05	2.48	2.07
RAINY PERIOD								
MEAN	0.46	0.07	0.21	0.16	0.29	0.07	0.8	-0.06
MEDIAN	0.38	-0.3	0.03	-0.07	0.00	-0.27	0.47	-0.29
STND. DEV	2.41	2.3	2.26	2.25	2.26	2.24	2.68	2.24
VARIANCE	2.0	2.69	2.59	2.56	2.58	2.53	7.19	2.53
YEARLY								
MEAN	-0.08	-0.01	-0.16	0.05	-0.17	0.08	0.19	-0.11
MEDIAN	-0.08	0.07	-0.44	0.1	-0.19	0.01	-0.24	-0.18
STND. DEV	2.65	2.07	2.37	2.04	2.59	2.12	2.05	2.17
VARIANCE	2.71	2.14	2.88	2.08	2.52	2.25	4.21	2.36

Source: Planos Gutierrez et al., 2012; in Somoza J. De la Colina A., 2018 (Appendix 2.4)[12]

12. Table 1 also shows that in the less-rainy season ("Periodo Poco Lluvioso"), negative average values were common in the 1961–1979 period, while the tendency in the following decades rose toward positive values with a reduced range of variation of means values and increase in extreme positive anomalies. Thus, there is a change in the mean values in the 1980–2007 period, compared with the 1961–1979 period, which in the case of the Central Region was -0.81 in the 1961–1979 period and 0.05 in the 1961–2007 period. In the Eastern Region, we can also see a trend toward increased average values of positive anomalies, particularly in the 1980–2007 period (-0.44 to -0.15), also with a reduction in variation of the mean values.

13. With respect to the rainy season, distribution of precipitation anomalies reveals a change in average values during recent decades, but contrary to the trend described for the non-rainy period, there is a tendency to predominance of negative anomalies. This behavior implies reduction of the range of variation of average values of rainfall, particularly in the Eastern Region. The most notable factor in this rainy period is the sharp decrease in average values and variation in the Eastern Region. The reduction of accumulated rainfall in the Eastern Region is largely due to the more frequent occurrence of meteorological drought processes in recent years in that region.

1.2.1.2. Extreme weather events in Cuba

(iii) **Droughts**: Drought events have increased in the 1961–1990 period compared with 1931–1960. In the 1990s, the most notable drought occurred in the Caribbean Basin, Central America, Mexico and the Southeast of the United States (from April to July 1998), generated under the influence of the ENSO 1997-1998. The event affected the entire Cuban archipelago, particularly several municipalities in the Eastern region. After 2000, drought periods have been more frequent and severe, especially in the

[12] Planos Gutiérrez, E.O., Rivero Vega, R., Guevara Velazco, V., 2012. Impacto del Cambio Climático y Medidas de Adaptación en Cuba. La Habana: Cuba / *Climate Change Impact and Adaptation Measures in Cuba*. Havana: Cuba.
in. Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project*. La Habana, Cuba, 2018. (Appendix 2.4).

Eastern region and in some municipalities in the Central region; almost the entire country was affected in 2003–2005. In 2004–2005, a severe drought (categorized as Cuba's most critical event in the last 100 years) threatened the livelihood of more than 2 million people (17% of the population) by causing agricultural losses, livestock death, and facilitating invasion by alien species such as *Dicostrachys cinérea* (*marabú*).[13] The drought of 2015 affected 100 000 people in the country.[14]

(iv) **Hurricanes**: Tropical cyclones, severe local storms and hurricanes are the meteorological phenomena associated with the greatest risk of disaster.[15] The frequency of such events varies from zero to four annually. On average, Cuba is affected by one tropical cyclone per year and one hurricane every two years. Between 2005 and 2017, Cuba was affected by 11 hurricanes. From 1980 to 2000, Cuba was affected by 10 tropical cyclones and over the period of 2001–2018, the occurrence of such phenomena doubled (19 tropical cyclones affected Cuba from 2001–2018).[16] Two tropical cyclones occurred in 2005, affecting[17] 2.6 million people (approximately 22% of the total population) causing damage equivalent to USD 2.1 million. The impact of storms occurring from 2007 to 2017 affected more than 1 million people and caused USD 6 672 000 in damages.[18] In recent years, the province of Las Tunas (in the Eastern Region) has been affected by four tropical storms (see Table 2).

Table 2. Impacts caused by tropical cyclones and other extreme events

[13] Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project*. La Habana, Cuba, 2018. (Appendix 2.4)
[14] EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - http://www.emdat.be/, Brussels, Belgium
[15] Tornadoes, hailstorms, waterspouts and linear winds above 90 km / hour are included as severe tropical storms. The cyclonic season starts June 1 and continues through November 30, in which the September-October period is the most active and October the most dangerous month, in which most of the intense hurricanes have been reported.
[16] EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - http://www.emdat.be/, Brussels, Belgium
[17] It includes, Injured, Affected and Homeless estimates.
[18] EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

Year/Event	Economic losses (Million Pesos MP)					
		From those:				
	TOTAL	Spent in preventive measures	Housing Replace-ment cost	Facilities	Agricultural	Unproduced Goods and Services
2005	**3036**	**117.2**	**1074.8**	**213.2**	**893.4**	**658.0**
Dennis (July)	2124.8	188.7	1026.1	201.0	603.4	265.3
Rita (September)	207	25	3.1	8.9	117.7	52.3
Wilma (october)	704.2	73.5	45.6	3.3	172.3	340.4
2006	**95.1**	**15.2**	**24.6**			**40.0**
Ernesto (september)	95.1	15.2	24.6			40.0
2007	**1155.4**	**12.8**	**364.4**	**168.5**	**559.5**	**32.6**
Strong rains and storms						
tropical Noel (october)	1155.4	12.8	364.4	168.5	559.5	32.6
2008	**9759.3**	**137.7**	**4983.8**	**372.9**	**3605.8**	**525.4**
Fay (august)	37.8	1.6	16.8	4.9	7.1	4
Gustav (september)	2096.7	30.9	1121.5	59.6	868.4	9.8
Ikie (september)	7325.3	95.9	3764.7	304.8	2540.2	501.9
Paloma (november)	299.5	9.3	80.8	3.6	190.1	9.7
2012	**6966.9**	**70.6**	**3546.6**	**295.8**	**2469**	**398**
Sandy (november)	6966.9	70.6	3546.6	295.8	2469	398
2016	**2430.8**	**24.1**	**388.5**	**70.1**	**519.5**	**81.9**
Matthew (october)	2430.8	24.1	388.5	70.1	519.5	81.9
2017	2600	44.0	416.0	75.0	600.0	1248.0
Irma (september) a/	2600	44.0	416.0	75.0	600.0	1248.0

Source: National Statistics and Information Office – ONEI (2016).[19]

(v) **Floods**: Cuba suffers from moderate to severe coastal flooding caused by seawater intrusion or intense rains; as well as the occurrence of moderate and strong coastal floods independent of meteorological events. In the period from 1996 to 2016, 12 flood events occurred, affecting 134 957 people.[20]

1.2.1.3 Climate projections- Cuba

14. Future scenarios show climate change causing risks to natural and human systems will worsen. In addition to increased global temperature, climate change in the 21st century is projected to significantly reduce both surface and underground water resources in most subtropical dry regions, causing intensified competition between sectors for water. Due to the projected rise in sea levels, coastal systems and low-lying areas will increasingly experience adverse impacts such as soil loss, flooding, saltwater intrusion, salinization of waters and soils, and coastal erosion.[21]

15. Projections in Cuba for the years 2050 and 2100 show that the trends described in section 1.2.1.2 will continue (toward a hotter and drier climate) and extreme events will be more common. The Coupled

[19] National Statistics and Information Office- ONEI. 2016. Panorama Ambiental Cuba 2016. Havana, Republic of Cuba http://www.one.cu/panambiental2016.htm

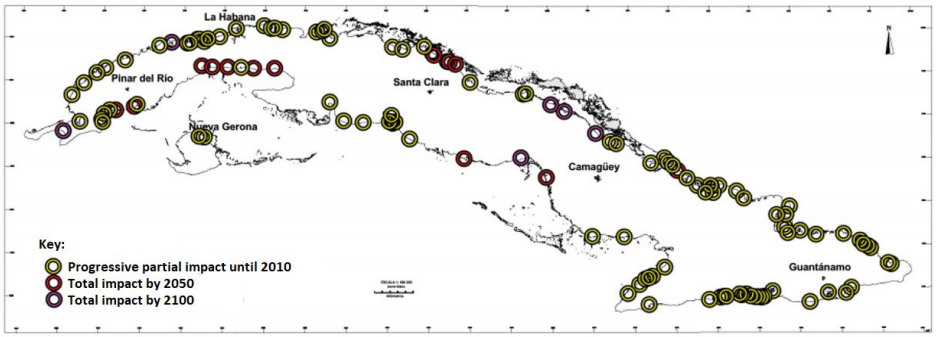
[20] EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

[21] Further information is presented in Appendix 2.4: Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project.* La Habana, Cuba, 2018.

Model Intercomparing Project, Phase 5 (CMIP5)[22] is included in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC)[23] and is one of the models most widely used by decision-makers to understand projections of future climate change and related impacts. The Representative Concentration Pathways (RCPs) describe four different pathways of greenhouse gas (GHG) emissions and atmospheric concentrations, air pollutants and land use for the 21th century. RCP2.6 refers to a rigorous mitigation scenario; RCP4.5 and RCP6.0 are intermediate, and RCP8.5 corresponds to a high GHG-emission scenario.[24]

16. CMIP5 projections indicate that by 2050, mean annual temperature in Cuba will rise by 1.6°C; total annual extremely hot days (temperature >35°C) will rise by 20.8 days, and mean annual precipitation will fall by 48.7mm (RCP 8.5, High Emission).[25] By 2050, it is also predicted that 2.45% of current land surface will be permanently submerged, severely affecting the population in those territories. By 2050, 78 settlements are predicted to be partially affected by sea level rise and 107 settlements by 2100, while it is estimated that by 2050, 15 settlements will be totally destroyed and another 6 by 2100. It is estimated that the consequences could partially or totally affect approximately 500,000 people by the year 2100 (Figure 4).

Figure 4. Coastal settlements that may be affected by permanent flooding due to rise of mean sea level



Source: Iturralde-Vinent Manuel and Serrano Herminia (2015) [26]

17. In summary, it is expected that by the end of this century, Cuba's climate scenario will be characterized by: i) up to 4°C increase in average air temperature; (ii) annual precipitation will drop by 15 to 63%; (iii) increased potential evapotranspiration and actual evaporation, leading to progressive decrease in net primary productivity of terrestrial and agricultural ecosystems as well as decrease in potential density of biomass; (iv) dry sub-humid climates will advance inward from the Eastern region moving westward; and

[22] Program for Climate Model Diagnosis & Intercomparison. CMIP5- Coupled Model Intercomparison Project Phase 5- Overview. https://pcmdi.llnl.gov/mips/cmip5/
[23] Intergovernmental Panel on Climate Change- IPCC. 2015. Geneva, Switzerland https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf
[24] The World Bank Group. Climate Change Knowledge Portal. Climate data. Projections. https://climateknowledgeportal.worldbank.org/country/cuba/climate-data-projections?variable=pr
[25] The World Bank Group. Climate Change Knowledge Portal. Climate data. Projections. https://climateknowledgeportal.worldbank.org/country/cuba/climate-data-projections?variable=pr
[26] Iturralde-Vinent Manuel y Serrano Herminia. 2015. Peligros y vulnerabilidades de la zona marino-costera de Cuba: estado actual y perspectivas ante el cambio climático hasta el 2100. Agencia de Medio Ambiente, CITMA. Editorial Academia. La Habana, Cuba. 86p

(v) dry sub-humid climates, susceptible to desertification, will take hold in the Eastern mountain ranges.[27] Climate change has a strong negative impact on almost all natural and human ecosystems. In the case of Cuba, such effects have been identified and projected for the agricultural sector (crops and livestock), human settlements (as shown in Figure 4), and land uses.

18. Agriculture is one of the human activities most dependent on climate and other environmental factors such as water quantity / quantity and soil conditions. All aspects of food production and food security systems are potentially affected by climate change, including access to food and price stability. For the principal crops (sugarcane, potatoes, bean, rice, yucca, corn) produced in Cuba in a scenario without adaptation actions, it is projected that climate change, with 2% increases in local temperature above the levels at end of 20th century, will negatively impact production. Studies by Rivero et al. published in 2004[28] show that the agricultural potential for the main crops will steadily decrease by 10–25% over the next century. Sugarcane production, for example, would decrease by 5–10%; and potatoes would decrease by up to 50% of the yields potential of production. Crop evapotranspiration will generally decrease, with the exception of potatoes; but needs for irrigated water would rise progressively, between 40–55%, for short-cycle crops and 15–30% for long-cycle and perennial crops.

19. The effects of climate change on air humidity could also impact pastures in livestock areas, which in the case of Cuba are composed predominantly of grass, benefiting invasive alien species such as *marabou*. According to climatic scenarios (1–2°C increases in mean temperature), there will be greater presence of existing pests and emergence of new ones, which could favor secondary potentially more-resistant species, which could displace the current primary ones.

20. In the forestry sector, impacts from the expected higher air temperatures and lower rainfall will lead to modification of phenological patterns in coastal and mountain arboreal species, loss of biodiversity in higher-altitude forest formations, and acceleration of pests' reproductive cycles, increasing their destructive potential. The rising sea level and increased effect of tropical cyclones (more frequent and intense) would have negative impacts, including significant losses of timber products and ecosystem services (such as water quality) as well as severe impacts on biological diversity in forests. Finally, increased concentration of atmospheric CO2 would result in expansion of the carbon-nitrogen ratio and increased foliage consumption by insects in some forest species; higher levels of biomass in forests increasing the danger of forest fires, and increased incidence of insects and damage caused by diseases.

21. With respect to human settlements and land uses, the Second National Communication to the United Nations Framework Convention on Climate Change made a broad and detailed assessment of the impact of climate change on the population and land uses in different regions of Cuba. It is estimated that climate change will have a negative impact on the quality of life of individuals and communities, which will be reflected as well in the agricultural sector, food production, and food security. These negative impacts are directly linked to the increased frequency and intensity of extreme events in coastal areas and the loss of territory in low areas due to rising sea level. It is expected that the rise of mean sea level with the

27 Appendix 2.4: Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ Adaptation and vulnerability baseline for the implementation of the project. La Habana, Cuba, 2018.
28 A., Rivero, R.R., Rivero, R.E., 2004. Manual de estudio integrado de los impactos del cambio climático y medidas de adaptación en el sector agrícola, ganadero y forestal (Informe Técnico). Centro Meteorológico de Camagüey. Departamento Científico., Camagüey, Cuba.

scenarios estimated for 2050 and 2100 will represent an increase of 0.27 to 0.85 m, which means a loss of 2.3–5.5% of total surface of the territory. Changes in spatial distribution of human settlements in areas experiencing occurrence of more severe drought due to climate variability and climate change is a fact already experienced by Cuba's population and it is expected to worsen with climate projections.[29]

1.2.2 Observed and future climate trends in Cuba's Central and Eastern regions and extreme weather events affecting these regions

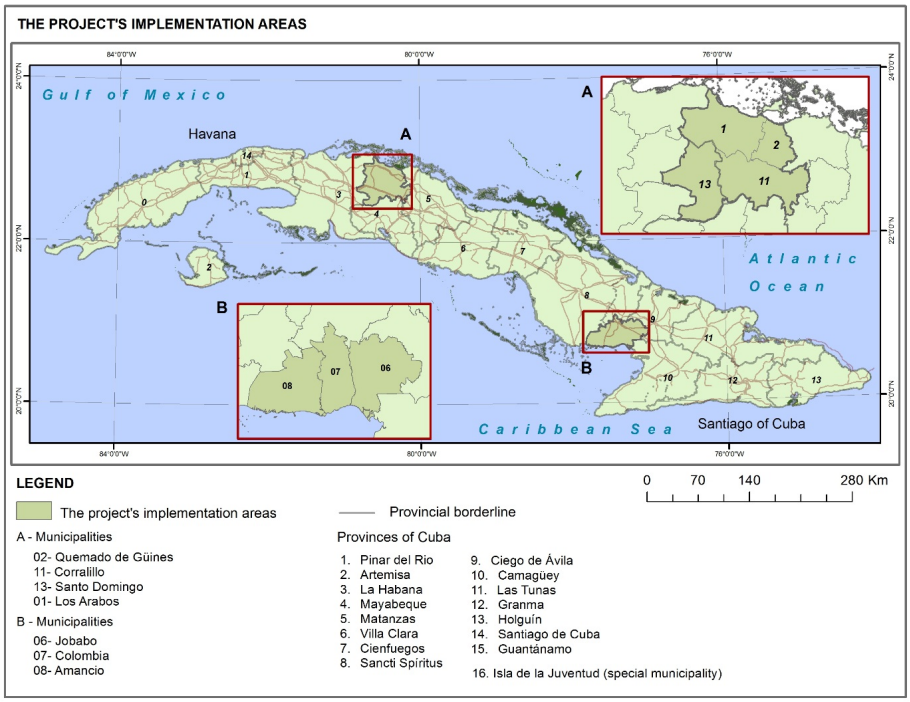
22. Although Cuba's entire territory is already being affected by climate change, seven municipalities in the provinces of Las Tunas, Las Villas and, Matanzas[30] were prioritized by the GoC to install adaptation measures due to their vulnerability and importance in the agricultural sector. Over the last three years, the project intervention area (PIA) suffered the most intense and prolonged drought of the last 115 years, leading to a decrease in crop productivity and livestock production. In Cuba's Central and Eastern regions, more than 237 000 people are vulnerable to drought, corresponding to 79 005 vulnerable households[31] (for more information, see Appendix 2.5: Socioeconomic Characterization of Implementation Areas).

Figure 5. Location of project intervention areas (PIA)

[29] For detailed information see Appendix 2.4: Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project.* La Habana, Cuba, 2018.

[30] Jobabo, Colombia and Amancio in the province of Las Tunas; Corralillo, Quemado de Güines, Santo Domingo in the province Las Villas; and Los Arabos in the province of Matanzas.

[31]



1.2.2.1 Observed climate trends in Cuba's Central and Eastern regions

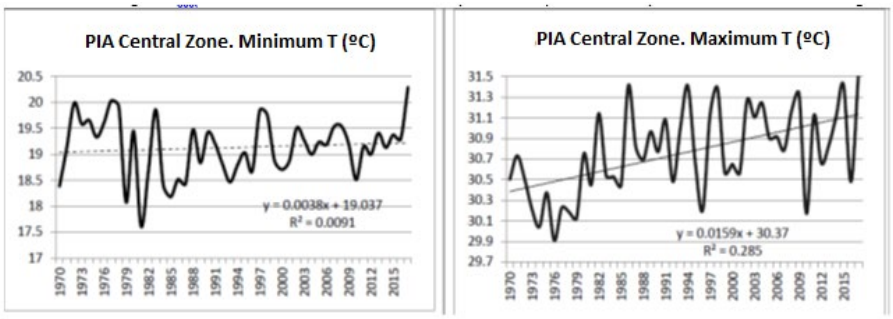
23. Several municipalities in Cuba have already been affected by climate change, including Jobabo, Colombia and Amancio in the province of Las Tunas; Corralillo, Quemado de Güines, Santo Domingo in the Villas; and Los Arabos in the province of Matanzas. These municipalities are mostly located on the coast in the Central and Eastern regions of the island where effects of climate change have already been observed and are expected to worsen in the coming years. The following is a summary of the findings provided in Appendix 2.4 Adaptation Baseline and Vulnerability Analysis.

Temperature

24. Trends in temperature variables are expected to increase (see Figures 6-a and 6-b), consistent with national trends. The rising temperatures in the Central Region are even higher than national averages, reaching an annual increase of 1.6% over the last 35 years. CMIP5 projections indicate that by 2050, mean annual temperature will rise by 1.6°C, total annual hot days of temperature >35°C will rise by 20.8 days, and mean annual precipitation will fall by -48.7mm (RCP 8.5, High Emission).[32]

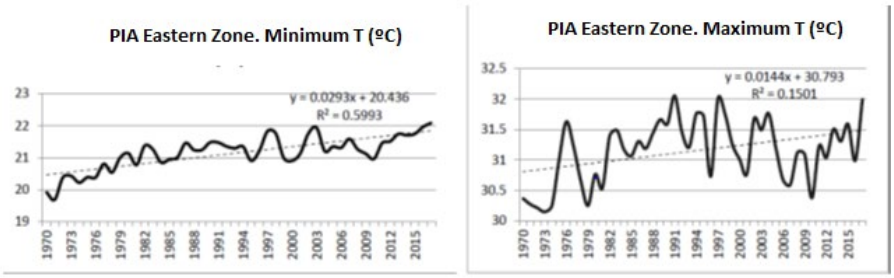
Figure 6-a. Minimum and maximum temperatures (1970–2015). Santo Domingo Station

[32] https://climateknowledgeportal.worldbank.org/country/cuba/climate-data-projections?variable=pr



Source: Meteorological Station Santo Domingo. In Somoza J. De la Colina A., 2018

Figure 6-b. Minimum and maximum temperatures, 1970–2015. Las Tunas Station

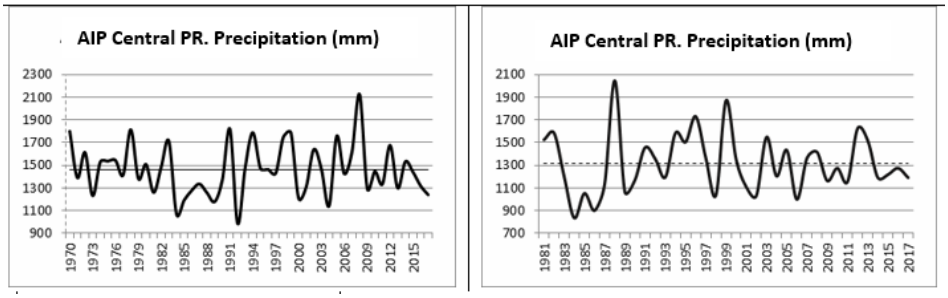


Source: Meteorological Station Las Tunas. In Somoza J. De la Colina A., 2018.

Precipitation

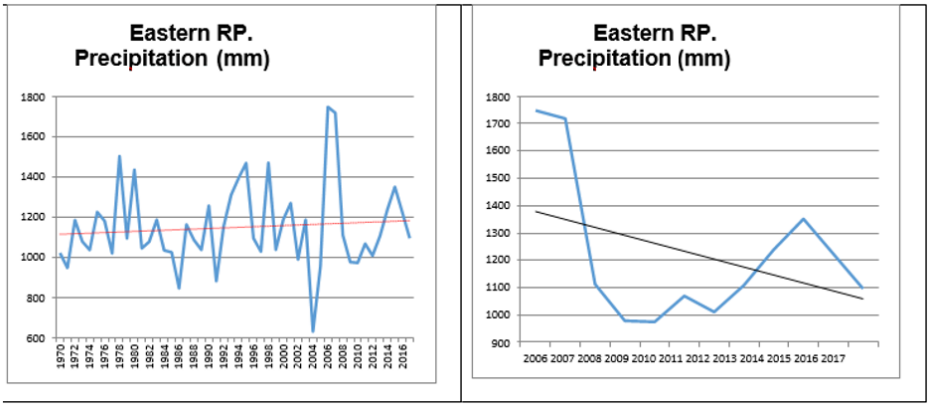
25. Changes in intensity of precipitation are of much greater concern. Anomalies in precipitation patterns have increased significantly, as shown in Figures 7-a and 7-b for the Eastern Region (Las Tunas Station). A rise in mean annual precipitation has been caused by cyclones and hurricanes, whose intensity increased significantly. Over the last decade, Cuba has been hit by 11 hurricanes, 4 of which affected Las Tunas Province. Hurricanes bring massive unforeseen amounts of rainfall, which are unable to infiltrate to recharge the groundwater in degraded landscapes, leading to increased surface runoff and downstream flooding, erosion, and soil degradation.

Figure 7-a. Annual rainfall (mm), 1970-2015, Colón and Santo Domingo Station.



Source: Colón and Santo Domingo Meteorological Station. In Somoza J. De la Colina A., 2018.

Figure 7-b. Annual rainfall (mm) Las Tunas Station.

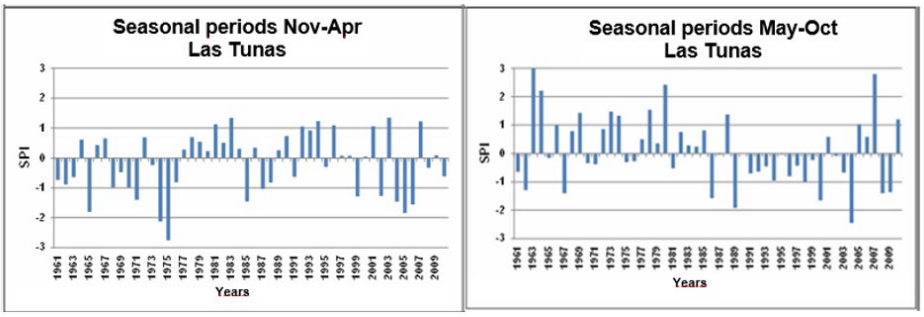


Source: Meteorological Station Las Tunas. In Somoza J. De la Colina A., 2018.

26. A slight increase in annual average rainfall (left) turns into decrease (right), depending on the time period under consideration due to extreme rainfall events related to hurricanes in individual years (e.g., 2006, 2015) that produce massive rainfall. Both figures above show the increasing anomalies fluctuating between years of massive rainfall or extreme dry years.

27. Figure 7-a shows the Standardized Precipitation Index (SPI) for Las Tunas Province: the accumulated water balance (blue bars) during the dry season reflects more frequent extreme droughts. Unexpected massive rainfall during the dry season results in more total rainfall (red line). In contrast, during the rainy season, when farmers need water to grow their crops, water balance deficits have increased steadily (blue bars), putting crops and rural livelihoods under severe water stress. Recurring severe droughts (in 2004, 2008, and 2009) and a diminishing water balance (red line) are among the changes of greatest concern observed in Cuba's Eastern Region during the last decades.

Figure 8-a. Standardized precipitation index for Las Tunas (Eastern project region) 1961–2009.

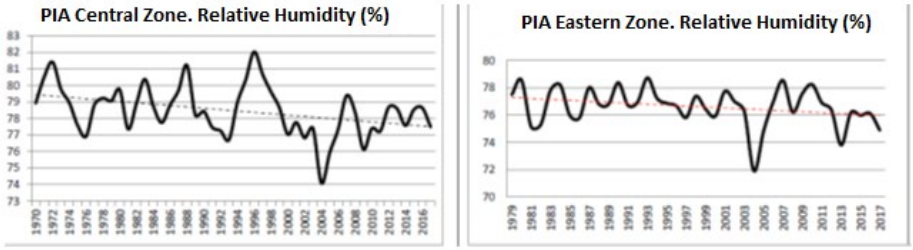


Source: Somoza J. de la Colina A. 2018.

Air Humidity

28. The weather is generally becoming more arid, with significantly reduced air humidity (see Figure 8-b). These trends, combined with a lack of incentives for climate-change-adapted agriculture, have led to a steady reduction in the area covered with agricultural crops and pastureland, as the invasive spread of *marabou* (which is more resistant to such climate conditions) continues. There is a positive correlation between the changing climate and the increase of these areas occupied by invasive species.[33]

Figure 8-b. Relative humidity of the air 1970–2016. Station Santo Domingo and Las Tunas.



Source: Meteorological Station Santo Domingo and Las Tunas. In Somoza J. De la Colina A., 2018.

1.2.2.2. Extreme weather events in the Central and Eastern Regions

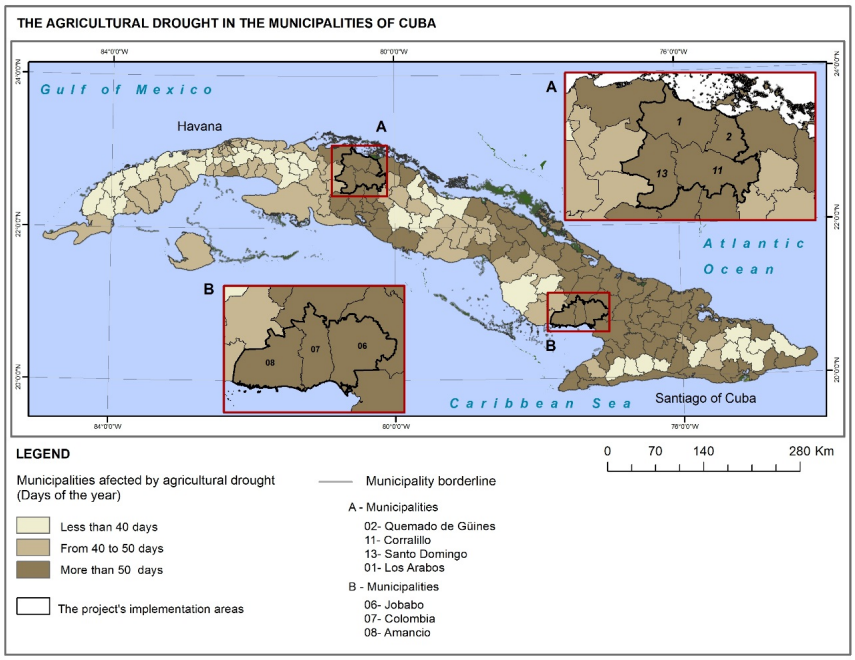
[33] For detailed information on climate change impacts on agriculture, see Appendix 2.4, Somoza J., De la Colina A.: Estudio de Linea Base de Adaptación y Vulnerabilidad para el Proyecto IRES FAO/ *Adaptation and vulnerability baseline for the implementation of the project*. La Habana, Cuba, 2018.

29. In Cuba, the main effects attributed to climate change include: i) agricultural drought; ii) saltwater intrusion; iii) floods due to heavy rains; and iv) increased frequency and impact of hurricanes over the last 30 years.

i) Agricultural drought

30. The changes in the behavior patterns of rainfall and its reduction as well as expected increases in evaporation have had a significant impact on agricultural droughts.[34] Figure 9 shows the municipalities most affected by the agricultural drought in the country, based on data calculated from records from 1951 through 2018. These include Corralillo, Quemado de Güines and Santo Domingo in Las Villas province; Los Arabos in Matanzas province (Central Region); and Amancio Rodríguez, Colombia, and Jobabo in Las Tunas province (Eastern Region).

Figure 9. Cuban municipalities affected by agricultural droughts.



Source: Adaptation from information on agricultural droughts in: Centella A. et al. (2006)[35]

[34] Scientific research on climate change has defined four types of drought: 1) meteorological drought; 2) hydrological drought; 3) agricultural drought; and 4) socioeconomic drought. Meteorological drought happens when dry weather patterns are predominant in an area. Hydrological drought refers to shortages of water resources, when for example levels of groundwater, reservoirs, or streams are significantly reduced. This is considered the drinking-water type of drought. **Agricultural drought** refers to circumstances when soil moisture is inadequate and results in lack of crop growth and production. The socioeconomic definitions of drought associate the supply of / demand for some economic goods with elements of meteorological, hydrological, and agricultural drought. Socioeconomic drought occurs when demand for an economic good exceeds supply as a result of a weather-related shortage in water supply.

[35] Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baéz, S. González, J. Sille, P. Rosario y L. Duarte (2006). La sequía meteorológica y agrícola en la República de Cuba y la República Dominicana. Tomo I, 172 pp,

31. The statistics revealed by this map show that 78 municipalities (representing an area of 50 907 km^2 and about 46% of the national territory) were the most affected by this phenomenon in terms of intense values of agricultural drought during more than 50 days a year (see Table 3).

Table 3. Vulnerable municipalities due to agricultural droughts.

Average number of days per year with agricultural drought*	Number of municipalities	Area of affected municipalities (km^2)	Area of affected municipalities (%)
<40	38	23,799,21	21.91
40–49	52	33,871,03	31.19
≥50	78	50,907,32	46.88
Total	168	108,577.57	100

*Number of days in which soil moisture is insufficient, resulting in lack of crop growth and production.

Source: Adapted from information on agricultural droughts in: Centella A. et al. (2006).[36]

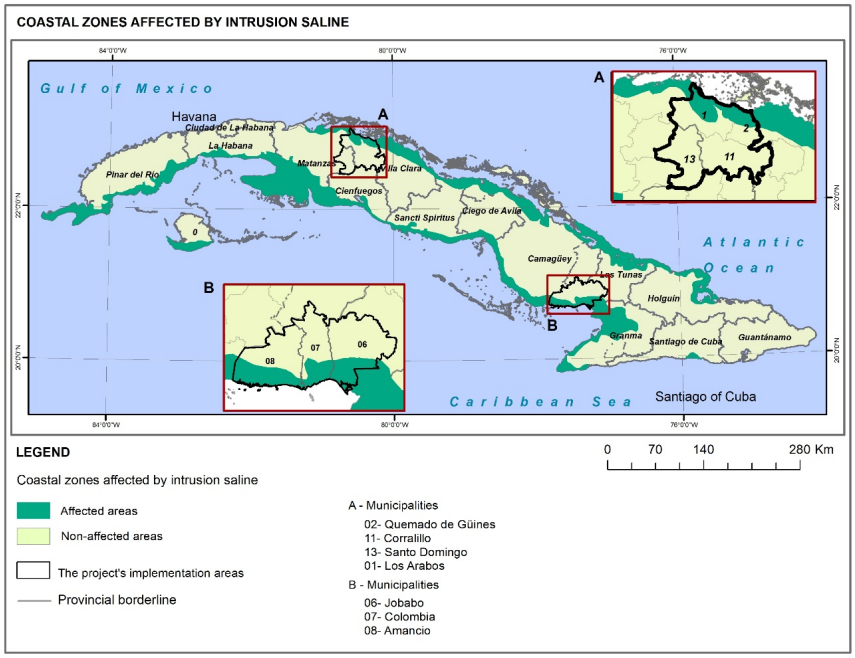
32. In both the Central and Eastern regions, drought processes have enabled the expansion of invasive plants that are better adapted to scarcity of water and arid soils. These areas are also characterized by the exodus of population and abandonment of the rural areas in these territories.[37]

ii) Saltwater intrusion

33. The decrease in rainfall associated with saltwater intrusion (both due to climate change) will worsen the potential deficit of fresh water availability, as there will be a lower potential of recharging aquifers (decreased precipitation) and aquifers will be affected by saltwater intrusion in Cuba's coastal region. Such a situation would lead to a significant reduction in availability of groundwater and, in smaller coastal aquifers, it could represent the complete salinization of local water reserves. Figure 10 shows the provinces most affected by saltwater intrusion in 2015.[38]

Figure 10. Cuban provinces affected by saltwater intrusion.

[36] Centella A, B. Lapinel, O. Solano, R. Vázquez, C. Fonseca, V. Cutié, R. Baéz, S. González, J. Sille, P. Rosario y L. Duarte (2006). La sequía meteorológica y agrícola en la República de Cuba y la República Dominicana. Tomo I, 172 pp,
[37] Further information is provided in Section 1.2.3 and Appendix 2.4.
[38] Further information is provided in Section 1.2.3 and Appendix 2.4.



Source: Based on information in the SNC (2015).[39]

34. In Las Tunas, these areas account for 73 071 hectares, corresponding to 3% of the affected area in Cuba and 32% of the areas in the three project-targeted municipalities in the Central Region. In the municipalities of Las Villas, these areas account for 46,882.7 hectares, corresponding to 2.09% of the affected area in Cuba and 16% of the targeted area of the two coastal municipalities in this region.

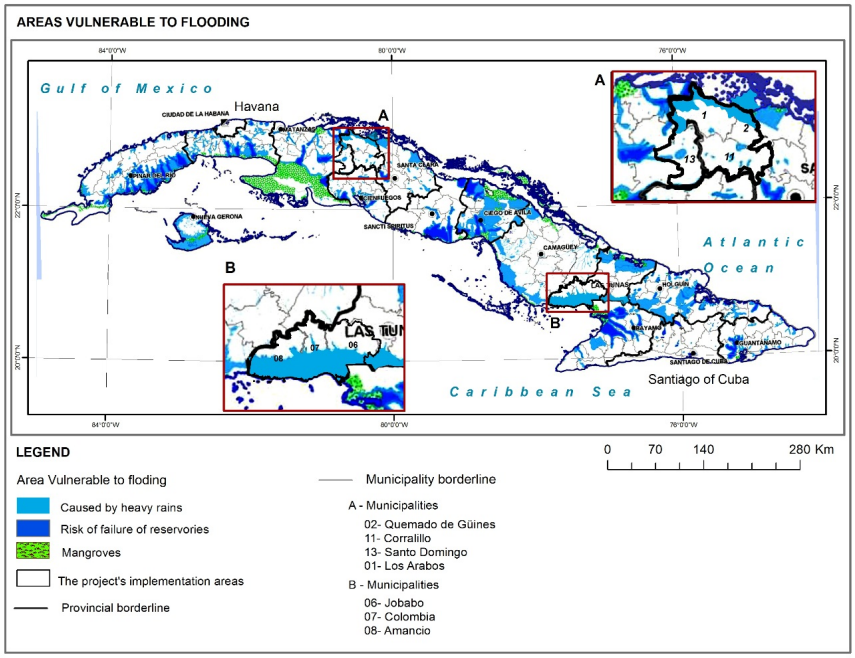
iii) Floods due to heavy rains

35. The increase during the last three decades of the occurrence of moderate and strong coastal floods is closely related to the trajectory of cyclones with varying categories and of cold fronts, and consequently the communities facing the greatest dangers are located in low-lying areas, areas with flat relief, areas near rivers or channels or with poor drainage, and locations where surface runoff is prevalent (preventing infiltration of the water). Figure 11 shows areas vulnerable to flooding.

36. The north coast of the Central Region (in particular the municipalities of Corralillo and Quemado de Guines) and the south coast of the Jobabo, Amancio and Colombia municipalities are among the areas periodically affected by flooding, which has worsened with weather events whose impacts have increased over the last 30 years.

Figure 11. Areas vulnerable to rain-induced flooding.

[39] Second National Communication to the UNFCCC. 2015. Havana: Republic of Cuba https://unfccc.int/sites/default/files/resource/cubnc2.pdf



Source: Based on information in the SNC (2015).[40]

37. According to Figure 11, in the three municipalities in the province of Las Tunas selected for project intervention, 139,639 hectares are vulnerable to flooding, which is 2.3% of Cuba's total area vulnerable to flooding and 61% of the Eastern Region's vulnerable area, where the project will be implemented. In Las Villas, 61,303.3 hectares are vulnerable to flooding, which is 1.8% of Cuba's total area vulnerable to flooding and 21.77% of the Central Region's vulnerable area.

iv) Hurricanes

38. The island of Cuba is located in the geographic range of the Atlantic Ocean Basin that has been traditionally affected by hurricanes. Over the last 30 years, these meteorological phenomena have increased significantly in frequency and intensity. According to experts, we are in an active cycle to which we should add the potential impact of climate-change-induced global warming (Appendix 2.1, p.7).

39. Global warming raises ocean temperatures, which, along with hot air, catalyze the occurrence of hurricanes. From 1990 to 2017, Cuba was affected by 29 hurricanes. The municipalities of Corralillo, Quemado de Güines and Santo Domingo in Las Villas province; Los Arabos in the Matanzas province (Central region);[41] and Amancio Rodríguez, Colombia and Jobabo in Las Tunas province (Eastern region) are all located in the area of influence of historical hurricane tracks. In recent years, the Central and

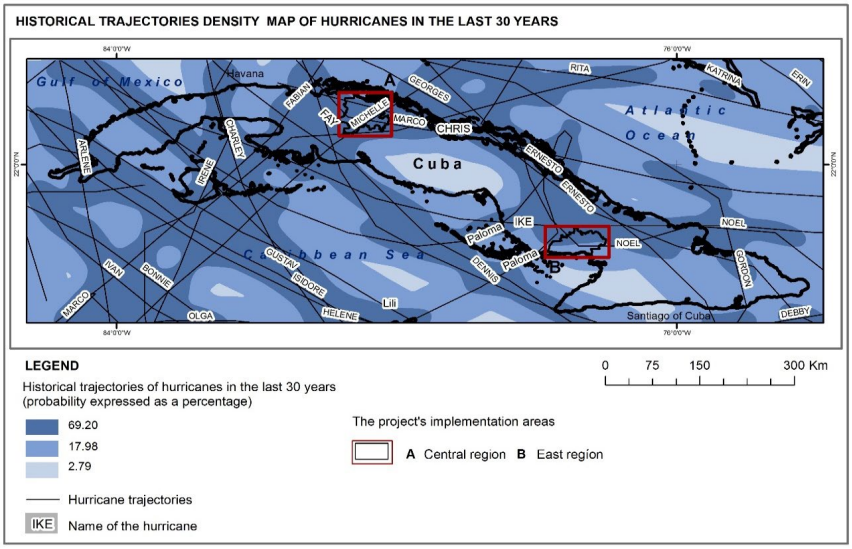
[40] Second National Communication to the UNFCCC. 2015. Havana: Republic of Cuba https://unfccc.int/sites/default/files/resource/cubnc2.pdf

[41] In figures presented in this section, Los Arabos will be grouped with municipalities of Las Villas province.

Eastern regions of the country have been affected by some of the most intense storms to hit the island, a meteorological phenomenon that has particularly impacted the project-targeted areas.

40. Figure 12 depicts a density surface showing the zones with the highest concentration in historical trajectories of the hurricanes from 1990 to 2017, expressed as percentage values.

Figure 12. Trajectories of hurricanes affecting Cuba in the last 30 years.



Source: Based on data from National Hurricane Center and Central Pacific Hurricane Center (2019). (https://www.nhc.noaa.gov/data/).

1.2.2.3 Climate projections

41. As predicted in the national climatic scenarios, mean temperature values in 2050 would rise to 29°C in the Central Region (an increase of 14%) and 30°C in the Eastern Region (an increase of 16%); while average maximum temperatures are estimated to be 35 °C and 36°C, respectively (increases of 11% and 12.5%). On the other hand, national rainfall scenarios estimate drastic reductions in the 2050–2100 period, with precipitation falling 15–63% below current averages. As such, according to this scenario, accumulated rainfall would hover between 975–481 millimeters in the Central Region and 750–370 millimeters in the Eastern Region, leading to a water crisis situation with repercussions on crop yields and human health.

42. Climate trends and related extreme events described in this section (1.2.2) have a decisive influence on population and food security in the affected areas as well as on ecosystems and ecosystems services. Climate impacts and an analysis of the vulnerability of affected areas will be addressed in the next section and detailed information will be presented in Appendix 2.4 –Vulnerability and Adaptation baseline.

1.2.3 Climate impact and assessment of vulnerability

43. Appendix 2.4 provides a complete analysis on the vulnerability to impacts of climate change of the PIAs, including crop and livestock production, as summarized here. The future climate of Cuba can be described as more arid and extreme, with prolonged and intense drought periods and severe water deficit. The dry landscapes of the Eastern Region will intensify and advance progressively westward, producing a transformation of the current climate (humid tropical) to dry sub-humid with threats of desertification. Current climate trends and the 100-year scenarios under consideration (A2 and B2 of the IPCC)[42] indicate that deterioration of environmental quality will generally occur as a consequence of the reduction of water potential, loss of land in low-lying coastal areas, impoverishment of soil, reduction of agricultural yields, loss of biodiversity, deteriorating conditions of coastal settlements, as well as increases in communicable diseases and the resulting negative impact on economic activity.

44. The combined effect of rising temperature / falling rainfall will lead to adverse impacts on agricultural production, animal husbandry and forests; decreased water and soil potential / quality, accompanied by the expansion of *marabou*, affecting land use and the PIA's vulnerability to climate change.

45. The project proposes agroforestry modules that constitute a paradigm shift in traditional forms of land management and an alternative to face the challenge of breaking the environmental degradation-vulnerability loop by reducing and reversing desertification / degradation processes, creating adaptation capacities and local knowledge that increase the resilience of the most vulnerable population and households.

46. The table below summarizes the expected changes in climate and corresponding impacts, mapped to project interventions.

Table 4. Expected changes in climate and corresponding impacts in the PIAs.

OBSERVED AND EXPECTED CHANGE CLIMATE TRENDS	EFFECTS AND EXTREME WEATHER EVENTS	IMPACT ON AGRICULTURE, LIVESTOCK, FORESTS, SOIL, WATER AND LAND USE/ LAND COVER	PROJECT INTERVENTION	MITIGATION AND ADAPTATION BENEFITS
INCREASE IN TEMPERATURE **DECREASES IN AVERAGE RAINFALL DURING DRY SEASON**	Increased evaporation and drought	Changes in productivity, crop yields, pasture, forests Increased heat stress and changes in suitability (growing conditions) for the agricultural sector	Output 1 – Production landscape restored (hectares) with improved resilience and production capacity to ensure food security in vulnerable populations Output 2 – Extension	CO_2 captured through rehabilitation of production landscapes Increased water infiltration capacity of soils in rehabilitated areas

[42] "The B2-scenario family is based on the long-term UN Medium 1998 population projection of 10.4 billion by 2100. The A2-scenario family is based on a high population growth estimate of 15 billion by 2100 that assumes a significant decline in fertility for most regions and stabilization at above replacement levels. It falls below the long-term UN High 1998 projection of 18 billion." Intergovernmental Panel on Climate Change. Emissions Scenario. https://www.ipcc.ch/site/assets/uploads/2018/03/sres-en.pdf

		production Reduced availability of water for irrigation (rain-fed systems) due to extension and frequency of droughts Changes in land use and land cover and increased area prone to desertification and degradation Invasion of *marabou* due to its adaptability to increased temperatures, drought conditions and more degraded lands	workers, farmers and communities provided with TA and training for landscape rehabilitation and climate resilient agriculture	Reduction of water runoff due to land cover in rehabilitated areas Increased biodiversity due to removal of *marabou* and implementation of rehabilitated areas Increased resilience of productive landscapes due to implementation of CC-resilient varieties Increased soil productive capacity due to crops and trees used in agroforestry systems to rehabilitate degraded areas, reduce erosion, fix nitrogen Increased resilience of household and communities to climate change due to improvement of food and water security through implementation of agroforestry systems and rainwater capture and storage Technical and institutional capacities strengthened for implementation of adaptation
INCREASE IN RAINFALL INTENSITY (PARTICULARLY DURING RAINY SEASON)	Increased risk of landslides, flash floods Floods and saltwater intrusion Increased frequency and intensity of hurricanes	Increased damage to irrigation infrastructure, crops Increased soil erosion and degradation Saltwater intrusion affecting soils and water resources	Output 1– Production landscape restored (ha) with improved resilience and production capacity to ensure food security for vulnerable populations Output 2 – Extension workers, farmers and communities provided with TA and training for landscape rehabilitation and climate resilient agriculture Output 3 – Landscape Resilience Fund established / operational, providing incentives	

			to farmers and producers' organizations to apply resilience-enhancing agricultural production practices and systems	measures and increased resilience to climate change countrywide

1.2.3.1 Impact on crop and livestock production and forests in the project intervention area (PIA)

1.2.3.1.1 Agriculture

47. The main cause of the decrease in potential yields is the progressively rising temperature, which not only leads to a progressive shortening of crop-cycle duration but also to reduced intensity of gross photosynthesis and increased intensity of respiratory processes.[43] The models of general circulation of the atmosphere and the ocean indicate an increase in the months with moderate and intense droughts, a lower availability of water for crops compared to the current situation.

48. As presented previously in Figure 7-a, section 1.2.2.1, (Standardized Precipitation Index, or SPI) the accumulated water balance during the dry season reflects more frequent, extreme droughts. Recurring severe droughts (in 2004, 2008, 2009, 2015) and a diminishing water balance are among the greatest concerns in Cuba´s Eastern Region during recent decades. Unexpected massive rainfall during the dry season results in more total rainfall. In contrast, during the rainy season, when farmers need water to grow their crops, water shortages have steadily increased, putting crops and rural livelihoods under severe water stress.

49. In the PIA in the Central region, it is estimated that total cultivated area is approximately 32,000 hectares, of which 8.9% are dedicated to cultivation of sweet potatoes, plantain, beans, rice and corn. For the PIA in Cuba`s Eastern zone, of the 27,000 hectares of cultivated area, almost 21% (5644 hectares) are dedicated to cultivation of cassava, sweet potato, plantain and corn.

50. According to climate change projections for 2030, 2050 and 2100, net primary agricultural productivity and biomass potential density will decline. Estimated yield under projected climate scenarios show that for 65% of the 29 crops studied, potential yields will drop by 12% (for beans, rice, manioc) and by as much as 48% for potatoes (as shown in Table 5 below).[44]

Table 5. Estimated yields for selected agricultural crops for 2030, 2050 and 2100 under climate-change scenarios (tons/hectare).

Crop	Baseline (3)	2030	2050	2100	Variation from baseline
Potato	12.34	10.68	9.57	6.44	-48.0%
Bean	2.92	2.84	2.77	2.61	-10.0%

[43] Rivero *et al*., 2011 and Rivero *et al*., 2010

[44] Appendix 2.4, p.36-38, presents more information on current and projected yields for main crops cultivated.

Rice (1)	12.0	11..44	11.16	10.7	-12.0%
Rice (2)	14.49	13.78	13.54	12.9	-12.0%
Yucca (1)	16.56	16.2	15.84	12.87	-16.0%
Yucca (2)	13.45	13.11	12.81	11.16	-17.0%
Corn	12.82	11.77	11.27	10.09	-22.0%
Sugarcane (1	76.46	74.42	73.1	69.84	-9.0%
Sugarcane (2)	72.11	71.15	70.28	68.17	-6.0%

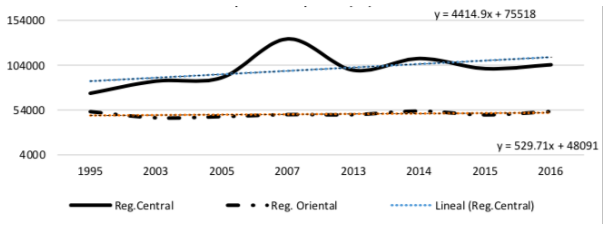
Legend: (1) Spring planting; (2) Winter planting; (3) Baseline (current scenario), 2010

Source: Rivero R et al (2010) in SNC Cuba (2015). In Somoza J. De la Colina A., 2018 (Appendix 2.4)

1.2.3.1.2 Livestock

51. The dynamics of natural pasture surfaces in the Central region has maintained a modest growth rate in the 1995–2016 period. the Eastern region has experienced a tendency toward stagnation, with slight downward trends at certain periods (see Figure 13).

Figure 13. Variations in pasture surfaces (hectares).



Source: Appendix 2.4, based on ONEI (2017).[45]

52. Past and recent climate-change effects – as well as projected future scenarios of rising average temperatures and decline in rainfall – show an impact on reducing yields of natural grasses and therefore of pasture lands in the PIA. As a result of livestock exploitation, there is also a substantial modification of pasture biodiversity indexes, of both the predominance index and Shannon index. This is a reflection of

[45] National Office of Statistics and Information- ONEI. "Balances de la Tierra". 2017. La Habana, Republic of Cuba

a greater dominance of pastures C4 over grasses and shrubs C3, and reaffirms the importance of pastures, their improvement and efficiency in their management in livestock farming systems in the PIA, where pastures are practically the only source of animal feed. The progressive decline of organic-matter content in the soil – and therefore deterioration of the soil's capacity to retain water, resist erosion and avoid compaction – worsens as the exploitation load of the pasture increases. Pasture yields will be fall in all regions of the country (see Table 6) and the process of pasture growth will move toward greater lignification and lower protein and carbohydrate content.[46] In addition, all bio-productive indicators of the cattle evaluated for the scenarios underwent considerable changes with tendencies that point toward a lower birth rate, increased optimum age of first parturition, and general increase in mortality.[47]

Table 6. Percentage decrease in total biomass and pasture C4 (%).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Total biomass	19.3	23.1	22.7	20.6	19.1	16.5	18.2	17.4	14.4	14.5	15.1	18.2	17.9
C4 biomass	13.8	20.1	15.4	12.4	9.0	4.3	5.9	6.4	6.8	8.9	8.5	26.1	9.0

1.2.3.1.3 Forests

53. In a current reference scenario, there is a progressive increase in degree of aridity and evolution toward transformation of forests areas in the PIAs into drier conditions. This evolution is caused by rising temperatures and potential evapotranspiration, and a progressive decrease in rainfall.

54. At the same time that the climate and regions become increasingly dry, episodes of drought are projected to increase, as well as frequency of years with moderate and severe droughts. Both the evolution of aridity and frequency of droughts will make forest fires more frequent and intense and will increase the vulnerability of forests to these disasters, which will progressively spread to the Central zone.

55. Finally, if the effect of CO_2 fertilization at the ecosystem scale does not occur, all these processes described in the previous paragraphs will be accompanied by a progressive reduction of potential biomass density and net primary productivity of forests throughout the current century. All this involves increased competitiveness, favoring the species more adapted to dry sites. Changes in composition of flora and biological diversity of forests are also expected with climate change effects related to temperature and precipitation patterns and will have impact on crop and livestock production and forests in the project intervention area (PIA).

1.2.3.2 Climate change impact on soils and water resources in the project intervention area (PIA)

1.2.3.2.1 Water resources

[46] Rivero, et al., 2010
[47] Appendix 2.4, Section I.2.2 present detailed information on climate change impacts on the livestock sector.

56. The potential of water resources in the PIA has been assessed for more than a decade and was estimated at total "production" of 835 million cubic meters per year. Of these, 490 million are underground, distributed in 9 hydrogeological units, and the remaining 345 are superficial, distributed in 21 water basins. However, changes in rainfall patterns and its decline, increased evaporation, and increased saltwater intrusion as a consequence of sea-level rise, will affect water availability and quality in the PIAs.[48]

57. According to Scenario A2 of the IPCC, for PIA`s water balance, the potential volume of water in 2050 will be reduced to 695 million cubic meters (17%) and in 2100 to 398 million cubic meters, decreasing by 52% with relation to the current registered average volume which indicates that in this scenario the shortage of water in the PIA will be a critical element.

58. Sea level rise is a climate change impact that will affect five of the seven municipalities in the PIA for the expected scenarios of sea-level rise of 27 cm by 2050 and 85 cm by 2100. This threat will affect 20,070 hectares of land surface in the PIAs, which accounts for 4% of the total PIA area, of which 13,239 hectares are in the Eastern region (66%). In the affected areas, natural forests predominate. In subsection g of the Appendix 2.4, a detailed summary is presented with a spatial zoning that identifies the areas most affected by saline intrusion and drought in the PIA at the Popular Council level.

59. In addition to the effects on land surface and current land uses, the rise in sea level will enhance the phenomenon of saltwater intrusion in coastal aquifers (groundwater). Undesirable consequences of saltwater intrusion are the impossibility of using the resources as drinking water or for irrigation purposes; limiting factors for soils such as salinity, poor drainage, erosion, compaction and desertification, which cause a decrease in quality of living conditions of populations living in such areas due to crop losses, low food sustainability and, risk of food and water insecurity.

60. There is a close interrelation between the impacts and effects of climate change, changes in land cover and land use and, water resources. In the case of the PIA and target beneficiaries, agricultural systems are dependent on rainfall. For this purpose, and in light of expected climate change impacts on water resources, the project aim at implementing small scale infrastructure for rainwater capture and storage in order to help increasing households' resilience to climate change effects on precipitations, the occurrence of floods and saltwater intrusion related to it.

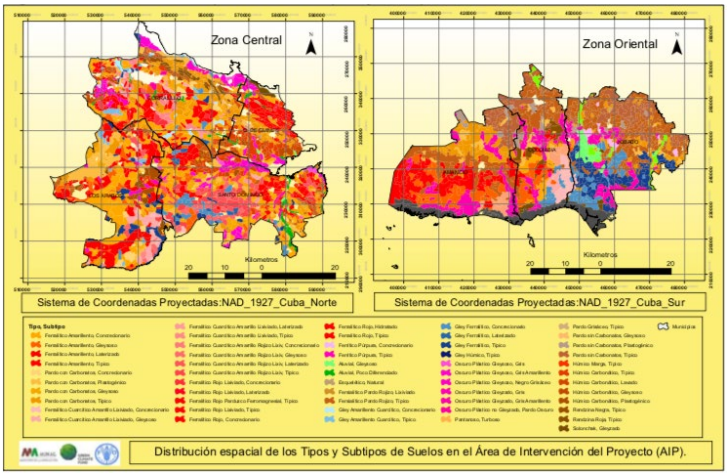
1.2.3.2.2 Soils and land use

1.2.3.2.2.1 Soil conditions and climate change effects in the PIA

61. The different types of soil in the PIA are shown in Figure 14.

Figure 14. Distribution of soil types in the PIAs.

[48] See detailed information in Appendix 2.4, section I.3.3, p. 7.



Source: Appendix 2.4. Vulnerability and Adaptation baseline.

62. Soil vulnerability (see Table 7 and Figures 15 and 16) was classified and mapped according to possible scenarios that may occur due to climate change in Cuba (rising temperatures, changes in precipitation patterns, and greater frequency and intensity of extreme weather events). For this, an environmental matrix was proposed by Leopold (1971), where the magnitude of how soils would be affected was standardized, classified in 1, 2 and 3 (which represents a low, medium and high magnitude) and their vulnerability classified with values from 3 to 9, where categories 3–4 means *less vulnerable*, 5–6 *moderately vulnerable*, 7 is *vulnerable*, and 8 and 9 *extremely vulnerable*. Table 7 shows the classification for the main soils of the PIAs.

Table 7. Soil vulnerability in the PIAs.

Suelos	+ Temp.	+ Intensidad de precipitación	Sequía prolongada	Total	Vulnerabilidad
Ferralítico Amarillento	1	1	1	3	Poco vulnerable
Pardo con Carbonatos	2	2	1	5	Medianamente vulnerable
Húmico Carbonático	3	2	3	8	Muy vulnerable
Ferralítico Cuarcítico Amarrillo Rojizo Lixiv	1	1	1	3	Poco vulnerable
Oscuro Plástico Gleysoso	3	2	3	8	Muy vulnerable
Gley Ferralítico	1	1	2	4	Poco vulnerable
Fersialítico Pardo Rojizo	1	2	1	4	Poco vulnerable
Ferralítico Cuarcítico Amarrillo Lixiviado	1	1	1	3	Poco vulnerable
Ferralítico Rojo	1	1	1	3	Poco vulnerable
Ferralítico Rojo Lixiviado	1	1	1	3	Poco vulnerable
Aluvial	1	1	1	3	Poco vulnerable
Rendzina Roja	1	3	1	5	Medianamente vulnerable
Gley Amarillento Cuarcítico	1	1	3	5	Medianamente vulnerable
Ferralítico Rojo Parduzco Ferromagnesial	1	1	1	3	Poco vulnerable
Pardo sin Carbonatos	2	2	1	5	Medianamente vulnerable
Ferrítico Púrpura	1	1	1	3	Poco vulnerable
Oscuro Plástico no Gleyzado	3	1	3	7	Vulnerable
Solonchak	3	1	3	7	Vulnerable
Rendzina Negra	2	3	1	6	Medianamente vulnerable
Húmico Marga	3	3	1	7	Vulnerable
Esquelético	1	3	1	5	Medianamente vulnerable
Gley Húmico	3	1	3	7	Vulnerable
Pantanoso	1	1	1	3	Poco vulnerable
Pardo Grisáceo	2	3	1	6	Medianamente vulnerable

Source: Appendix 2.4. Vulnerability and Adaptation baseline.

63. Less-vulnerable soils predominate in both regions (59% in the Central region and 69% in the Eastern region). The Central region has 27% of soils in the *Medium* vulnerable category, while the Eastern region has 16%. *Vulnerable* and *Extremely vulnerable* soils account for about 15% in both areas (see Figures 15 and 16).

Figure 15. Percentage distribution of soil vulnerability classifications in the PIAs.

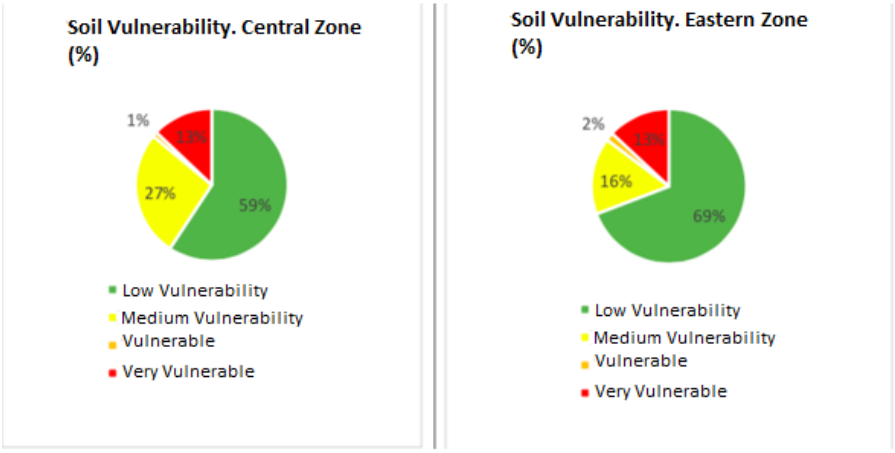
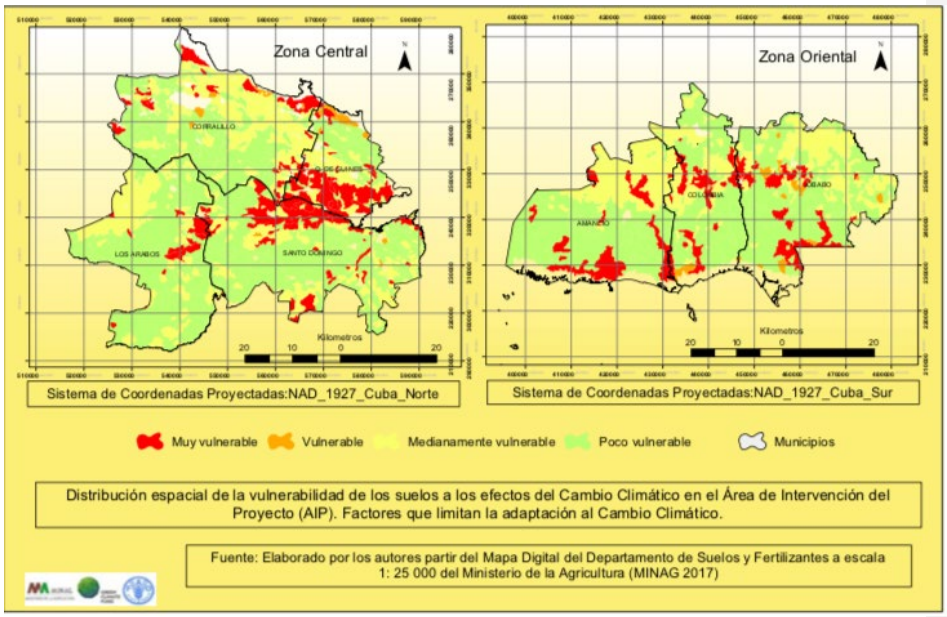


Figure 16. Distribution of soil-vulnerability classifications in the PIAs.



Source: Appendix 2.4. Vulnerability and Adaptation baseline adapted from MINAG (2017).

64. Erosion occupies in the Central zone an extension of 147 496 hectares, which constitutes 60% of the territory affected by erosion in the total of the AIP, they 88018 ha (59.7%) considered medium to very erosive and 1022 hectares (0.5%) of moderately to very strongly eroded. The geographical distribution of erosion in the area indicates that the municipality of Santo Domingo has the most affected area with 55803 hectares (37.8% of the total), followed by the municipalities of Corralillo and Los Arabos with 71617 hectares, both represent 48.5% of the total, and a lower incidence in terms of area in Quemado de Güines. The municipalities that present areas with effects of the category of very eroded are Quemado de Güines and Corralillo with 3271 hectares.

65. In the Eastern zone, erosion is less significant and extends to 98,034 ha (almost 40% of the total of the AIP), of which 54,201 hectares (23.8%) considered to be fairly eroded (with loss of up to 50% of the horizon) and 43,514 hectares (19.1%) are slightly eroded. The geographical distribution of erosion in the project intervention area is concentrated from the mid to northern part of the municipalities of Amancio and Colombia. In the case of Jobabo (in the central-southern part), it is the municipality with the most affected area (45,730 hectares; 47% of total), followed by the municipality of Colombia with 29,607 hectares (30.2%), accounting for 76.8% of the total. The municipality of Jobabo has the largest areas affected by the categories of *Medium* to *Very eroded* with 42,191 hectares, representing 77% of the total eastern area.

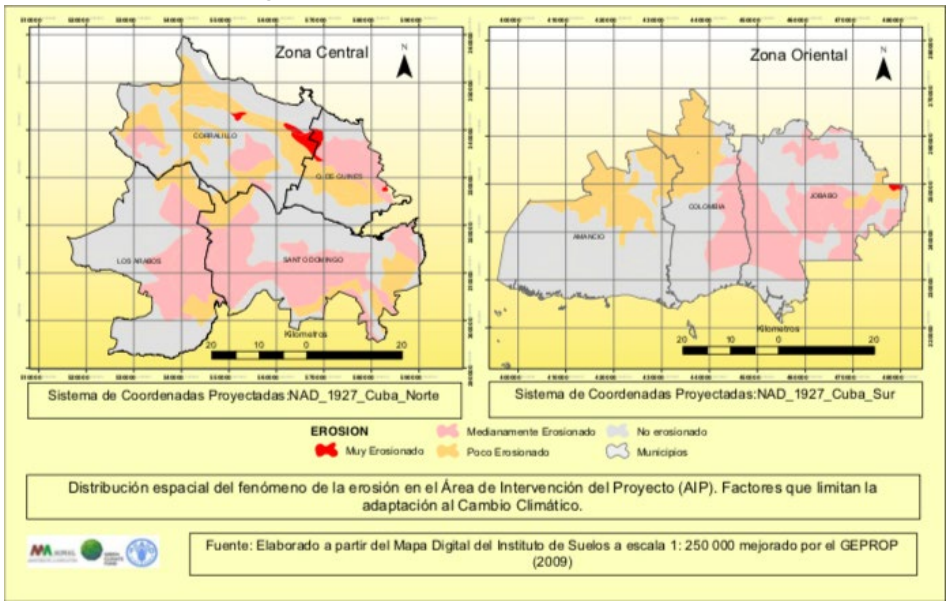
66. Table 8 and Figure 17 below show information on soil erosion and; Table 9 and Figure 18 show soil productivity categories in the PIA,[49] factors that are already being affected by climate change whose adverse effects will increase according to climate change projections.

Table 8. Area with soil erosion in the PIAs.

	PIA		Central Zone		Eastern Zone	
Type	Area (ha)	%	Area (ha)	%	Area (ha)	%
Very Eroded (Total loss of A and + 50% of B	3590	0.7	3271	1.2	319	0.1
Moderately Eroded (Loss of 50% or less of A	138948	27.4	84747	30.2	54201	23.8
Fairly Eroded	102992	20.3	59478	21.2	43514	19.1
Subtotal	245530	48.3	147496	52.6	98034	43
Not Eroded	262451	51.7	132764	47.4	129687	57
Total	507981	100	280260	100	227721	100

[49] Detailed information on the PIA`s soils properties and factors that limit adaptation to climate change are presented in Appendix 2.4, section I.3.1, p.44.

Figure 17. Distribution of soil erosion in the PIAs.

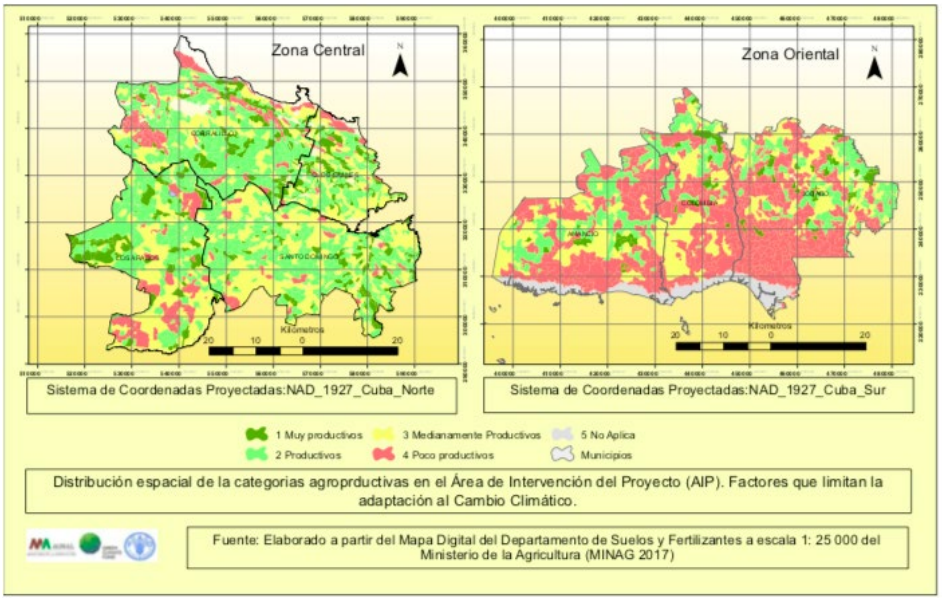


67. In the PIA the soils within the medium-to-productive agricultural categories occupy 267.857 ha (53.9%) and the ones in the productive-to-very productive categories represent 215.821 ha (43.4%). However, in the Eastern region, soils within the medium-to-less productive categories represent 161.441 ha (60.3%), where the less productive category exceeds 113.875 ha.

Table 9. Soil production categories.

	PIA		Central Zone		Eastern Zone	
Productive Categories	Area (ha)	%	Area (ha)	%	Area (ha)	%
I: Very Productive 70%	45091	9.1	35541	13.3	9550	4.2
II: Productive 50-70%	170730	34.3	125720	46.9	45009	19.6
III: Moderately Productive 30-50%	125599	25.3	78033	29.1	47567	20.8
IV: Fairly Productive <30%	142256	28.6	28383	10.6	113875	49.7
V: N/A	13362	2.7	150	0.1	13212	5.8
Total	497040.	100	267828	100	229213	100

Figure 18. Distribution of soil productivity categories.

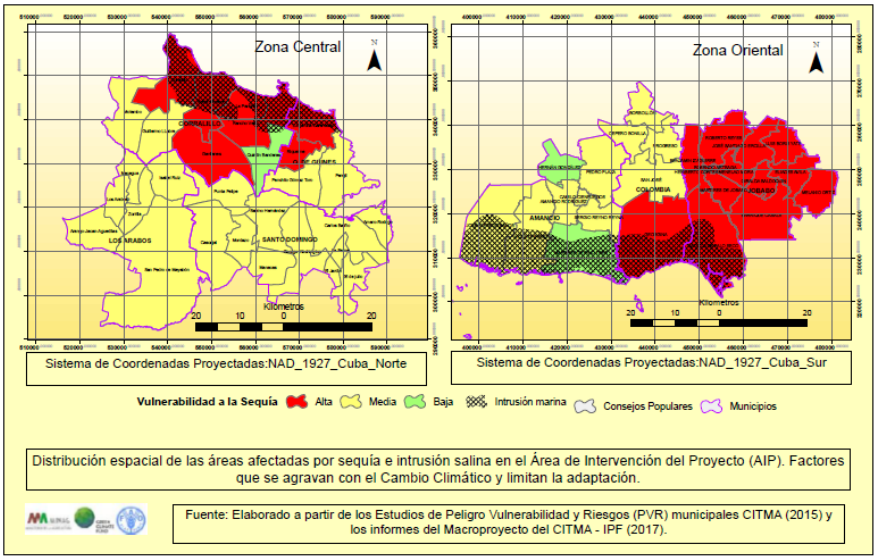


Source: Appendix 2.4: Somoza J., de la Colina A., 2018 on basis of: Ministry of Agriculture- MINAG (2017).

68. As a result of climate change, the impacts of drought are notable in both PIAs, although the affected surface of the Central Region constitutes almost 41% of the total area of the PIA, in particular the 7 Coastal Popular Councils (CPs)[50] within the municipalities of Corralillo and Quemado de Güines. In the Eastern Region, the saline intrusion processes affect a larger area, and negatively impact the availability of water for the supply of the population and the productive characteristics of the soils. In the PIA, approximately 60% of the soils are in a moderately degraded to degraded stage, and 67.2% of the PIA's surface classifies in the categories of areas of medium to very prone to desertification, degradation and salinization, with the Central Region standing out in this indicator with 69.3%. Figure 19 below shows the distribution of areas affected by droughts and saltwater intrusion in the PIA:

Figure 19. Distribution of areas most severely affected by drought and salt water intrusion in the Central (left) and Eastern (right) project regions.

[50] The Popular Council is an institution of the People's Power. It is local, of representative character, and invested with the highest authority for the performance of its functions. It covers a given territorial demarcation within a municipality, supports the Municipal Assembly of People's Power in the exercise of its powers and facilitates better knowledge and attention to the needs and interests of the inhabitants in its area of action. It does not constitute an intermediate venue for the purpose of political division; rather, it represents the demarcation where it acts and is, at the same time, representative of the municipal, provincial and national Popular Power bodies before the population and institutions / entities located there.



Source: Appendix 2.4: Somoza J., de la Colina A., 2018, based on: *Estudios de Peligro, Vulnerabilidad y Riesgo Municipales* (CITMA 2015) and *Macroproyecto del CITMA* / IPF (2017).

1.2.3.2.2.2. Land use and climate change effects in the PIA

Observed changes on land cover and land use

69. Observed changes and trends on land cover and land use in the PIA for the period 2007–2013 show a significant decrease in the areas of natural grasses (88.508 ha) and sugar cane fields (54626 hectares) with a moderate growth of other crops (21,364 hectares), forest cover (30797 ha) and, idle land (78257 hectares). The idle land in the PIA amounts to 144,418 hectares resulting from the sum of the area that remains stable (66,161 hectares) and the increase of 78,257 hectares. The decrease in the area of natural pastures occurred due to conversion to idle land in 45,202 hectares and forestry in 18,974 hectares, representing 72.5% of pastures converted in the period of observation. Sugarcane production fell due to its conversion of plantations to idle lands (23,998 hectares) and natural pastures (20,730 hectares), accounting for 82% of sugarcane areas converted.

70. The changes and trends on the land cover and land use in the PIA Central region for the same period, show a decrease in pasture areas (63,335 hectares) due to their conversion into sugar cane (12,486 hectares), forestry (16,478 hectares), other crops (4548 hectares) and idle land (29,823 hectares). Sugarcane areas have decreased of 23,483 hectares (converted to 11,888 hectares of pasture and 6126 hectares of idle land). The increase in idle areas (which in more than 90% are occupied by the invasive exotic species known as "*marabou*") represents loss of biodiversity and is the result of the effect of inadequate land management practices (traditional and conventional) worsened by climate change conditions that favor *marabou* (a resilient species thriving through successive periods of severe droughts and increased temperature as a result of climate change).

71. Areas occupied by sugar cane and pastures decreased due to their conversion to idle lands in 6126 ha and 29823 ha respectively. A slight increase in the area used for other crops is observed in the Central region of the PIA (8367 ha) occupying areas previously covered by sugar cane and natural pastures. The pasture coverage that has the largest area remains stable (69899 ha).

72. In the Eastern region (South of Las Tunas) the changes and trends on land cover and land use represent a decrease in sugar cane areas (31,143 ha) converted into pastures (8842 ha), other crops (3373 ha) and idle land (17872 ha). The increase in the areas of idle lands (Marabou) in the Eastern region has been more significant in relation to Central region. In the Eastern region, drought has been more extensive and severe than in the Central region, affecting in particular areas occupied by sugar cane and pastures that decreased (in 17872 ha and 15379 ha respectively), being converted to idle lands. A notable increase in the area covered by other crops is observed due to the conversion of areas previously covered by pastures (5922 ha), sugar cane (3373 ha) and idle land (3448 ha). Finally, idle land, that represents the largest area in the Eastern region remain stable (53285 ha).

73. The spatial zoning of areas in process and/or prone to the phenomena of desertification, salinization and degradation in the PIA shows that the Central Region has more cultivated areas (sugarcane and other crops) and natural pastures in the category of highly exposed, while in the Eastern Region, the most exposed land use covers are those occupied by forestry and idle lands. It is the same for areas considered to be in the category of moderately prone to desertification, degradation and salinization.

Projected changes on land cover and land use

74. According to future climate-change projections, without project intervention, shifts in land use and land cover in the PIAs indicates that the above-mentioned changes would worsen, leading to more areas (sugarcane, other crops, natural pastures, forest, and idle lands) prone to desertification, salinization and degradation and increased vulnerability of households that depend on these areas for their livelihood (further detail on household vulnerability is presented in the Section 1.2.3.3, below).

75. Without the project intervention, where current traditional land-management systems without adaptation measures would continue to be used and, in face of climate-change projections and effects on land cover and land use, the production of sugarcane and other crops in both areas will fall dramatically. Areas of natural pastures, forestry, and idle land, on the other hand, would experience growth. Trends would be toward moderate growth in the case of pastures and, in the case of forest and idle land, a notable growth trend, although there is evidence that pastures and forests will experience impacts on their composition and biodiversity, where *marabou* invasion, growth and territorial dominance is predicted due to the plant's resilience to projected climate conditions.

76. Regarding the invasion of *marabou*, which currently occupies 90% of idle lands, with higher incidence in the Eastern Region, a loop of environmental degradation and vulnerability can be observed, which is aggravated by the impact and effect of climate change favoring expansion of this species, in particular due to the occurrence of extensive and persistent periods of severe and intense droughts. In the coastal areas, *marabou* invasion is made worse by the concurrent threat of saltwater intrusion caused by floods. According to the adaptation and vulnerability baseline study (see complete version in Appendix 2.4), both

regions included in the PIA are in a process that will lead to desertification of the rural landscape, and therefore require immediate action under a new paradigm of land management that helps increase the resilience of rural landscapes, reversing the processes of vulnerability and increasing communities' adaptation capacity.

77. The implementation of agroforestry modules, as part of the project, will take into account the differences between the Central and Eastern regions in terms of how soil conditions, land use and land cover have been and will be affected by climate change.

1.2.3.3 Household and productive landscape vulnerability in the PIA

78. The increase in frequency and destructive potential of extreme events, and related effects (droughts, intense rains, floods, and saltwater intrusion due to sea level rise, strong winds, and related disasters), calls for an improved approach (politically, socially, economically, environmentally) to risk management in order to reduce the communities' vulnerability to these climate-related threats.

79. This project will improve the capacity of households and communities to adapt to the effects of climate change through rehabilitation of productive landscapes. The project's agroforestry modules (see further information in Part 5 and Appendix 2.6 of this document), with the combination of trees and crops more resilient to current and projected climate change, will help to diminish the impacts of droughts, intense rainfall and floods due to sea level rise and strong winds related to the increased frequency and intensity of hurricanes on household and communities located in the PIA.

80. The methodology used to assess the vulnerability of the targeted population and the productive landscapes their livelihood depends on includes: i) identify scenarios of danger; ii) calculate the danger; iii) calculate the vulnerability and; iv) estimate the risks.[51] For the purpose of estimating the scope of the households and population at risk in order to allocate funds to help increase resilience of the most vulnerable to the threats posed by climate change (including: a) droughts, b) intense rainfall, c) floods due to sea level rise, and d) strong winds), a numerical classification based on cluster analysis was applied to a spatial data matrix composed of 55 popular councils (PC), the four above-mentioned threats (a–d) and three variables (cultivated area, technical capacity of households, and population exposed to risks). Five groups were identified and categorized into the groups: *Extremely vulnerable*, *Vulnerable*, *Moderately vulnerable*, *Slightly vulnerability*, and *Very low vulnerability*.

Table 10. Distribution of Popular Councils by vulnerability classification in PIAs.

Vulnerability classification		Number of PCs in PIAs	Central region		Eastern region	
			# of PCs	%	# of PCs	%
I	Extremely vulnerable	10	5	50	5	50
II	Vulnerable	18	2	11	16	89
III	Moderately vulnerable	12	7	58.3	5	41.7

[51] Please see Vulnerability Assessment in Section II.2 of Appendix 2.4.

IV	Slightly vulnerable	7	7	100	-	-
V	Very low vulnerability	8	8	100	-	-
	Total	55	29	52.5	26	47.3

83. In the Central region, all categories are represented. In the Eastern region, however, all PCs are within the categories of *Extremely vulnerable*, *Vulnerable*, and *Moderately vulnerable*. Popular Councils of the Eastern region therefore face greater vulnerability to combined effects of climate-change threats and the variables of cultivated area, technical capacity of households, and exposure to risks.

84. In the Central region, 20.471 hectares of cultivated area are classified in the *Extremely vulnerable* and *Vulnerable* categories. Approximately 14,288 households (32,923 inhabitants) are in the *Extremely vulnerable* and *Vulnerable* groups in the Central region, and represent almost 36% of the total number of households (approximately one-quarter of the population) located in the PIA.

Table 11. Land use surface classified as *Extremely vulnerable* and *Vulnerable* (in hectares), Central region.

	Total surface	**Agricultural surface**	**Cultivated surface**	**Sugarcane**	**Other crops**	**Natural pasture**	**Forest**	**Idle lands**
Group I. *Extremely vulnerable*	47394	38616	13300	7609	4409	18201	1183	7115
Group II. *Vulnerable*	28004	17215	7171	4794	2213	9705	179	6634
Total	75398	62361	20471	12433	6467	28242	1362	13648

85. The total area belonging to Group I (*Extremely vulnerable*) and Group II. (*Vulnerable*) of the Eastern region is at least 215,387 hectares and represents 90.4% of the PIA in the Eastern region. Idle surfaces are predominant (90,397 hectares), of which almost 81,400 hectares are overgrown with *marabou*. There are 30,639 households (96,922 people) classified in Groups I and II, of which 80% are in the *Vulnerable* Group.

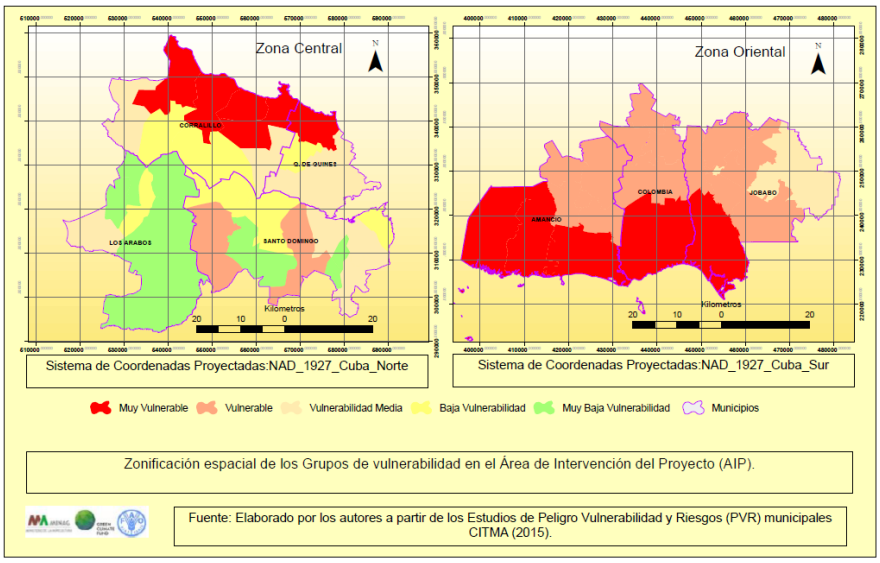
Table 12. Land use surface classified as being *Extremely vulnerable* and *Vulnerable* (in hectares), Eastern region.

	Total surface	Agricultural Surface	Cultivated surface	Sugar cane	Other crops	Natural pasture	Forests	Idle lands

Group I. Very vulnerable	100573	22573	9124	7942	1182	10015	54020	49875
Group II. Vulnerable	114814	58108	25434	16.086	9109	32675	10957	40515
Total	215387	80681	34557	24028	10291	42690	64977	90390

86. In both the Central and Eastern Regions, distribution of the *Extremely vulnerable* land and population category is concentrated in the coastal zones, which overlaps with the Popular Councils that are most exposed to the threats taken into account in the vulnerability analyses (a. droughts, b. intense rainfall, c. floods due to sea level rise, and d. strong winds). Figure 20 below shows distribution of vulnerable categories in the PIA.

Figure 20. Spatial distribution of vulnerability categories in both project areas.



Red: High vulnerability **Carmine**: Vulnerable **Yellow**: Low vulnerability **Green**: Very low vulnerability.
Source: Somoza J. De la Colina A., 2018.

1.3 Project location setting (site selection)

87. This proposal is built on a previous government initiative called "Phase 1," which was focused on research and development of agroforestry and silvopastoral systems to improve productivity and climate resilience of agricultural production. "Phase 2" would be the proposed project, which aims to apply the results from Phase 1 in project intervention areas (PIAs), which are on the front line of climate change

observed and projected threats that affect the whole country and that will worsen by mid-century. The project activities and implementation strategy (Phase 2) were defined in order to enable the GoC to enhance its technical and institutional capacities to upscale project interventions and implement a program to improve climate-resilience of Cuban agro-ecosystems based on enhancement of ecosystem services countrywide, considering that the entire country is affected by climate change.

88. In Phase 2, the systems developed and tested in Phase 1 will be upscaled in two broadly representative regions vulnerable to climate change impacts. The seven municipalities selected are part of a larger cohort of 78 vulnerable municipalities prioritized for climate-change adaptation of agricultural production systems. Phase 2 will produce concrete adaptation and mitigation benefits in the seven municipalities, as well as knowledge and information vital to the design and implementation of Phase 3. Institutional capacities built under this project include training of farmers and government staff for more efficient input provision; irrigation planning and management; development of a landscape-resilience fund to finance farmer-led initiatives to improve agricultural productivity and sustainability, and more efficient marketing of climate-resilient products.

89. As the effects of climate change on Cuba's physical-geographical and socioeconomic conditions are aggravated, the areas affected by agricultural drought increase and cultivated lands decrease. A chain of events is generated leading to the shrinking of the agriculture land base; areas occupied by invasive plants expand (especially *marabou*, which thrives in arid environments); food production declines; both urban and rural unemployment rates rise; and there is general exodus of the population, first in search of better income, and then as a survival mechanism.

90. These processes create tension in the territories and migration toward urban areas that lack the capacity to generate employment and proper infrastructure to receive and accommodate these migrants. This dynamic occurs when preventive measures are not adopted to mitigate land degradation and plans / projects are not drawn up to combat drought, climate variability and other negative impacts arising from climate change. In order to address the impacts of climate change on agricultural productivity, the Cuban government undertook a selection process to identify the most affected and vulnerable areas, which also have the greatest potential for impact and upscaling in other areas across the country. The selection process has been designed to ensure objectivity, consistency, fairness and transparency in determining PIAs and project beneficiaries. For this purpose, the main objective has been to prioritize support to families located in the areas most vulnerable to impacts of climate change, based on the following variables:

I. Municipalities most affected by the impact of climate change based on the rise in average local temperature and association with extreme weather events (in particular, hurricanes);

II. Municipalities with less average financial income linked to climate-change impact on income-generating activities (e.g., agriculture);

III. Migratory balance in municipalities due to impact of climate change on livelihoods.

IV. Prevalence of non-state agricultural production forms in PIA municipalities;

V. Comparative advantages for proximity of PIA to principal tourism regions and facilities.

Variable I: Municipalities most affected by climate-change impacts based on rise in average local temperature and association with extreme weather events (in particular, hurricanes).

91. According to studies on the macro-project of dangers, vulnerabilities and risks 2050–2100 in Cuba (for further information, see Section 1.2 and Appendix 2.4), the seven beneficiary municipalities rank among the 10 in Cuba where average annual temperature has increased at a faster pace, with a general rising trend of average temperatures in neighboring areas as well (see Table 13).

Table 13. Average annual temperature rise in the PIAs.

Municipality	Province	Average annual temperature increase (estimated by Cuban Institute of Meteorology)[52]
National average		0.90 ºC
Los Arabos	Matanzas	1.10 ºC
Martí	Matanzas	0.92ºC
Colón	Matanzas	1 ºC
Perico	Matanzas	0.90 ºC
Jagüey Grande	Matanzas	0.90 ºC
Calimete	Matanzas	0.93 ºC
Corralillo	Villa Clara	0.71 ºC
Quemado de Güines	Villa Clara	0.76 ºC
Sagua La Grande	Villa Clara	0.80 ºC
Cifuentes	Villa Clara	0.75 ºC
Santo Domingo	Villa Clara	0.9 ºC
Ranchuelo	Villa Clara	0.67 ºC
Aguada de Pasajeros	Cienfuegos	No data
Rodas	Cienfuegos	No Data

[52] **Source**: National Statistics Office. Weighting of income in selected municipalities for Ministry of Agriculture, 2019.

Lajas	Cienfuegos	0.86 ºC
Guáimaro	Camagüey	no data
Najasa	Camagüey	no data
Santa Cruz del Sur	Camagüey	1 ºC
Las Tunas	Las Tunas	1 ºC
Jobabo	Las Tunas	1.1 ºC
Colombia	Las Tunas	1 ºC
Amancio	Las Tunas	1 ºC
Río Cauto	Granma	1.1 ºC

92. Appendix 2.4 summarizes the main local consequences of rising temperatures that directly affected by extreme weather phenomena. Cuba was affected by 11 hurricanes from 2005–2017. The PIAs are located in the geographical area affected by hurricanes in the Atlantic Ocean Basin (see Section 1.2 and Appendix 2.4), where these destructive events have significantly increased in frequency and intensity in the last 15 years. The Central and Eastern regions of the country (especially the province of Las Tunas) have been affected by four tropical extreme events. The northern part of Villa Clara was affected by Hurricane Irma, the most intense hurricane in the Atlantic in recent years; its most destructive impact in Cuba was precisely in the north of Las Tunas, where the project will be implemented.

93. When analyzing events from 2008 to date, a number of remarkably intense hurricanes have affected the island. Table 14 summarizes some of the most significant ones, and their impact on the PIAs.

Table 14. List of hurricanes that affected Cuba from 2008 to present.

Hurricane	Year	Category	Provinces affected
Gustav	2008	4	Isla de la Juventud to Pinar del Río. Area of greatest destructive impact in Eastern Cuba Las Tunas.
Ike	2008	4	Isla de la Juventud to Pinar del Río. Area of greatest destructive impact: southern las Tunas.
Paloma	2008	3	Camagüey and Las Tunas. Area of greatest destructive impact: Las Tunas
Sandy	2012	3	Santiago de Cuba
Matthew	2016	4	Guantánamo

Irma	2017	5	North coast (Guantánamo to Artemisa). Area of greatest destructive impact: northern Villa Clara.

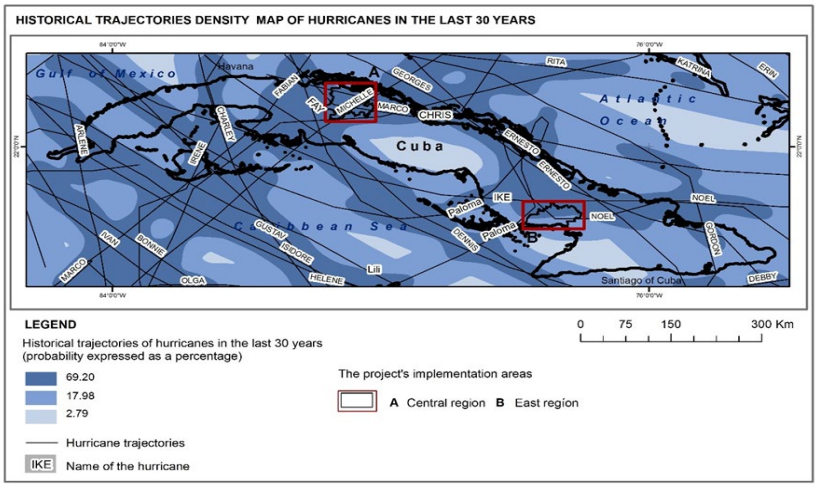
94. While the country's average is about two hurricanes every five years, the project's target municipalities have almost twice this number (see Table 15). In the case of the municipality of Los Arabos, although the average impact is lower, the destructive power has been greater given the area's economic and climatic vulnerability (see more information in Appendix 2.4).

Table 15. Number of hurricanes affecting the PIAs and nearby provinces in Cuba.

Municipality	Province	Number of hurricanes and destruction impact range from 1–5 Saffir-Simpson scale. National scale by provinces (2)
National average	-	2
Los Arabos	Matanzas	3
Martí	Matanzas	0
Colón	Matanzas	0
Perico	Matanzas	0
Jagüey Grande	Matanzas	0
Calimete	Matanzas	0
Corralillo	Villa Clara	3
Quemado de Güines	Villa Clara	3
Sagua La Grande	Villa Clara	3
Cifuentes	Villa Clara	3
Santo Domingo	Villa Clara	3
Ranchuelo	Villa Clara	3
Aguada de Pasajeros	Cienfuegos	1
Rodas	Cienfuegos	1
Lajas	Cienfuegos	1
Guáimaro	Camagüey	3
Najasa	Camagüey	1
Santa Cruz del Sur	Camagüey	1
Las Tunas	Las Tunas	3
Jobabo	Las Tunas	4
Colombia	Las Tunas	4
Amancio	Las Tunas	4
Río Cauto	Granma	2

95. In the model constructed from hurricane trajectories over the past 15 years, almost the entire island of Cuba and its adjacent seas fall within the areas of greatest probability. The trajectory lines show the increase in recent years of impacts on the whole of Cuba, and especially the territories containing the project intervention areas (see Figure 21).

Figure 21. Trajectories of hurricanes over last 30 years.



Source: Based on data from National Hurricane Center and Central Pacific Hurricane Center (2019). https://www.nhc.noaa.gov/data/

96. The PIAs are also affected by heavy rains, floods, saltwater intrusion and droughts. While Figures 9–12 (Section 1.2) provide a national reference and show that the project-targeted PIAs are among the most highly vulnerable, Figures 22–24 below illustrate in greater detail the risk of vulnerability to these adverse climate-change impacts in the two PIAs (Appendix 2.4 Section II.1 provides an in-depth analysis of distribution of risk, danger and vulnerability to climate-change effects in the PIAs).

Figure 22a. Vulnerability due to rain-induced flooding and strong winds, Central region.

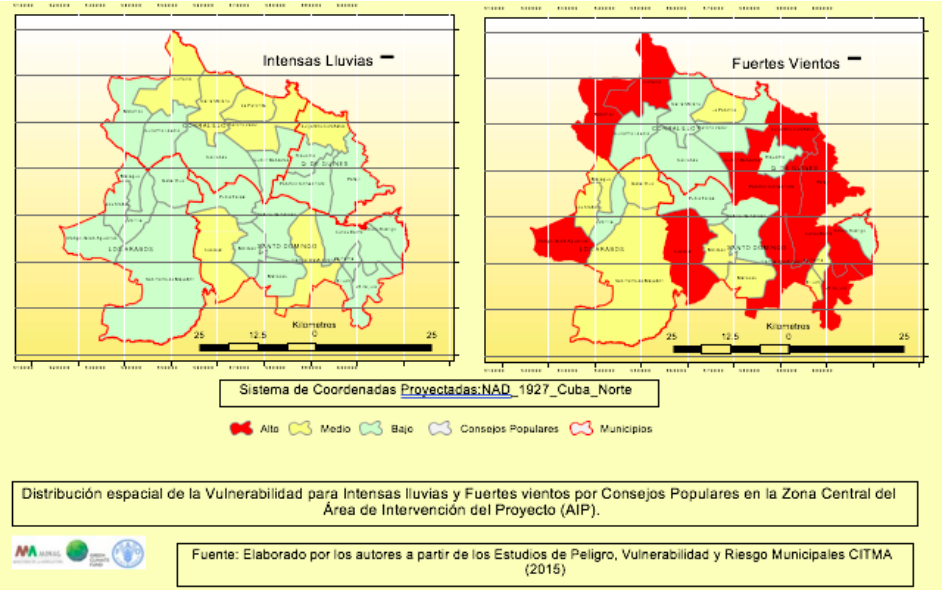


Figure 22b. Vulnerability due to rain-induced flooding and strong winds, Eastern region.

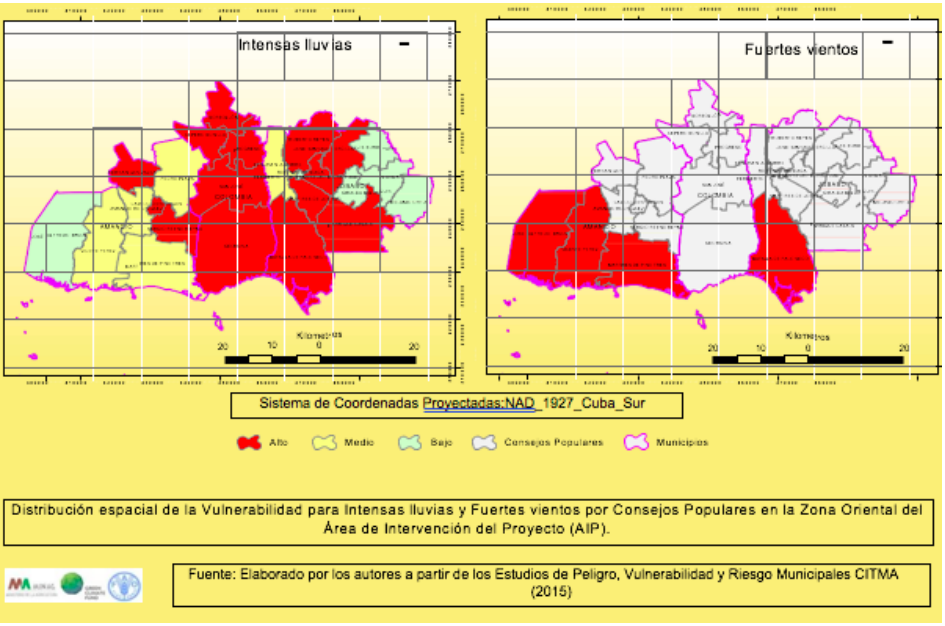
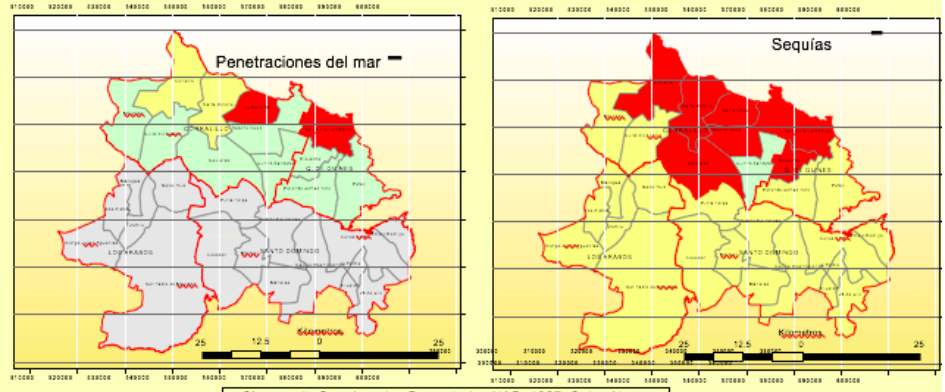


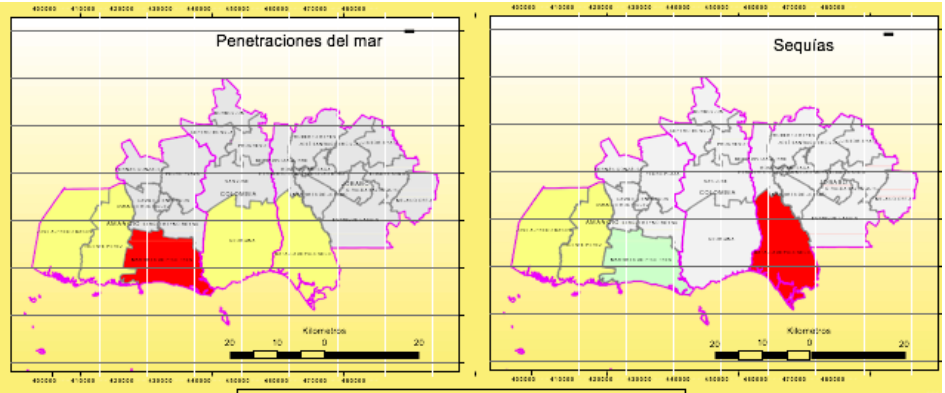
Figure 23a. Vulnerability due to seawater intrusion and drought, Central region.



Distribución espacial de la Vulnerabilidad para Penetraciones del mar y Sequías por Consejos Populares en la Zona Central del Área de Intervención del Proyecto (AIP).

Fuente: Elaborado por los autores a partir de los Estudios de Peligro, Vulnerabilidad y Riesgo Municipales CITMA (2015)

Figure 23b. Vulnerability due to seawater intrusion and drought, Eastern region.



Distribución espacial de la Vulnerabilidad para Penetraciones del mar y Sequías por Consejos Populares en la Zona Oriental del Área de Intervención del Proyecto (AIP).

Fuente: Elaborado por los autores a partir de los Estudios de Peligro, Vulnerabilidad y Riesgo Municipales CITMA (2015)

Figure 24a. Hazard and risk due to droughts to which Popular Councils are exposed in PIAs in Central region.

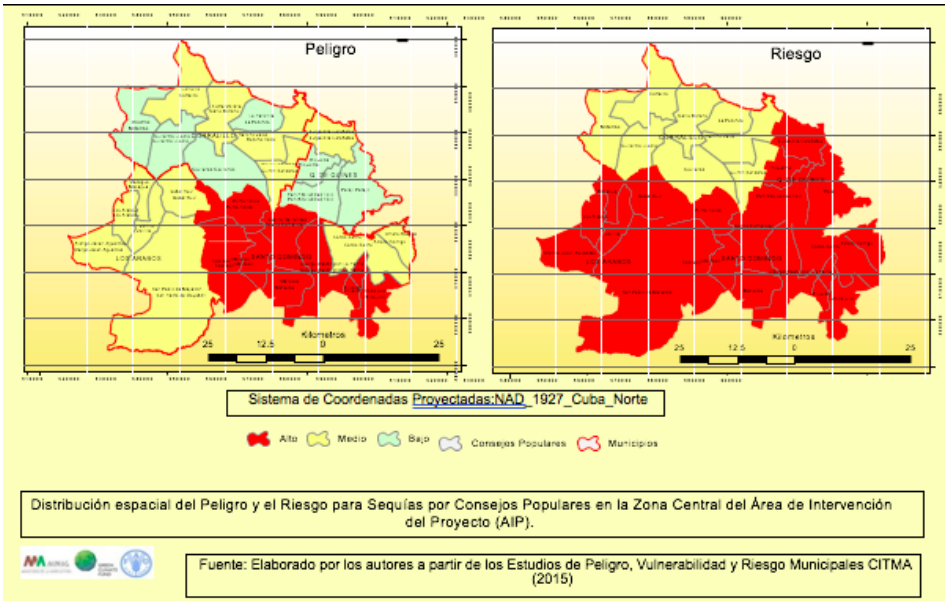
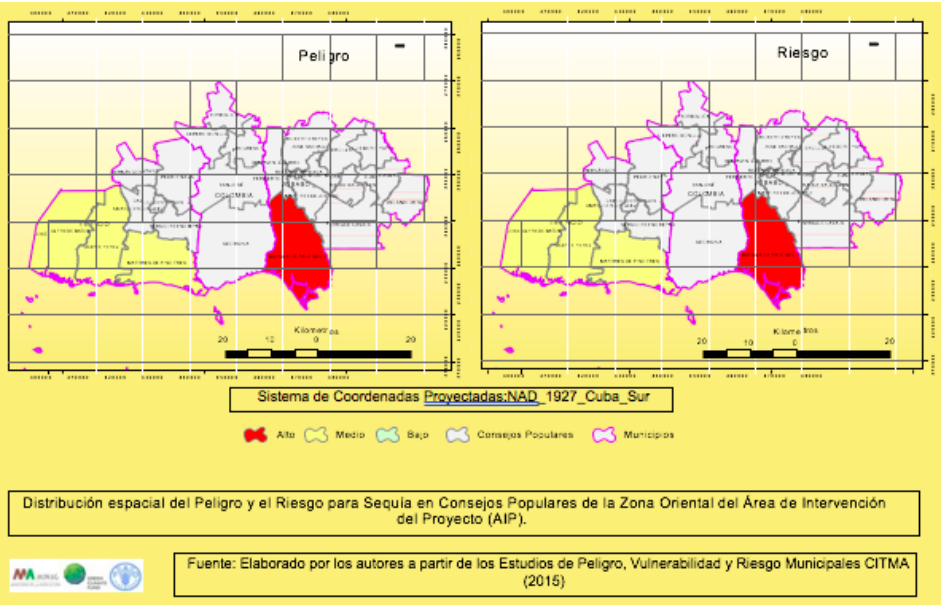


Figure 24b. Hazard and risk to drought to which Popular Councils are exposed, Eastern region.



Variable II. Municipalities with lower average financial income.

97. The PIA municipalities are within territories where the average income is lower compared to the national average (see Table 16). This phenomenon is multi-causal, but could also be associated with climate-change impacts on the PIAs' physical-geographical and socioeconomic conditions. The areas affected by the rise in agricultural drought and decline in arable lands, resulting in a weakening in the foundation of agricultural land. The areas occupied by invasive plants expand, as those plants are usually better adapted to aridity (e.g., *Dichrostachys cinerea*, or marabou). Food production therefore declines, meaning that both urban and rural employment falls, and remuneration for work remains low in comparison with other regions in the country.

Table 16. Average financial income in PIA municipalities.

Criteria	National average	Municipality of Jobabo	Municipality of Colombia	Municipality of Amancio	Municipality of Quemado	Municipality of Corralillo	Municipality of Santo Domingo	Municipality of Los Arabos
Average financial income (in relation to average income in country's agricultural sector)[53]	1200 CUP	345 CUP (one of the 5 lowest in Cuba)	370 CUP (one of the 5 lowest in Cuba)	400 CUP (one of the 5 lowest in Cuba)	555 CUP (one of the 5 lowest in the Villa Clara Province)	500 CUP (one of the 5 lowest in the Villa Clara Province)	400 CUP[54]	400 CUP (One of the 5 lowest in Cuba)

Variable III. Migratory balance in municipalities.

98. The aforementioned factors associated with climate change aggravate and accelerate the exodus of the general population in the municipalities of the PIA, in comparison with the national average and neighboring areas (Table 17). The impact is even greater in rural areas where there is a marked tendency toward increased migration, first in search of better income and then as a survival mechanism. These processes create tensions in the territories losing population and suffering a rupture in socioeconomic dynamics,[55] as well as in urban areas that do not have the capacity to generate employment or appropriate infrastructure to receive and house the migrants.

Table 17. Population dynamics and distribution in PIA municipalities and their surroundings, 2012–2017.

Municipality	Province	2012	2015	2017	Migratory balance rate 2012–2017 (per 1000 inhabitants)
Los Arabos	Matanzas	24 787	24 416	24 119	-2.77
Martí	Matanzas	22 786	22 507	22 236	-2.47

[53] **Source**: National Statistics Office. Weighting of income in selected municipalities for the Ministry of Agriculture, 2019.
[54] In Santo Domingo municipality the average income is 800 CUP, but the local income in the project intervention areas is less than 400 CUP, the lowest in the municipality.
[55] Appendix 2 (page 8) provides details on impact of migration on gender balance, placing greater hardship on rural women as more men migrate to urban areas.

Colón	Matanzas	70 248	70 350	69 881	-0.53
Perico	Matanzas	31 191	31 042	30 774	-1.36
Jagüey Grande	Matanzas	59 722	60 284	60 391	1.11
Calimete	Matanzas	28 751	28 499	28 100	-2.32
Corralillo	Villa Clara	26 843	26 393	25 834	-3.91
Quemado de Güines	Villa Clara	22 089	21 689	21 359	-3.42
Sagua La Grande	Villa Clara	53 077	52 516	51 687	-2.69
Cifuentes	Villa Clara	28 425	27 835	27 323	-4.03
Santo Domingo	Villa Clara	51 013	50 514	49 445	-3.17
Ranchuelo	Villa Clara	54 889	54 244	53 329	-2.93
Aguada de Pasajeros	Cienfuegos	32 159	32 249	32 098	-0.19
Rodas	Cienfuegos	34 376	34 139	33 848	-1.56
Lajas	Cienfuegos	21 999	22 037	21 826	-0.79
Guáimaro	Camagüey	39 118	38 276	37 551	-4.17
Najasa	Camagüey	15 816	15 579	15 260	-3.64
Santa Cruz del Sur	Camagüey	45 710	44 762	43 229	-5.74
Las Tunas	Las Tunas	202 105	207 648	210 412	3.95
Jobabo	Las Tunas	44 851	44 211	43 123	-4.01
Colombia	Las Tunas	32612	32 537	32 186	-1.32
Amancio	Las Tunas	38957	38714	38111	-2.22
Río Cauto	Granma	47189	47381	46804	-0.82

Note: Colored lines represent PIA municipalities; remaining municipalities border the PIA municipalities.

Source: ONEI (2012). Nomenclador Nacional de Asentamientos Humanos del Censo de Población y Viviendas del 2012. La Habana; ONEI (2018). Sistema de información estadístico nacional (SIEN), de demografía 2017.

99. The beneficiary municipalities are notable for their high negative migration rates; four had >4 per 1000 inhabitants (Santa Cruz del Sur, Guáimaro, Cifuentes and Jobabo); Santo Domingo, Quemado de Güines, Najasa and Corralillo had 3–4; Amancio, Calimete, Martí, Sagua La Grande, Los Arabos and Ranchuelo had 2–3 (see Table 18 below).

Table 18. Migration balance rates in PIA municipalities

Criteria	National average	Jobabo Municipality	Colombia Municipality	Amancio Municipality	Quemado Municipality	Corralillo Municipality	Santo Domingo Municipality	Los Arabos Municipality
Negative migratory balance rates (per 1000 inhabitants)	-1.30 National migratory balance.	-4.01	-1.32	-2.22	-3.42	-3.91	-3.42	-2.77

Variable IV. Prevalence of non-state agricultural production forms in PIA municipalities

100. In Cuba, state-run farms still occupy an important place in agricultural production at the national level. As such, one of the criteria for selection of beneficiary municipalities is number of private producers, as these are generally more flexible and can implement the project with greater independence and can apply innovative and CC-resilient productive practices. The project-targeted municipalities have the highest number of non-State farms, as can be seen in Table 19 below.

Table 19. Entities and landowners according to management structure in provinces with PIA municipalities.

Province	Entities		Individuals		% of non-State farms
	State	Cooperatives	Usufructuaries'*	Owners**	
Cuba	3437	3816	287421	132906	52.61
Artemisa	322	156	11599	3152	32.64
La Habana	250	80	8999	1534	24.24
Mayabeque	183	193	13484	4162	**51.33**
Matanzas	326	221	16424	4624	40.40
Granma	251	302	27945	17370	54.61
Cienfuegos	104	140	15722	5572	57.38
Sancti Spíritus	192	197	21187	7264	50.64
Ciego de Ávila	151	162	12521	3282	51.76
Holguín	317	221	15114	10086	41.08
Las Tunas	230	476	28000	20100	**67.42**
Villa Clara	215	420	31373	16170	**66.14**
Santiago de Cuba	246	394	27438	13228	61.56
Guantánamo	281	250	13558	8620	47.08
Isla de la Juventud	15	13	1628	89	46.43
% del total	26.01	19.50	20.70	24.14	

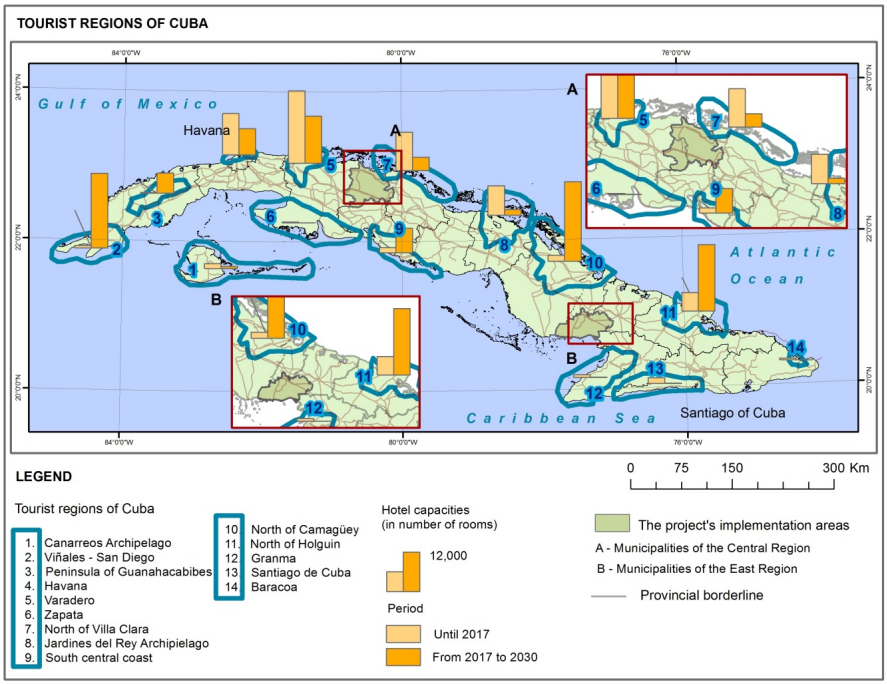
*PIA municipalities in **bold**.

Source: Balance de tierra, 2016. Centro de control del registro de la tierra, MINAG.

Variable V. Comparative advantages for proximity of PIA to principal tourism regions and facilities

101. The World Tourism Organization considers Cuba to be one of the most important emerging destinations in the world.[56] Tourism in the country is divided among 14 touristic regions, the majority of which are focused on sun and beach located along the archipelago's coastal zones. As can be seen in Figure 25, the project-targeted areas are located in the only provinces on the island that are both in close proximity and equidistance to the most important tourist regions of Cuba. These tourism poles offer a comparative variable of great significance in relation to other regions in the country due to tourism's role propelling the Cuban economy. As such, it offers strategic market access potential for products used by the sector's hotels and restaurants, and thereby fosters stability and sustainability of agricultural productions, which is a project objective.

Figure 25. Location of PIAs in relation to tourist regions in Cuba.



Source: MINTUR, 2019, Perelló, J. (2019).

102. The project's selection process, through consideration of Variables I–V, led to the selection of seven municipalities located in two regions: The **Central Project Region (CPR)**, in northern Villa Clara and Matanzas; and the **Eastern Project Region (EPR)**, in southern Las Tuna (Figures 26a–c).

[56] Mintur, 2019.

Figure 26a. Location of PIAs in Central and Eastern regions.

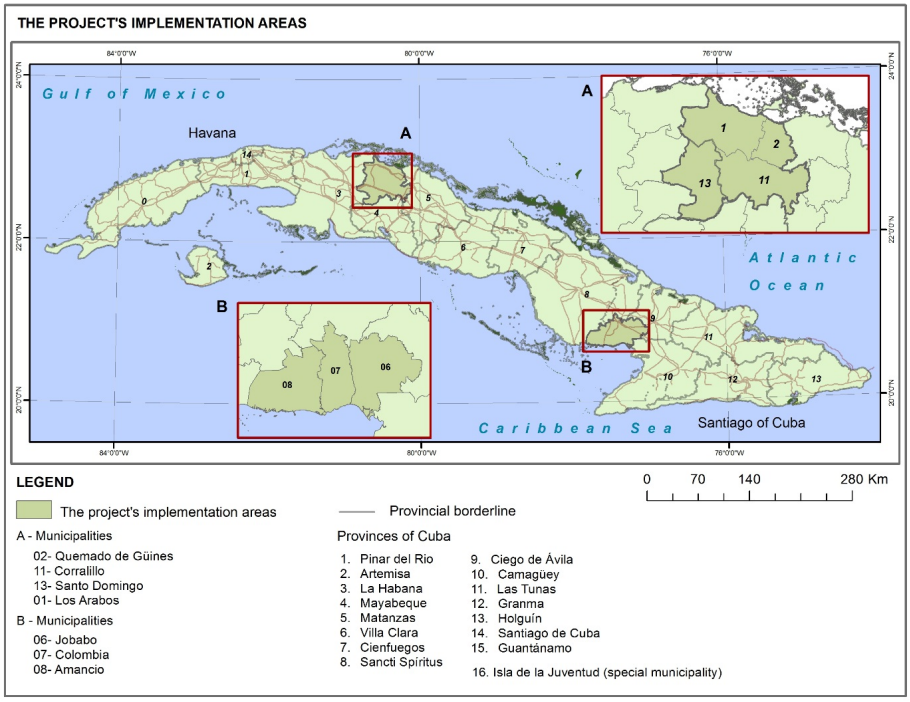


Figure 26b. Topography of project intervention areas.

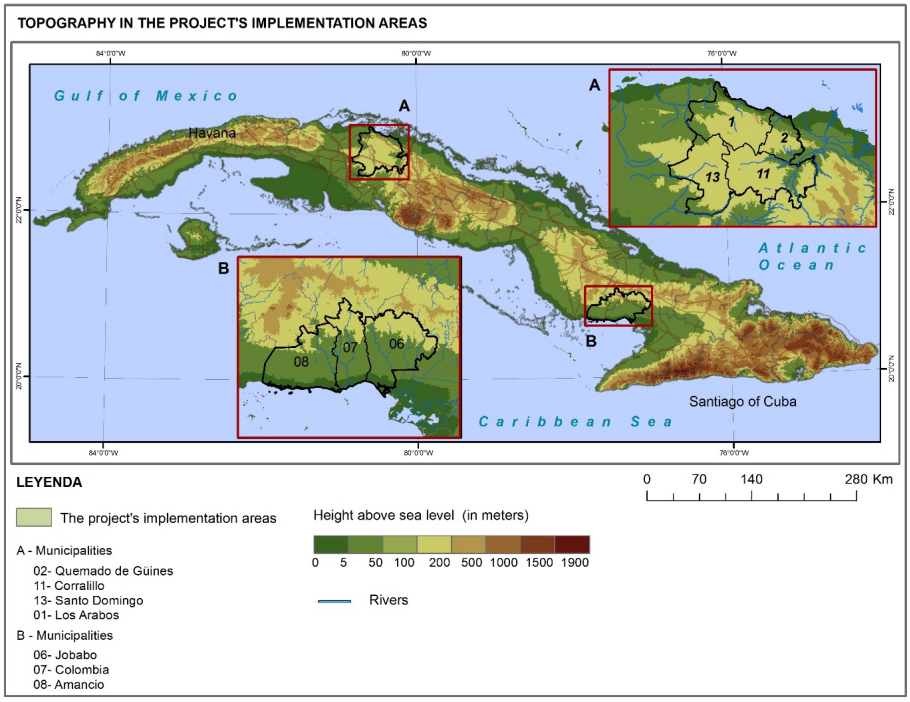
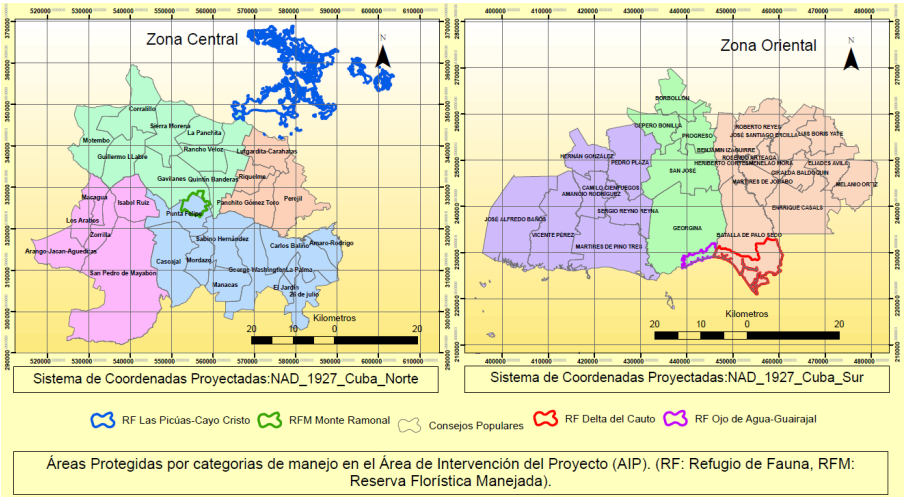


Figure 26c. Location of protected areas in PIAs.



Central Region

103. The selected agroecosystems are located in an area totaling 280,654 hectares with a combined population of 123,919 inhabitants. The municipalities are:

- Los Arabos (province of Matanzas);
- Santo Domingo (province of Villa Clara);
- Corralillo (province of Villa Clara);
- Quemado de Güines (province of Villa Clara).

104. Agro-productive landscapes are predominant, totaling 223,092 hectares, and account for an average of 80% of the municipalities' total areas. The main agricultural products are sugarcane, extensive livestock, grains, rice, roots and tubers, plantain, vegetables and forest plantations. The most valuable natural ecosystems are conserved in two protected areas (totaling 18,871 hectares). In the coastal zones, mangrove forests are prevalent and in the interior, semi-deciduous forests and palm savannas.

Eastern Region

105. The selected agroecosystems are located in an area totaling 229,813 hectares with a combined population of 116,198 inhabitants. The municipalities, all belonging to the province of Las Tunas, are:

- Amancio Rodriguez;
- Jobabo;
- Colombia.

106. This region is dominated by agro-productive landscapes totaling 165,424 hectares, which represents an average of 72% of the total area of the municipalities. The main agricultural production involves sugarcane, extensive livestock, grains, roots and tubers. Natural ecosystems include a forest patrimony of 47,433.2 hectares, mainly mangroves. The most valuable are under conservation in one terrestrial protected area covering 9,485.8 hectares. In this area, mangroves occupy 57.5%, semi-deciduous forest 24.7%, and savannah 3.5% respectively.

107. Appendix 2.5 presents a socioeconomic overview of the municipalities included in the PIAs; population in the two PIA regions totals 240,117 inhabitants. The appendix also explains that the PIAs have been facing intense population migration as land productivity drops due to climate-change impacts, such as drought, saltwater intrusion, and the invasion of *marabou*.[57] The characterization of climate-change impacts on these two PIAs can be summarized as follows: a) rising air surface temperature; b) changes in precipitation patterns; c) greater frequency and length of severe droughts, especially in summer, putting crops and rural livelihoods under severe water stress and increasing vulnerability to invasive alien species (i.e. *marabou*); d) increase in the occurrence of moderate and strong floods for coastal areas; e) increase in saline intrusion as a consequence of rising mean sea level; f) greater frequency of hurricanes contributes to more extreme climate, ultimately affecting the livelihoods of the majority of vulnerable

[57] Appendix 2.2 also provides supporting data from: ONE (several years). Demographic yearbook of Cuba. Havana; ONEI (several years). Demographic yearbook of Cuba. Havana; ONE (2005). Demographic series 1982-2002. Center for demographic studies. T I. Havana; ONEI (2008). Demographic series 1982-2002). Center for demographic studies. T II. Havana. Balance of use and land tenure of the MINAG (several years).

households (see Appendix 2.4). Both project regions are vulnerable to the climate-change impacts described above, as presented in Table 20.

Table 20. Impacts of climate change on PIAs by region.

Impact	Central (CPR)	Eastern (EPR)
Temperature rise (Appendix 2.4)	Increase of 1.6% per year in CPR during last 35 years and average minimum temperature has increased by at least 0.9 ^{o}C	Average minimum temperature has increased by at least 0.8 ^{o}C since 1970
Precipitation change (Appendix 2.4)	Drought affects 41% of CPR	Drought affects 37% of EPR. 4 hurricanes in Las Tunas in last 10 years
Sea level rise (SLR) (Appendix 1, Figures 9-a, -b)	3.3% surface area affected	5.5% surface area affected
Saltwater intrusion (Appendix 1, Figures 10–a, 10–b)	17% area affected	26% area affected
CC-induced invasive species: "*marabou*" (*Dichrostachys cynerea* "sicklebush") (Appendix 2.6)	75,398 hectares 32,923 inhabitants	215,387 hectares 96,922 inhabitants

108. These impacts are of particular concern due to the fact that agriculture accounts for a significant portion of land use in both PIAs (Table 21 and Appendix 2.4: Tables 46 and 48).[58] According to MINAG, 197 agricultural cooperatives are registered in the PIAs and have a total of 15,968 active members, of which only 19.6% are women. Forty state companies in the PIAs' agricultural sector employ 4,000 people, 25% of who are women.[59] However, both PIAs are classified as aged, placing them at the forefront of a labor force deficit and older agricultural workers in a position of vulnerability to assume the PIAs' productive tasks with limited or no access to climate-resilient technologies and production models.

Table 21. Population and agricultural area of PIAs by region.

[58] Land Use and Land Use Cover Database 2013, processed by Somoza de la Colina A., 2018.
[59] Mirabal Patterson Ania 2018: Caraterización socioeconómica de las zonas del Proyecto (Appendix 2.5).

Project region and municipalities	Total population	Rural population	Total land area (hectares)	Agricultural area (hectares)	Agricultural area (%)
CENTRAL REGION					
Corralillo	26,592	6,970	83,730	66,151	79
Quemado de Güines	21,851	7,687	33,282	29,207	88
Sto. Domingo	50,872	13,692	87,807	73,845	84
Los Arabos	24,604	9,575	75,835	53,889	71
Subtotal	*123,919*	*37,924*	*280,654*	*223,092*	*80*
EASTERN REGION					
Amancio Rodriguez	38,900	10,601	85,253	52,212	61
Colombia	32,665	9,578	55,997	42,249	75
Jobabo	44,633	23,886	88,563	70,963	80
Subtotal	*116,198*	*44,065*	*229,813*	*165,424*	*72*
TOTAL	***240,117***	***81,989***	***510,467***	***388,516***	

Source: National Statistical Annual Report. ONEI, 2014. Land Balance MINAG 2016.

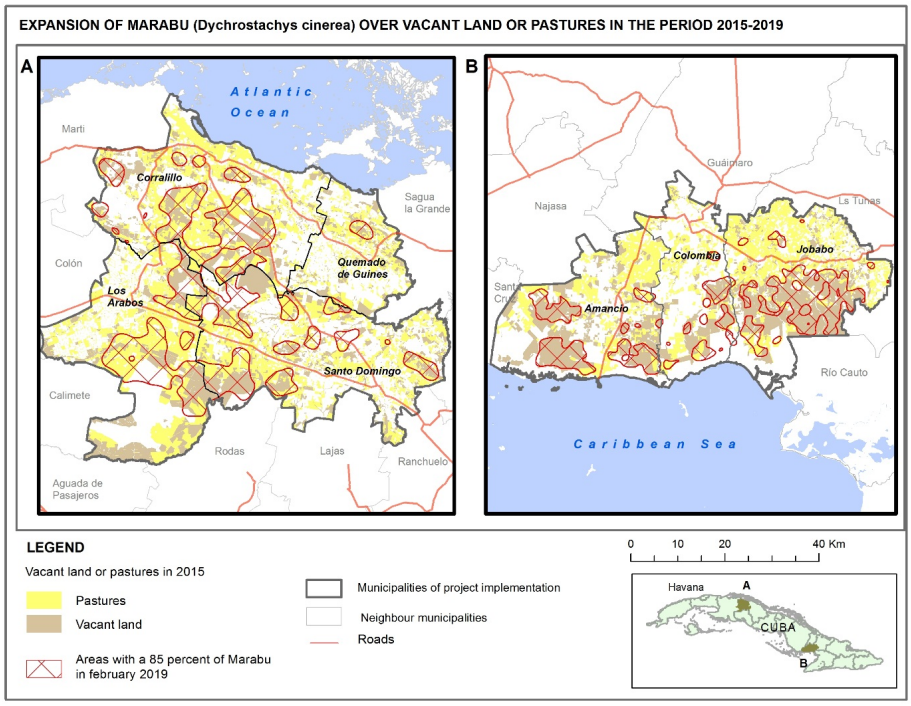
109. A soil's texture, depth and organic-matter content are crucial to its capacity to retain, absorb and regulate water and nutrient cycles at the ecosystem and landscape levels. About 76% of the soils in the PIAs are shallow or extremely shallow (<10–40cm); 70% are poor in organic matter and edaphic biodiversity; and 48.3% are in different stages of erosion, mostly in the Central region. More than half the soils in the PIAs are of medium or low productivity, especially in the Eastern region (see Appendix 2.4, Table 23) and more than one-third of the soils in both PIAs are rated as having medium to high vulnerability to temperature rise, precipitation anomalies, and drought (see Appendix 2.4, Table 18). Approximately 11% (57,235 hectares) of the soils in the PIAs are at extremely high risk of desertification and degradation, and 11,414 hectares are currently covered with natural grass rangeland.

110. Only one-tenth of the area in the PIA is covered with forests, three times less than the overall national forest cover of 31.2% (Appendix 2.6, Table 3). There are less than 20,000 hectares of forests plantations, 90% of which are monocultures (several species are used, but 1 per plantation).[60] Approximately 14,505 hectares are "idle land," of which more than 90% is estimated to be covered with *marabou*.

[60] Herrero 2018. Personal communication.

111. As described in detail above in Section 1.2.3.2 "Impacts on food security and ecosystems," nearly one quarter of the land area of the seven municipalities (approximately 144,418 hectares) is covered with these thorny bushes that form dense impenetrable thickets that have expanded steadily as the climate becomes drier, soils degrade, and land is abandoned. While *marabou* provides for some soil cover and fixes atmospheric nitrogen, it accumulates only a fraction of biomass in comparison with forests or agroforestry systems.[61] The ecosystem services it provides (particularly in terms of livelihood resilience and food security) are therefore extremely poor, leading to further land abandonment and migration. Due to lack of appropriate technology, heavy bulldozers are being used to recuperate areas covered with *marabou*. They push the *marabou* shrubs and stumps to strips that are subsequently burned, causing severe soil damage, compaction and erosion; in addition, this process releases significant amounts of CO_2 from soils and biomass.[62]

Figure 27. Expansion of areas overgrown with *marabou* bushes on lands declared idle or with natural pastures, 2012–2019.



Source: Prepared by the authors with images from Sentinel 2a satellite (February 2019). MINAG land use and tenure balance (several years).

112. Both project areas are included in *Tarea Vida*, the state plan for confronting climate change in Cuba. In this regard, both areas were preliminarily approved by the Minister of CITMA, with the understanding that

[61] Only 2–3% of *marabú* biomass is actually used for poles or charcoal (Herrero J. 2018).
[62] https://oncubamagazine.com/economia-negocios/marabu-en-cuba-se-prolonga-la-infeccion/

the label of "most vulnerable municipalities" (as they appear in *Tarea Vida*) does not exclude or invalidate work in other municipalities. Rather, Cuban environmental considerations view the entire archipelago – and not just isolated areas – as vulnerable to climate change. Indeed, given that each project intervention area (PIA) comprises a different set of conditions and CC impacts, the project's structure offers the ***greatest potential*** for generating lessons learned for ***replicability*** in similar areas throughout the country.

1.4 Description of profiles of target beneficiaries

113. This project will directly benefit 51,713 people[63] (with an average of 46% women in the PIAs) throughout the seven project-targeted municipalities. Direct beneficiaries correspond to 51,098 smallholders and family members; 74 machinery operators that will be trained in activity 1.1; 68 machinery operators that will be trained in activity 1.2, 443 extension service technicians, agricultural technicians and cooperative administrators trained in activity 2.1 and; 30 leadres of local organizations trained in activity 3.3. All inhabitants of the target areas (240,117 people, of who 46% are women), will indirectly benefit from increased food security, as a result of enhanced and more stable production, better hydrological regulation, and increased opportunities for employment in agricultural tasks and value addition.

114. Taking into consideration the climatic threats affecting the Central and Eastern regions identified in the "Adaptation baseline and vulnerability analysis study" (Appendix 2.4), the proposal focuses on Popular Councils (CPs), households, and population with greater vulnerabilities to the identified phenomena (temperature rise and erratic changes in precipitation patterns, droughts, floods, saltwater intrusion and hurricanes). Of the 55 total CPs (29 CPs in Central region and 26 in Eastern region), project activities will focus on the 27 CPs classified as "most vulnerable and vulnerable" (See section 1.2.3.3 and Appendix 2.4, Section II.2).

115. There are 132,046 people of working age in the entire PIAs. Both territories are classified as aged. The classification of aging is closely related to the birth rate. Although percentage values of aging may seem low (17–22% of the total population), they put these territories at high risk of workforce shortage and increased vulnerability, as it implies that productive tasks are carried out with less technological development.

General features of the Central Region

116. The fundamental economic activity of the three municipalities of the northern Villa Clara is the sugar industry, as well as agricultural work (livestock and various crops). The sugar industry has deteriorated in the area due to the closing of one of the two sugar mills in the area. Corralillo, Quemado de Güines and Santo Domingo have a productive history of grains, mainly beans, which has been affected by the change in rain patterns after Hurricane Irma. Food production in this area is mainly based on grains, fruit, vegetables, milk, eggs and meat. Local food production is complemented with development of urban and sub-urban agriculture programs where vegetables are grown. In this territory, families have found a common way to subsist socially and economically; these socioeconomic strategies are fundamentally

[63] About 15,968 farmers, members of agricultural cooperatives will directly participate in the project activities and an average of 3.2 people per household is being considered to estimate the project direct beneficiaries of agroforestry, reforestation and silvopastoral activities.
National Office of Statistics and Information- ONEI. 2012. Population and Housing Census 2012- National report- Final results of selected indicators in Cuba, Provinces and Municipalities (www.one.cu/informenacional2012.htm

based on pig and poultry farming and, to a lesser extent, that families with small lots produce food for self- consumption.

117. When referring to access and availability of food in this zone, what is produced is eaten, although some products for the "basic basket" also come from other provinces, e.g. private sector livestock production. As in the rest of the country, these foods are available in state markets and/or in non-state squares, highlighting the proliferation of "carretilleros." Price stability or not is related to supply in state markets that force the rest to maintain attractive prices. Commercialization circuits found along specific municipal roads are not in good condition.

118. External migration commonly occurs in the three territories, with migrants (largely young people) going mainly to the United States. Internal migration consists of people from this area migrating to Santa Clara, the head of the province and a large percentage, mostly young, to Matanzas, Varadero, Cárdenas - municipalities that constitute a tourism hub and offer well-paid jobs. There is also population movement from the most rural areas to urban areas in each municipality.

119. In all municipalities in this PIA, approximately 82 to 95% of the households use electricity for cooking, and 3–7% use firewood. However, due to their low incomes, many families must limit their use of electricity and instead use coal or wood stoves in their backyards, thus alternating use of energy to cook food.

120. In the northern part of Villa Clara/Matanzas, 19,911 people receive water from water trucks during periods of drought. From a gender perspective, women are the most affected by lack of water. Women say that one of their basic needs is access to potable water (see Table 22). There are 47,267 houses in this area. The houses in poor condition are located mainly in the rural part of the municipalities of this area, which in turn are located in the southern part of each municipality. According to a classification system based on construction materials, Types III and IV prevail among the housing found in rural areas, meaning they are more vulnerable to natural disasters, especially hurricanes, strong winds and heavy rains.

Table 22. Potential beneficiaries, based on vulnerability due to water supply and drought in Central project region.

MUNICIPALITIES	Corralillo	Quemado de Güines	Santo Domingo	Los Arabos	Total
Variable					**Average %**
Total population supplied by water network	19 998	5 407	35 249	8 192	**68,846**
% of total population	76	25	70	34	51
Total population with permanent supply of piped water	398	790	1 231	1 488	**3,907**

% of total population	2	4	2	6	3
Total population supplied with water trucks during drought	388	2 692	11 623	5 208	**19,911**
% of total population	1	12	23	21	15
Total number of people supplied by wells in the territory		16 259	3 630	2 028	**21,917**
Total population supplied by individual wells	4 071	4 239	5 664		**13,974**
Population vulnerable to drought	24 855	29 387	57 397	16 916	**128,555**
Households vulnerable to drought	8 285	9 796	19 132	5 639	**42,852**

Source: Prepared by the authors based on data provided by the municipalities.

General characteristics of the Eastern Region

121. The three municipalities of southern Las Tunas base their fundamental economic activity on the sugar industry and agricultural work; there is a sugar mill in each municipality. In the case of Colombia, the economy is also based on tobacco and forestry, as well as the food industry, construction material, and shrimp farming. Jobabo also has a tobacco and a handicraft factory based in Yarey. In addition to sugarcane, Amancio, Colombia and Jobabo produce corn and viands such as plantain and yucca. They recognize that food production in this area is based mainly on yucca, corn, plantain, sweet potato, rice, beans, and vegetables such as carrots, okra, and snap beans fostered by urban agriculture.

122. As in the Central Region, food prices are reasonable when they are set by the state. “Carretilleros” have a price system set by the municipal administration that offers more affordable prices than in other territories. After Hurricane Irma, these municipalities have had to fully self-sustain through contracts with different productive forms of the territory (CCS and CPA). However, there are problems with food transportation and storage due to unreliable conditions. Prices follow the same patterns as in northern Villa Clara.

123. An exodus of people began with the closing of sugar mills, as many people associated to both sugarcane and industrial agriculture moved to urban areas. Entire rural communities have disappeared.

124. In the three municipalities of this PIA, 57–82% of all households cook with electricity; only 10–26% cook with firewood in the rural area.

125. In times of drought, a total of 19,429 people are supplied by water trucks in time of drought, and the Central Region, women are the most affected by the lack of water because they are the ones who carry the burden of the domestic responsibilities (see Table 23). This area has 41,223 homes. The houses in poor condition are located mainly in the rural part of the municipalities. According to a typology based on construction materials, TYPE III, IV (to a lesser degree) and V of the housing fund in rural areas prevail, being more vulnerable to natural disasters, especially hurricanes, strong winds and heavy rains.

Table 23. Potential beneficiaries, selected considering identified vulnerabilities, Eastern Region.

MUNICIPALITY	Amancio	Colombia	Jobabo	Total
Variable				**% Average**
Total population supplied by water network	15 651	5 206	10 378	**31 235**
% of total population	40.4	16	23.5	26.6
Total population supplied with piped water permanently	1 686	2 161		**3 847**
% of total population	4.4	6.6		5.5
Total population supplied with water trucks during drought	7 872	2 333	16 324	**26 529**
% of total population	20.3	7.2	36.9	21.5
Total number of people supplied by wells in the territory	2 608	27 331		**29 939**
Total population supplied by individual wells			16 909	**16 909**
Population vulnerable to drought	27 817	37 031	43 611	**108 459**
Households vulnerable to drought	9 272	12 344	14 537	**36 153**

Source: Prepared by the authors based on data provided by the municipalities.

Direct beneficiaries participating in Climate Resilient Agriculture (CRA) activities

126. The CRA practices proposed in this project involve natural systems, households and communities, and imply a paradigm shift in the PIAs as they will include conservation, sustainable management, and restoration of natural ecosystems. The selected area in the seven municipalities in which the project will implement the CRA modules correspond to 35,734 hectares and directly benefit 51,098 people, representing farmers who are members of agricultural cooperatives in the target municipalities and their household members. Table 24 below presents the six modules proposed and the experiences on which they were built (For detailed information, see Appendix 2.6).

Table 24. Names of modules and previous experiences.

	Module	Name / description	Previous implementation in Cuba

1	CEDPLA	Agroforestry system with cedar / plantain	Grupo Empresarial "Tabacuba"
2	MARREG	Management of natural regeneration of native arboreal species	Bosque Modelo Sabanas de Manacas (BMSM)
3	MARFOM	Establishment of close-to-nature planted forests	Bosque Modelo Sabanas de Manacas (BMSM) and in the Empresa Agroforest (EAF) Las Tunas.
4	FRUAGR	Agroforestry system with fruit trees, agricultural crops and living fences	Finca Los Velásquez. Las Tunas and El Aguacate, Santo Domingo.
5	SILLEC	Silvopastoral system with arbustive leguminous	Instituto de Ciencia Animal (ICA) Institute of Animal Science
6	SILSOM	Silvopasture with shadow trees and protein banks	Instituto de Investigaciones de Pastos y Forrajes (IIPF)

127. MINAG prepared a detailed database with information on cooperatives and their members and other entities in the agricultural sector in the PIAs.[64] The database on which selection of beneficiaries is based identifies the number of farmers per entity willing to implement the modules presented in Table 24. The information prepared by MINAG for the IRES project is presented in Tables 25–27 (below).

128. Tables 25–a and 25–b show the number of people who will directly benefit from implementation of the modules proposed in the project.

Table 25a. Number of farmers participating in implementation of each module.

BENEFICIARIES	CEDPLA	FRUGAR	MAGREG	MARFOM	SILLEG	SILSOM	TOTAL
TOTAL	**946**	**2470**	**1459**	**648**	**5432**	**5013**	**15968**
PERCENTAGE	**5.9%**	**15.5%**	**9.1%**	**4.1%**	**34.0%**	**31.4%**	
TOTAL OF WOMEN	**174**	**542**	**387**	**177**	**846**	**997**	**3123**
% of women	**18.4%**	**21.9%**	**26.5%**	**27.3%**	**15.6%**	**19.9%**	**19.6%**
% of women from total	**1.1%**	**3.4%**	**2.4%**	**1.1%**	**5.3%**	**6.2%**	

129. Adoption of CRA practices and implementation of the proposed modules will directly benefit all household members. Therefore, Table 25b presents the total number of direct beneficiaries of the CRA project activities,

[64] Ministry of Agriculture – MINAG. 2019. Database with information about areas per module / beneficiary and entity for the IRES PROJECT. La Habana, Cuba.

considering an average number of 3.2 people per household.[65] While 19.6% of beneficiary farmers are women, 46% of the population in households in the implementation area are women (see Annex 8 on Gender Analysis for more information), so it is understood that 46% of the total direct beneficiaries of this project are women.

Table 25b. Total direct beneficiaries .

BENEFICIARIES	CEDPLA	FRUGAR	MAGREG	MARFOM	SILLEG	SILSOM	TOTAL
TOTAL	**3027**	**7904**	**4669**	**2074**	**17382**	**16042**	**51098**
TOTAL WOMEN	**1392**	**3636**	**2148**	**954**	**7996**	**7379**	**23505**
Total number of people = Selected farmers x 3.2 family members/household **Total number of women= 46% of women per household**							

130. Table 26 shows the number of beneficiaries implementing each of the modules in the seven project-targeted municipalities.

Table 26. Beneficiaries by municipality and province.

Province and municipality	CEDPLA	FRUGAR	MAGREG	MARFOM	SILLEG	SILSOM	TOTAL	%
Las Tunas	**750**	**1611**	**164**	**159**	**2544**	**1669**	**6897**	43.2%
Amancio		548		159		1669	2376	14.9%
Colombia	31	84	164		542		821	5.1%
Jobabo	719	979			2002		3700	23.2%
Matanzas	**79**	**119**	**50**	**88**	**198**	**174**	**708**	4.4%
Los Arabos	79	119	50	88	198	174	708	4.4%
Villa Clara	**117**	**740**	**1245**	**401**	**2690**	**3170**	**8363**	52.4%
Corralillo	117	16	9	176	2116	1618	4052	25.4%
Quemado de Güines			524		240	123	887	5.6%
Sto Domingo		724	712	225	334	1429	3424	21.4%
Total	**946**	**2470**	**1459**	**648**	**5432**	**5013**	**15968**	
PERCENTAGE	5.9%	15.5%	9.1%	4.1%	34.0%	31.4%		

131. Tables 27–a and 27–b present the number of farmers implementing each one of the modules in each cooperative targeted by the project:

Table 27–a. Number of farmers implementing the proposed modules in each cooperative.

ENTITY	CEDPLA	FRUGAR	MAGREG	MARFOM	SILLEG	SILSOM	TOTAL
CCS El Vaquerito	12	36			81		129

[65] National Office of Statistics and Information- ONEI. 2012. Population and Housing Census 2012- National report- Final results of selected indicators in Cuba, Provinces and Municipalities. http://www.one.cu/informenacional2012.htm

CCS Lázaro Peña	6						6
CCS Roberto Reyes	10						10
CCS Abel Santa María		91			18		109
CCS Amado Mesa		9				8	17
CCS Amistad Cuba Viet Nam		12				36	48
CCS Anastasio Quiñones		58				146	204
CCS Antonio Fernández					168		168
CCS Antonio Maceo		4			140		144
CCS Armando Perera		16					16
CCS Camilo Cienfuegos		19				119	138
CCS Cándido González		6			5		11
CCS Clemente Cardenas		9					9
CCS Conrrado Benitez		20			7		27
CCS David Diaz		13				38	51
CCS Diosdado Perez		16					16
CCS Frank País			73				73
CCS George Aleaga		210			256		466
CCS Heriberto Tabio						146	146
CCS Hernán González		119				57	176
CCS Jesús Menendez		17					17
CCS José Martí		12					12
CCS José Oviedo Chacón		62				174	236
CCS José Ramírez Cruz					8		8
CCS Julio Antonio Mella	57	27			9		93
CCS Lazaro Penton						79	79
CCS Lázaro Peña		12			2		14
CCS Leonel Martí						84	84
CCS Lino Álvarez		63				135	198
CCS Manuel Azcunce		16					16
CCS Martir del Moncada						8	8
CCS Mártires de Pino 3						115	115
CCS Nelson Veitia						49	49
CCS Osvaldo Figueredo	205				178		383
CCS Ovidio Rivero		20				117	137
CCS Pedrito Morejón		24					24
CCS Pedro Julio Marcelo						119	119
CCS Pedro Lantigua						19	19
CCS Pedro San Martin					12	19	31
CCS Protesta de Baraguá		130					130
CCS Quintin Banderas		24	220			128	372
CCS Ramón Ruiz del Sol						10	10
CCS René Almansa						63	63

CCS Roberto Reyes					8		8
CCS Rogelio Rojas					19		19
CCS Romárico Cordero					15		15
CCS Rubén Martin		82				63	145
CCS Ruben Martínez Villena		21				52	73
CCS Sabino Pupo		110				125	235
CCS Saturnino Aneiro						80	80
CCS Simón Bolívar		3			7		10
CCS Victoria de Girón					170		170
CPA 26 de Julio						19	19
CPA Alianza Obrera Campesina						17	17
CPA Camilo Cienfuegos	27				14	82	123
CPA Conrado Benítez	3				6		9
CPA Eligio Fonseca	87						87
CPA Gabriel Valiente	29	7			14		50
CPA Hermanos Castillo					174		174
CPA José Martí	15	17					32
CPA Juan Canino		18				20	38
CPA Luis Ridel Gonzalez	24				36	53	113
CPA Mariana Grajales		83				123	206
CPA Martires de Sto Domingo						40	40
CPA Melanio Ortiz		21			34		55
CPA Nicaragua Libre					34		34
CPA Perucho Figueredo						38	38
CPA Reynaldo Rodríguez	86				32		118
CPA Roberto Reyes						45	45
CPA Rodolfo Ramírez		17					17
CPA Sabino Pupo	32	24					56
CPA Victoria de Girón				5	27	21	53
Empresa Agroforest Matanzas			50				50
Granja Ganadera			54		12	44	110
Granja Pecuaria Sto Domingo						107	107
Niceto Perez					228		228
UBF Adelaida						956	956
UBF Agroforest			470	348			818
UBF Agroforest Colombia			164				164
UBF Agroforest Corralillo			9				9

UBF Agroforest los Arabos		62			92	108	262
UBF Agroforest Sto Domingo		75					75
UBF Agropecuaria		16					16
UBF Flora y Fauna				67			67
UBF Forestal Amancio				159			159
UBF Integral					322		322
UBF Integral Agropecuaria						126	126
UBF Integral Melanio Ortíz	252				442		694
UBF San Pedro					390	468	858
UBF Silvicola Sto Dgo			308				308
UBPC 26 de Julio					84		84
UBPC Aguas Dulces	24				106		130
UBPC Alvaro Morel						50	50
UBPC Amado Arocha		44	72		78	41	235
UBPC Antonio Maceo						52	52
UBPC Batalla de Santa Clara				5			5
UBPC Bermejal						110	110
UBPC Cascajal			39		92	123	254
UBPC Combate de la Federal					6		6
UBPC Delicias		110				48	158
UBPC El 55		78					78
UBPC Everaldo Saez		145					145
UBPC Fe del Valle	18				25	20	63
UBPC Fernando de Dios					53		53
UBPC Israel Ruiz					122	121	243
UBPC Jaime Hugo Vilellas		25					25
UBPC Las Brisas	17				13	20	50
UBPC Las Margaritas		120					120
UBPC Llabre					874		874
UBPC Pedro Plaza						45	45
UBPC Primero de Enero		86			258		344
UBPC Progreso	42			21	18		81
UBPC Protesta de Baragua				43	317		360
UBPC Ramiro Núñez		70			29		99
UBPC Ricardo Gonzáles		42				44	86
UBPC Rolando Rubio		98					98

UBPC Rosendo Arteaga		51			153		204
UBPC San Andres					42	83	125
UBPC Santa Rita					162		162
UBPC Sociedad					40		40
Total	**946**	**2470**	**1459**	**648**	**5432**	**5013**	**15968**
PERCENTAGE	5.9%	15.5%	9.1%	4.1%	34.0%	31.4%	

Table 27–b. Number of women implementing proposed modules in each cooperative.

ENTITY	CEDPLA	FRUGAR	MAGREG	MARFOM	SILLEG	SILSOM	TOTAL
CCS El Vaquerito	6	15			21		42
CCS Lázaro Peña	3						3
CCS Roberto Reyes	3						3
CCS Abel Santa María		4			5		9
CCS Amado Mesa		4				2	6
CCS Amistad Cuba Viet Nam		4				10	14
CCS Anastasio Quiñones		18				26	44
CCS Antonio Fernández					24		24
CCS Antonio Maceo		1			9		10
CCS Armando Perera		4					4
CCS Camilo Cienfuegos		1				16	17
CCS Cándido González		1			1		2
CCS Clemente Cardenas		2					2
CCS Conrrado Benitez		7			2		9
CCS David Diaz		5				10	15
CCS Diosdado Perez		3					3
CCS Frank País			22				22
CCS George Aleaga		25			25		50
CCS Heriberto Tabio						26	26
CCS Hernán González		16				9	25
CCS Jesús Menendez		5					5
CCS José Martí		4					4
CCS José Oviedo Chacón		8				24	32
CCS José Ramírez Cruz					0		0
CCS Julio Antonio Mella	2	12			2		16
CCS Lazaro Penton						13	13
CCS Lázaro Peña		6			1		7
CCS Leonel Martí						8	8
CCS Lino Álvarez		21				35	56
CCS Manuel Azcunce		5					5

CCS Martir del Moncada						3	3
CCS Mártires de Pino 3						21	21
CCS Nelson Veitia						14	14
CCS Osvaldo Figueredo	54				54		108
CCS Ovidio Rivero		8				35	43
CCS Pedrito Morejón		5					5
CCS Pedro Julio Marcelo						43	43
CCS Pedro Lantigua						7	7
CCS Pedro San Martin					3	3	6
CCS Protesta de Baraguá		20					20
CCS Quintin Banderas		7	66			30	103
CCS Ramón Ruiz del Sol						3	3
CCS René Almansa						14	14
CCS Roberto Reyes					2		2
CCS Rogelio Rojas					7		7
CCS Romárico Cordero					5		5
CCS Rubén Martin		8				21	29
CCS Ruben Martínez Villena		7				13	20
CCS Sabino Pupo		40				40	80
CCS Saturnino Aneiro						30	30
CCS Simón Bolívar		1			2		3
CCS Victoria de Girón					30		30
CPA 26 de Julio						1	1
CPA Alianza Obrera Campesina						5	5
CPA Camilo Cienfuegos	3				6	20	29
CPA Conrado Benítez	1				2		3
CPA Eligio Fonseca	15						15
CPA Gabriel Valiente	11	4			6		21
CPA Hermanos Castillo					3		3
CPA José Martí	7	7					14
CPA Juan Canino		2				2	4
CPA Luis Ridel Gonzalez	9				3	5	17
CPA Mariana Grajales		18				27	45
CPA Martires de Sto Domingo						10	10
CPA Melanio Ortiz		8			8		16
CPA Nicaragua Libre					6		6

CPA Perucho Figueredo						9	9
CPA Reynaldo Rodríguez	5				5		10
CPA Roberto Reyes						11	11
CPA Rodolfo Ramírez		5					5
CPA Sabino Pupo	6	6					12
CPA Victoria de Girón				2	3	2	7
Empresa Agroforest Matanzas			30				30
Granja Ganadera			6		0	6	12
Granja Pecuaria Sto Domingo						17	17
Niceto Perez					68		68
UBF Adelaida						116	116
UBF Agroforest			110	71			181
UBF Agroforest Colombia			38				38
UBF Agroforest Corralillo			3				3
UBF Agroforest los Arabos		20			26	36	82
UBF Agroforest Sto Domingo		12					12
UBF Agropecuaria		5					5
UBF Flora y Fauna				21			21
UBF Forestal Amancio				63			63
UBF Integral					92		92
UBF Integral Agropecuaria						24	24
UBF Integral Melanio Ortíz	18				92		110
UBF San Pedro					33	72	105
UBF Silvicola Sto Dgo			84				84
UBPC 26 de Julio					16		16
UBPC Aguas Dulces	6				3		9
UBPC Alvaro Morel						15	15
UBPC Amado Arocha		8	17		12	9	46
UBPC Antonio Maceo						4	4
UBPC Batalla de Santa Clara				3			3
UBPC Bermejal						22	22

UBPC Cascajal			11		22	33	66
UBPC Combate de la Federal					2		2
UBPC Delicias		24				12	36
UBPC El 55		23					23
UBPC Everaldo Saez		48					48
UBPC Fe del Valle	6				7	7	20
UBPC Fernando de Dios					7		7
UBPC Israel Ruiz					23	36	59
UBPC Jaime Hugo Vilellas		7					7
UBPC Las Brisas	7				4	7	18
UBPC Las Margaritas		19					19
UBPC Llabre					74		74
UBPC Pedro Plaza						6	6
UBPC Primero de Enero		8			24		32
UBPC Progreso	12			5	0		17
UBPC Protesta de Baragua				12	27		39
UBPC Ramiro Núñez		16			5		21
UBPC Ricardo Gonzáles		7				9	16
UBPC Rolando Rubio		17					17
UBPC Rosendo Arteaga		11			33		44
UBPC San Andres					7	18	25
UBPC Santa Rita					27		27
UBPC Sociedad					7		7
Total	**174**	**542**	**387**	**177**	**846**	**997**	**3123**
% of women in total number of farmers	1.1%	3.4%	2.4%	1.1%	5.3%	6.2%	19.6%

Part 2. Policy and institutional framework

2.1 Policy commitments

132. Cuba has signed the majority of international environmental instruments to date, including the Vienna Convention for the Protection of the Ozone Layer in 1992; the Montreal Protocol on Substances that Deplete the Ozone Layer (also in 1992); the 1994 United Nations Framework Convention on Climate Change; the 2002 Kyoto Protocol of the United Nations in the Framework Convention on Climate Change, and the Paris Agreement in 2017 (also under the United Nations Framework Convention on Climate Change), among others.

133. From 1995 to 2013, a number of basic science programs were implemented for the SNC: “Global Changes and the Cuban Environment” (1995–2010) and “Terrestrial and Spatial Climate and Weather Forecast and Analysis” (1999–2012). The results informed decision-making processes at various levels.

Climate change was a priority under these programs, which delivered important scientific results that have enriched CC knowledge. Since 2012, a new national scientific program is under implementation called “Climate Change in Cuba: Impact, Mitigation and Adaptation.” All these programs have supported implementation of the UNFCCC in Cuba and have contributed results and resources to the process of preparation of national communications. The country is also developing a program to address climate change. It monitors the implementation of activities related to compliance with the convention at the Executive Committee of the Council of Ministers.

134. Cuba presented its intended nationally determined contributions (INDCs) on 23 November 2015. They are conceived as an on-going process to address climate change, which began in 1992 and continues today under the principles and mandates of the convention, particularly the differentiated obligations stipulated in Article 4. The INDCs consider adaptation as the main country priority and emphasize reducing coastal and human-health vulnerability, recovering mangrove areas, and incorporating adaptation dimension into programs / plans / projects related to food production, integrated water management, land-use planning, forestry, fisheries, tourism and health.

135. A survey of the regulatory framework related to environmental management, biodiversity and natural resources was conducted and the most relevant regulations are summarized in Table 28.

Table 28. Relevant regulatory framework for environmental analysis of project.

Legislation	Scope of application
Law 81/1997. Environmental Law	General environmental
Decree Law 200 /1999. Environmental violations 1999	General environmental
Resolution 111/2002. Bases for the functioning of the National System of Environmental Monitoring, of the Ministry of Science, Technology and Environment.	Environmental monitoring
Resolution 135/2004. Regulation for obtaining the National Environmental Recognition of the Ministry of Science, Technology and Environment.	Environmental diagnosis
Resolution 103/2008. Regulation of the state inspection of environmental regulatory activity, Ministry of Science, Technology and Environment.	Environmental inspection
Resolution 136/2009. Regulation for the integrated management of hazardous waste, Ministry of Science, Technology and Environment.	Hazardous waste management (including pesticides)
Joint Resolution MINSAP-MINAG “Rulebook containing the dispositions to regulate the use of formula pesticides in the national territory, and the extension of the functions and structure of the Central Register of Pesticides and of the Specialist Advisory Committee attached to that Register," 2007	Pesticide management

Resolution 132/2009. Regulation of environmental impact assessment process. Ministry of Science, Technology and the Environment.	Environmental management
Resolution 111/96. Biodiversity Regulations. Ministry of Science, Technology and Environment.	Biodiversity
Decree Law 201/ 1999. the system of protected areas	Biodiversity
Resolution 160/2011. Regulations for the control and protection of species of special significance for biological diversity in the country, of the Ministry of Science, Technology and Environment.	Biodiversity
Decree Law No.212/2000. Coastal Zone Management.	Coastal zone management
Decree 280/2007. Commissions of the Turquino Plan, reforestation system and National Council of Hydrographic Basins.	Watershed and forest management
Decree 21/1978. On Territorial Planning	Territorial planning
Decree 179/1993. Protection, Use and Conservation of Soils [66]	Soil management
Cuban Standard XX:2011. Sustainable Land Management: Terms and Definitions	Soil management
Decree 199/1995. Contraventions of regulations for the protection and rational use of hydraulic resources.	Water management
Resolution 287/2015. On water consumption indices, National Institute of Hydraulic Resources	Water management
Law 124/ 2017. On terrestrial waters	Water management
Law 85/1998. Forestry	Forest management
Decree 268/1999, Contraventions of forestry regulations	Forest management
Resolution 1/ 2000, Establishment of the Forestry Development Fund, Ministry of Finance and Prices-Ministry of Agriculture	Forest management and financing
Resolution 873/2007. National Reforestation Commission, Ministry of Finance and Prices-Ministry of Agriculture	Forest management
Joint Resolution 1/2012. On the income supporting the National Fund for Forest Development, Ministry of Finance and Prices - Ministry of Agriculture	Forest management and financing

[66] (http://juriscuba.com/wp-content/uploads/2015/10/Ley-No.-085-Forestal.pdf).

Resolution 768/2012. Manual of Procedures complementary to the Regulation of the National Fund for Forest Development, Ministry of Finance and Prices - Ministry of Agriculture.	Forest management and financing
Directive 1/2010. For planning, organizing and preparing the country for disaster situations.	Environmental risks and disasters
Decree 175/1992. Regulations on the quality of seeds, and their contraventions.	Plant genetic resources
Resolution 159/1993. Functioning of the National Plant Genetic Resources System, Ministry of Agriculture	Plant Genetic Resources
Decree 176 "Protection of Beekeeping and Melliferous Resources and their Contraventions," 1992	Animal genetic resources
Law 1279/1974. Law and Regulation of Livestock and Pure Breed Registries	Animal genetic resources
Resolution 462/2008: Regulations for the control of large livestock	Animal genetic resources
Decree-Law 190/ 199. On Biological Security	Biological safety
Decree Law 137 / 1993, On Veterinary Medicine	Animal health
Decree 169/1992 Contraventions of plant health regulations	Plant health
Decree Law 153/ 1994, Plant Health Regulations	Plant health
Joint MINSAP-MINAG Resolution: Regulation containing provisions regulating the use of formulated pesticides in the national territory and the extension of the functions and structure of the National Register of Pesticides and of the advisory committee of specialists attached to that register	Plant health pesticides
Decree-Law 259/2008 Delivery of idle state lands as usufruct	Land tenure
Decree - Law 300/2012. On the handover of idle state lands as usufruct.	Land tenure
Decree-Law 358/18 and its Regulation 350/18. Delivery of idle state lands as usufruct.	Land tenure
Law 41 "On Public Health" 1983	Human health
Decree-Law 200 /1999. Contraventions in environmental matters 1999	Environmental crimes
Civil Code Act 1987	Environmental crimes

Law 62 Penal Code 1987	Environmental crimes
Labor Code, 2013	Employment and wages

136. Below is a brief description of the most relevant of the above-listed laws and policies:

2.1.1 Climate change policies

137. National Environment Strategy 2007–2010, the guiding document for Cuban environmental policy, defines the five main environmental issues in the country (land degradation, factors affecting forest coverage, pollution, loss of biological diversity, and water scarcity) and proposes policies and instruments for their prevention, solution or minimization in order to improve environmental protection and rational use of national resources.[67] The latest update of this strategy (2011–2015) notes that climate change is one of the most pressing environmental problems in Cuba and its vision statement includes: "to achieve conservation and sustainable use of natural resources, environmental awareness and population wellbeing; ensuring adaptation to climate change."

138. The First National Program for Combating Climate Change "Programa de Enfrentamiento al Cambio Climático (PECC)" - ratified by the Cuban Parliament in December 2009- outlines Cuba's adaptation strategy around the need to guarantee in particular the rational use and protection of water and soil resources; the conservation and protection of coastal and mangrove areas; the improvement of Cuban agriculture; the conservation and protection of forest resources, land use planning with emphasis on human settlements, and the protection of biodiversity. The PECC, coordinated by CITMA and its Executive Environmental Agency (AMA), has the mission to ensure that the science-based environmental dimension is included in the development and implementation of all the climate change adaptation actions.

139. In November 2015, Cuba presented its Nationally Determined Contribution (NDC) to the UNFCCC that mentions six priority actions for climate change adaptation:

1. Reduce coastal vulnerability of the settlements threatened by sea-level rise, decline and flooding.
2. Recover the most affected mangrove areas of the Cuban archipelago and halt deterioration of coral reef ridges.
3. Incorporate adaptation measures into programs, plans and projects related to food production, integrated water management, land management, forestry, fisheries, tourism and health.

[67] For example: National Environmental Law (Law 81), National Forestry Law (Law 85), Law for Management of Coastal Areas; Law (179/93, decree) for Protection, Use and Conservation of Soils; Law for terrestrial water (Law 138- decree), Rational Use and Water Saving Program (since 2005), which aims to promote new forms and habits of water consumption as a way to reduce indiscriminate use and ensure their protection; Soil Improvement and Conservation Program (launched in 2000), with the aim of halting degradation of soils and creating conditions that allow gradual rehabilitation of soils; Program to Combat Desertification and Drought, (in implementation since 2000), with the objective of linking factors, processes and ecosystems that are in a constantly interacting nature, based on Sustainable Land Management;

4. Form environmental monitoring network to enable systematic evaluation of climate features and environmental trends for decision-making.

5. Reduce vulnerability in public health sector, based on better understanding of relationships between climate variability, climate change, and human health in two essential areas: infectious diseases and surveillance / early-warning systems in public health sector.

6. Supporting and developing comprehensive research to protect, conserve and rehabilitate the environment and adapt environmental policies to new projections of the economic and social environment in Cuba.

140. The NDC also mentions that the two priority sectors for reducing GHG emissions are the agricultural and energy sectors. Cuba's contribution to global emissions of greenhouse gases is minimal, and does not exceed 0.08% of the total emissions. The energy and agricultural sectors account for 76% and 15% of the country's emissions, respectively. The forest sector has shown sustained growth – forest coverage increased from 14% of the country's surface area in 1959 to 29% in 2013. Currently, it is estimated that Cuban forests have a sequestration capacity of approximately 14.3 million ton of CO_2 per year, according to data from the latest GHG inventory.

141. The country does not currently have NAPS and NAMAS, however, a NAMA in the pig farming sector is currently under development. It should be noted that since 1960, it has been extremely difficult for Cuba to access external financing sources for this type of processes due to the economic embargo imposed by the United States.

142. In April 2017, the Council of Ministers (*Consejo de Ministros*) approved the National Plan for Tackling Climate Change "*Tarea Vida: Plan de Estado para el enfrentamiento al cambio climático"* [national plan to confront climate change] (hereafter *Tarea Vida*). *Tarea Vida* is a comprehensive plan that sets national priorities in the short- (2020), medium- (2030) and long-term (2050 and 2100), which includes assessing and updating policies such as the Environmental Law (Law 81) and National Decree for Coastal areas. *Tarea Vida* includes five priority actions, two of which directly address adaptation in the agricultural sector,[68] with 11 activities focused particularly on coastal and agricultural areas. The plan also prioritizes, based on scientific studies, areas for implementation in the short-term.

2.1.2 Soil management policies

143. **Soil improvement and conservation program**, implemented since 2000, aim at mitigating degradation of soils and creating conditions that allow gradual soil rehabilitation. The program's annual budget finances implementation of soil conservation and improvement activities; the main beneficiaries are the producers, who have received more than 200 million CUPs to date.[69]

144. In order to provide greater attention and prioritize the problem in 2010, the Demonstration Polygons for the Improvement and Conservation of Soil, Water and Forest were established to develop capacities to address the effects of climate change, applying technologies with a focus on sustainable agriculture,

[68] Adapt agricultural and livestock activities (particularly those with greatest impact on Cuba's food security) to changes in land use as a result of sea level rise and drought; and reduce crop coverage in saline-affected coastal area and diversify crops, improve soil conditions, introduce and develop varieties resistant to new temperature scenario.
[69] Riverol and Aguilar, 2015.

starting with the farm as the basic unit of management and with special attention to the water basin as a physical-geographical space to be protected. At the end of 2015, there were 35 provincial polygons and 123 municipal polygons for an effective area of 30,889 ha in 1 893 farms, distributed in 61 CCS, 20 CPAs, 34 UBPCs, 26 UEBs, 6 state farms, and seven seed farms that represent the soils, edaphoclimatic regions, crops, and most important MINAG programs.

145. Program to combat desertification and drought, implemented since 2000, with the aim of linking factors, processes and ecosystems found in nature in constant interaction, based on Sustainable Land Management (MST), to obtain goods and sufficient and quality services, without compromising the status of renewable natural resources and their capacity to recover once the human pressure to extract their benefits has ceased (www.educambiente.co.cu).

146. Country association program supporting the national action program to combat desertification and drought (CPP). The program seeks to increase national capacities to adopt sustainable land management and offers technological alternatives that help halt, prevent or remedy the degradation of agricultural lands. It is financed by the Global Environment Facility (GEF) and involves UNDP, UNEP and FAO in various roles and has as a national coordinator CITMA's Center for Information, Management and Environmental Education. The program began in 2008 and has five projects with a budget of USD 10 million.

2.1.3 Forestry policies

147. **National forest program** has the objective of expanding the country's forest cover by up to 34% by 2030.

148. **The National Fund for Forest Development (FONADEF).** Founded in the year 2000, FONODEF provides financial support for establishment of long-rotation productive forest plantations, including inputs such as seeds and plants; short-rotation plantations when these are in the interest of the State; and silvicultural treatments and restoration or enrichment of forests when management costs exceed the value of the timber produced.

2.1.4 Water and irrigation policies

149. **Rational use and water-saving program**. Since 2005, this program has aimed at promoting new forms and habits of water consumption as a way to reduce indiscriminate use and ensure protection (www.hidro.cu).

Table 29. Main agro-environmental policies, strategies, programs and plans of the Ministry of Science, Technology and Environment.

Agenda issue	Policies	Objectives
Land degradation	Soil policy. National Soil Improvement and Conservation Program. Idle land handout policy.	Contribute to the country's food security through the development of sustainable agriculture. Strengthen soil monitoring capacities in Cuba. Reducing the impacts of climate change on agriculture by strengthening the implementation of adaptation and mitigation measures.

	Urban, Suburban and Family Agriculture Program. Bio-pesticides and bio-fertilizers program.	
Forest cover	Forestry and wildlife policy. National Forest Program. Fire Management and Management Strategy 2015–2020. National System of Protected Areas Plan 2014–2020. National Biodiversity Program 2015–2020. Strategy for Invasive Alien Species.	Continue to increase the country's forest cover according to the identified potential area. Prevent forest and rural fires. Decrease the pressure on natural forests and fragile areas. Reduce the impacts of climate change by strengthening the implementation of adaptation and mitigation measures. Control and manage invasive alien species.
Biodiversity loss	National Biodiversity Program 2015–2020. Fire Management and Management Strategy 2015–2020. National System of Protected Areas Plan 2015–2020. Strategy for Invasive Exotic Species. Forestry and wildlife policy.	Address the underlying causes of biodiversity loss. Promote the conservation of ecosystems, habitats, species and genes. Promote the restoration and conservation of ecosystems that provide essential services for all. Improve national capacities for the implementation of the National Biodiversity Program and Action Plan 2015–2020. Promote acknowledgement of ecosystem goods and services.
Water availability and quality	Water policy. National Water Program 2015–2020.	Promote the rational and productive use of water in function of socioeconomic development. Improve the quality of drinking water supply services, contributing to human health. Ensure integrated and sustainable water management by river basins with a view to their availability, protection and maintenance of the ecosystem. To reduce the impacts of climate change on the management of water resources by promoting the implementation of adaptation and mitigation measures.

2.2 Institutional framework

150. The institutional capacity linked to confronting climate change and sustainable resource management in Cuba is strong, made up of a large number of state agencies of the central administration (OACE), universities, research institutes, agricultural enterprises, cooperatives, and individual producers. All agencies involved, especially the Ministry of Agriculture (MINAG) and agricultural production cooperatives (CPAs), basic cooperative production units (UBPC) and credit and services cooperatives (CCS), as well as non-governmental organizations (especially ANAP, which is made up of private farmers) participate widely in the design, dissemination and application of conservation agricultural practices and techniques, and comply with the measures derived from the agro-environmental policy within the framework of their competences; immediately taking the measures within their reach or demanding the participation of higher levels if necessary.

151. The CCSs, CPAs and UBPCs are estimated to control more than 74% of the arable land and produce around 78% of the country's agricultural production.

152. Likewise, cooperatives, small farmers, usufructuaries, tenants, and other forms of non-state management are other actors to intervene at the local level (municipalities), through the Popular Councils to encourage rural producers' capacities through the improvement of value chains and livelihoods. (Appendix 7 provides a more detailed analysis of the institutions that are relevant to this project).

Organizations of the Central State Administration (OACE)2.2.1 Agriculture institutions:

153. Ministry of Agriculture (MINAG) (http://www.minag.gob.cu/): MINAG is the central state administration agency (OACE) in charge of proposing and implementing policy on the sustainable use, tenure and exploitation of the country's agricultural surface, agricultural and forestry production, to satisfy the needs of the population, industry and exports.

154. Specific MINAG functions associated with natural resources and their management:

- Manage the conservation, improvement and sustainable management of soils and use of fertilizers.

- Help protect the national territory from introduction and spread of plant pests and diseases, to achieve a satisfactory phytosanitary status in the country, exercising registration and control of use of chemical, biological and natural pesticides.

- Help protect national territory from introduction of animal diseases and achieve a satisfactory status of animal health in the country, register and control use of raw materials, products and by-products for these purposes and medicines for veterinary use.

- Implement the policy of genetic development and preservation of gene banks of animal species (both domestic and wild fauna).

- Manage the exploitation and use of agroforestry heritage, including fruit trees; administration and conservation of the national forest fund.

- Promote development of mechanization, irrigation and agricultural drainage systems, validate introduction of new technologies and their efficient exploitation and establish regulations for their technical assistance.

- Direct implementation of the policy of prospecting, conservation, introduction, maintenance, documentation and use of plant genetic resources and seeds in the country.

155. In the process of improvement of MINAG (in which the essence is separation of state functions from business), twelve specific functions have been established for organizations that perform state functions. Linked to the forestry sector, the following must be fulfilled: Specific function #9: Manage use of agroforestry heritage, including fruit trees, and administration of the National Fund for Forest Development (FONADEF).

156. ***MINAG provincial delegations****:* The mission of MINAG's provincial delegations is to control compliance with State and government policies on agricultural and forestry production in the province; ownership and possession of land and its sustainable use; use/conservation/improvement of soils; plant and animal health; registration and statistical control of livestock heritage; control of forest heritage and wild flora and fauna; mechanization, irrigation and agricultural drainage; animal genetics and animal genetic resources; seeds and plant genetic resources; as well as promotion and development of the cooperative movement in the agricultural/sugarcane sector (for more information, see Appendix 7, Section 3.1.4).

157. ***MINAG municipal delegations****:* The mission of the municipal agricultural delegations is to execute, implement and control State and government policies on agricultural and forestry production; ownership and possession of land and its sustainable use; soil use, conservation and improvement; and plant and animal health; registration and physical and statistical control of livestock heritage; control of forest heritage and wild flora and fauna; mechanization, irrigation and agricultural drainage; animal genetics and animal genetic resources; seeds and plant genetic resources; as well as promotion and development of the cooperative movement in the agricultural and sugar sector of the municipality. At the municipal

level, one specific function is to "execute and control use and exploitation of agroforestry heritage, including fruit trees and administration of FONADEF" (function #8; see FONADEF in Paragraph 161 and for further information on MINAG's municipal delegation, see Appendix 7, Section 3.1.5).

158. ***Cooperative system****:* The Cuban cooperative system is made up of three types of cooperatives: credit and service cooperatives (CCS) that emerged in the 1960s, agricultural production cooperatives (CPAs) created in 1976, and basic cooperative production units (UBPCs) constituted in 1993. They are closely related to the population settlements from which their members come. They offer a collective work option, a source of employment generation, and integration. These forms of collective production are regulated by Law No. 95, Chapter II, 14 (see Appendix 7 Section 3.1.6 for more information).

2.2.2 Forestry institutions

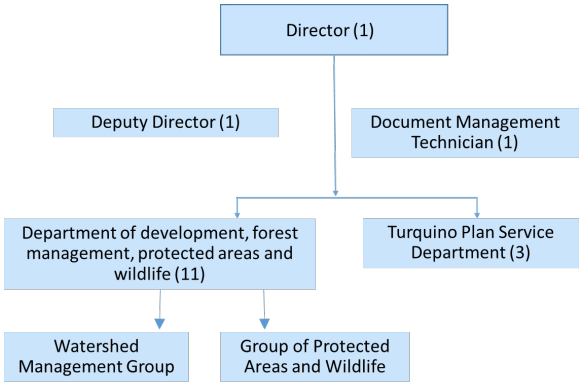
159. ***Forestry, Wildlife and Flora Department (FWFD)****:* FWFD's mission is to propose, implement and monitor national policies on compliance with regulations for the management, sustainable development, protection and conservation of forest heritage and wildlife (first section, article 24, 3.c). The specific functions of the DFFFS appear in the attributions and duties of the Forestry, Wildlife, and Fauna Department. It drafts policies, strategies, long-term and short-term programs and, once approved, exercises control over forest heritage, flora and fauna regulations (for more information, see Section 3.1.2 of Appendix 7).

160. Specific functions include:

- Direct technical, regulatory and methodologically the State Forestry Service and monitor compliance with the functions and powers assigned to it, including inspection and supervision, without prejudice to the administrative subordination of these organs to the territorial and municipal delegations' agency;
- Plan provisions on forest heritage and wild flora and fauna and control;
- Fulfillment of the measures adopted for their protection, increase and sustainable development, as well as of the activity of collection, benefit and forest industry; manage national programs and strategies for sustainable forest development and the conservation of wild flora and fauna;
- Organize and direct the work for the realization and updating of the national forest inventory and control the implementation and execution of forest management in the country;
- Manage FONADEF, control its execution and that of other varying sources of forest financing;
- Joint management (SEF and Ranger Corps), fire prevention measures of a specialized nature and control rehabilitation actions of areas affected by fires or other disasters (natural or not);
- Submit (jointly with CITMA and the National Institute of Hydraulic Resources) the control measures for protection of watersheds, through the conservation, improvement or establishment of forests, and control their compliance;
- Present together with the CITMA the necessary regulations for the areas declared as "areas under special protection regimes" and control compliance;

- Help identify the forest species and wildlife threatened or endangered according to the results of the studies and investigations conducted and direct / control the work for their recovery;
- Present and implement the necessary measures for compliance with the conventions and international agreements related to forests and wild flora and fauna. Represent the organism in this matter;
- Exercise the executive secretariat of the National Reforestation Commission (see Appendix 2);
- To exercise, in coordination with the agencies of the Central State Administration, the councils of the Provincial Administration and other institutions, the state control of the country's policy for the integral and sustainable development of the mountainous regions and the Zapata Swamp, in the environmental, economic, productive, social order, infrastructure, living conditions, and tasks related to defense and internal order.

Figure 28. FWFD organizational structure. *



* For more information, see Appendix 7, Section 3.1.2.

161. ***National Forestry Development Fund (FONADEF)****:* FONADEF was created through Forestry Law No. 85/1998, of 21 July 1988, which aims to promote sustainable development of forest resources. FONADEF's objective is to promote and finance projects and activities dedicated to conservation and sustainable use of forestry resources, especially with regard to inventories, management, protection and research (Art. 12). MINAG is responsible for FONADEF's management, through the Forest, Flora and Wild Fauna Department, which steers its execution.[70] FONADEF follows a general methodological procedure for financing sustainable forest management, protection and conservation of wild flora and fauna. FONADEF is to be applied by the directors and specialists of the forestry and finance and Prices departments of MINAG; the economic sub-delegates and finance specialists of MINAG's provincial delegations; the heads and specialists of the state forestry services of the provinces and municipalities;

[70] To provide criteria, FONADEF has a general methodological procedure for the financing of sustainable forest management, protection and conservation of flora and fauna.

and natural and legal persons who conduct activities related to sustainable forest management and protection and conservation of wild flora and fauna that have access to FONADEF. For more information on FONADEF, see Section 3.3 of Appendix 7.

162. Joint Resolution no. 1/2012, indicates that FONADEF will reimburse expenses of forestry activities that comply with set requirements, regardless of form of tenure and who manages the forests. For project approval, applicants must submit to the Municipal Forest State Service projects and technical evaluations that have been valued economically, setting forth the expected outcomes in the form and terms set under forestry law regulations. Reimbursement of activities will be made upon presentation of invoices issued by the executing agencies, when they are partially or wholly completed and have been certified by the Municipal Forestry State service, (Art. 2.1 and Art. 14). Reimbursements are made after one month of submission of certification (Art. 25). According to the resolution, activities eligible to be financed by FONADEF include:

    a) Establishment of long-cycle forest plantations (>7 years for productive purposes), including inputs of seed and positions;

    b) Establishment of short-cycle plantations when they are of the State interest;

    c) Production of positions of State interest;

    d) Silvicultural treatments and reconstruction of forests or enrichment, when handling costs are greater than the value of the extracted wood;

    e) Protective measures against fire/pests/diseases;

    f) Measures and actions for development, conservation and protection of forest-associated flora and fauna;

    g) Development of forestry projects of State interest;

    h) Studies and services necessary for solution of problems related to forestry management;

    i) Promotion, dissemination and training of forestry activities that reflect FONADEF's objectives;

    j) Managing forest for improvement of wooded formations when of State interest;

    k) Forest inventory and management work;

    l) Forest management as part of the protective strips for reservoirs and dams already built;

    m) Incentives to natural or legal persons running plantations, doing forestry and fauna management and carrying out measures for fire protection, up to 30% on technology costs;

    n) Measures of protection and conservation of soils and forest genetic resources;

    o) Construction, repair and maintenance of forestry roads;

    p) Trees outside forests and agroforestry systems;

q) Forestry projects related to the conservation and restoration of landscapes;

r) Other activities related to forestry assets that are expressly authorized by Ministry of Agriculture.

163. ***Agroforestry Group (GAF)****:* MINAG's Agroforestry Business Group is made up of 49 companies and three main productive branches: a) beekeeping; b) coffee, cocoa, coconut; and c) forestry and Henequén (type of Agave), of notable economic importance for the national economy, as well as management of agricultural production, carried out in each company. Complementarily, there is a Development Department, which channels to the productive sectors the research conducted in the institutes through short-, medium- and long-term programs (for more information, see Appendix 7, Section 3.1.3).

Other institutions closely related to the project

2.2.3 Ministry of Science, Technology and Environment (CITMA) and Ministry of Foreign Trade and Foreign Investment (MINCEX)

164. The Ministry of Science, Technology and Environment (CITMA) is the lead agency in the environmental sphere. Its mission is to direct, implement and control State and government environmental policy and its main functions contribute to sustainable development. Although CITMA plays a leading role in control, regulation, integration and coordination of natural resource management, MINAG (responsible for management of soils, forests, genetic resources, flora and wildlife) and the Water Resources Institute (water) also stand out for their role in state functions. CITMA functions sphere include:

- Draft and propose (in coordination with corresponding organisms) the environmental policy and control its fulfillment.
- Develop, improve and control strategies, plans and programs for protection of the environment, rational use of natural resources and prioritized ecosystems, with special attention to integrated management of watersheds, bays / coasts, mountainous areas and protected areas, evaluating their impact on the economy and society.
- Establish and control policies aimed at development of clean production, economic uses of waste, promotion of use of renewable energies, and introduction of certification systems and other forms of environmental recognition.
- Supervise and require the corresponding agencies and organizations to comply with the regulations established for protection and conservation of the environment and rational use of renewable resources.
- Reconcile the discrepancies between the agencies and other entities in relation to protection of the environment and rational use of natural resources, adopting the pertinent decisions or submitting to the government the corresponding proposals for measures in each case.
- Dictate, propose or pronounce (as appropriate), and control application of regulatory measures relating to conservation and rational use of soils, mineral resources, terrestrial and maritime waters, forests, atmosphere, flora and fauna and prevention of pollution in general.

- Direct and control the environmental regulation by means of observance of the requirements and environmental regulations in the plans of territorial ordinance, prior to approval.
- Direct, evaluate and control meteorological, climate, chemical composition and general atmospheric pollution surveillance; environmental radiological surveillance and seismological service, as well as seismic, meteorological and radiological hazard risk studies.
- Direct and control activities relating to protected areas.
- Direct environmental education strategies and programs.
- Propose the policy to be followed for use of nuclear energy. Direct and control its execution and compliance, especially with regard to nuclear energy, research and application of nuclear and radioisotope techniques.
- Regulate, supervise and control measures to ensure safe use of nuclear energy.
- Direct and control strategies and actions for international cooperation in environmental matters and coordinate national participation in relation to these issues in international organizations, agencies and treaties.
- Design and propose biosafety strategy and policies, establishing regulations and supervising measures to ensure compliance.
- Regulate, supervise and control measures that ensure biological security.
- Direct and control application of measures that ensure compliance with international commitments undertaken by the country in areas of the environment, biological safety, use of nuclear energy, and prohibition of chemical weapons.

165. The creation of the Ministry of Foreign Trade of Cuba (MINCEX)[71] in 1961 was an essential factor in the country's economic policy in response to the need of the Cuban state to assume management and control of the country's imports and exports. On 2 March 2009, through Decree Law No. 264, MINCEX was assigned the objective and mission of preparing and proposing to the government the integral State / government policy on foreign trade activity, creation of joint ventures, economic partnerships with other countries, foreign organizations and associations, and investments to be negotiated. MINCEX is responsible for directing, executing, coordinating and monitoring compliance in all entities at the national level, based on development strategies established therein.

2.2.4 Water institutions

[71] (www.minrex.gob.cu/es/mincex)

166. *National Water Resources Institute (INRH):* This agency is responsible for organizing and directing, in coordination with the competent agencies, protection of terrestrial waters, basins, natural watercourses, hydraulic works and installations against pollution hazards, silting and other forms of degradation and deterioration, as well as systematic control of water quality. INRH functions focus on directing, executing and controlling implementation of state and government policies regarding activities of hydraulic resources in the country, including:

- Organize and direct, in coordination with the competent bodies, the protection of terrestrial waters, basins, natural watercourses, hydraulic works and installations against the dangers of pollution, silting and other forms of degradation and deterioration, as well as the systematic control of water quality.

- Determine, with the corresponding organizations, the necessary regulations for the protection of economic and social objectives and the natural environment from the harmful effects that may be caused by terrestrial waters, establishing the actions of organization, assurance and control that guarantee the safety and correct operation of hydraulic installations, works of protection against floods, underground drainage and the capacity of conduction of natural or artificial watercourses.

- Determine and keep updated the country's hydraulic potential, make available to the competent bodies the data and characterization of the hydrological cycle, relating to surface water and groundwater, rainfall and evaporation.

- Propose the strategy of hydraulic development of the country and to regulate and control the activity of project and investments of the hydraulic works that are executed.

- Plan, regulate and control hydraulic resources, as well as the operation, technical surveillance and maintenance of hydraulic works and installations.

- Determine and keep up to date the studies and evaluations of the hydropower potential.

- Regulate and control the activity of aqueduct, sewerage and fluvial drainage.

- Organize and guarantee operation of the national land water registry in which concessions, allocations and permits relating to the use of water and its preservation will be registered, as determined by law.

2.2.5 Private sector

167. ***Banco de Crédito y Comercio [Credit and Commercial Bank] (BANDEC)*** is a partner in the financing and granting of loans. It serves as a link in management of environmental funds.

2.2.6 Research organizations and universities

168. Agroforestry Institute will be a member of the Technical Steering Committee, with expertise in the forestry sector.

169. Pasture and Fodder Institute, with expertise in pasture and fodder management.

170. Animal Science Institute, with expertise in pasture and forage management.

171. Institute of Tropical Fruticulture (IIFT), with expertise in the cultivation of fruit trees.

172. Tropical Viandas Research Institute (INIVIT), with expertise in tropical fruits and plantain/banana cultivation.

173. Institute of Agricultural Engineering (IAGRIC) serves as rector for agricultural machinery and irrigation.

174. The Universities of Matanzas, Villa Clara and Las Tunas are developers of technology and options for the application of scientific knowledge.

2.2.6 Nongovernmental organizations / community-based organizations

175. The ***Cuban Association of Animal Production (ACPA)*** and the ***Cuban Association of Agricultural and Forestry Technicians*** are providers of technical assistance services and organizational development opportunities.

176. The ***National Association of Small Farmers (ANAP)*** represents producers.

177. The ***cooperative system*** is made up of three types of cooperatives: credit and service cooperatives (CCS), which emerged in the 1960s; agricultural production cooperatives (CPA), which were established in 1976; and basic cooperative production units (UBPC), which were constituted in 1993 and are closely related to the population settlements in which their members live; these provide communities with an option for collective work, a source of employment generation, and integration.

178. A ***credit and service cooperative (CCS)*** is a voluntary association of small farmers who own or use their respective land and other means of production, as well as the production they obtain. A CCS is a type of agrarian cooperation through which state-provided technical, financial and material assistance is processed and made available to increase production of small farmers and facilitate their marketing. A CCS has its own legal personality and is accountable for its actions.

179. ***Agricultural production cooperative (CPA)*** is an economic entity that represents an advanced and efficient form of socialist production with its own assets and legal personality, constituted with land and other goods contributed by small farmers, to which other people are integrated, to achieve sustainable agricultural production.

180. ***Basic cooperative production units (UBPCs)*** are units of cooperative production that started in September 1993. They provided an option to alleviate the difficult situation of agriculture in Cuba during the Special Period. They are characterized by collective production and collective means of production. They constitute the predominant form of Cuban agriculture today.

181. These structures allow horizontal collaborative relationships to develop between producers located in project intervention zones where local stakeholders will be identified as UGAF members, including:

> **Farmer leaders:** Capable of proposing, implementing and multiplying their own initiatives and those they receive. They have well-developed production capacities to bring other actors together and they enjoy technical credibility, even though they have limited economic resources to multiply their actions.

Community leaders: Community leaders generally have solid knowledge of local conditions, climate, and degradation of natural resources. They have well-developed capacities to bring other actors together and enjoy political credibility, even though they lack training to perform certain technical functions needed by the project.

Extension workers: Extension workers enjoy technical credibility and the ability to demonstrate use of technologies, despite having limited economic resources and the fact that people with whom they have to interact sometimes lack sufficient capacity to assimilate new technologies. Their relationships with natural resources are indirect but they have a high degree of influence on farmers in relation to sustainable use of resources.

182. These intervention activities will allow communities to grow more resilience and constitute a way to implement the principles of sustainable development with a triple challenge, to: 1) Promote strengthened institutional and knowledge framework to respond to climatic change and plan for development; 2) increase food production through intensification and management of climate-change-adapted practices; and 3) rehabilitate and conserve vulnerable ecosystems and ecosystem services.

183. Cooperatives, small farmers, land users, tenants are also all relevant actors, as well as other forms of non-state management that needs to be considered at the local level (municipalities). The People's Councils can play a role in building capacities through improvement of value chains and livelihoods.

2.2.7 Donors

184. The GoC, in acknowledgement of the role played by foreign investment flows in contributing to the country's sustainable economic development, published "Portfolio of Opportunities for Foreign Investment" to attract foreign investment, which sets forth general and sectoral principles. The Foreign Investment Law (Law No. 118) further stipulates that such foreign investment can be conceived as a financial resource for development of activities that are of interest to the State. Donors who have funded development initiatives related to climate change and/or agriculture include:

Adaptation Fund of the UNFCCC;

Global Environment Facility (GEF);

International Renewable Energy Agency (IRENA);

Abu Dhabi Fund for Development (ADFD);

Ministry of Commerce of China (MOFCOM).

Appendix 7 of this document presents an Institutional Analysis (see Appendix 7, Section 5) as well as detailed information on the political, legal, institutional and regulatory framework relevant to the project (see Appendix 7, Section 4.1.1). Other information on project implementation arrangements is presented in Section 5.6 of this document and Section 5 of Appendix 7.

Part 3: Relevant projects (already completed and underway)

185. The project will integrate critical lessons learned from past and ongoing initiatives that have generated experiences in actions aimed at reducing degradation of productive ecosystems under extreme climatic conditions, some previously implemented by FAO or other government agencies and institutions. The project will incorporate the project's findings and recommendations, focusing on key issues; for example, relationships with producers and rural communities to respond to their needs and increase their resilience to the effects of extreme natural events and climate change; coordination mechanisms successfully implemented; barriers that have affected attainment of goals; timetables for implementation.

3.1 GoC investments

186. Cuba invested 233.7 million CUP[72] nationwide in forest development during 2017 through the National Forest Development Fund (FONADEF; see paragraph 29), 31% of which was spent on forests plantations (see Table 8-a). The primary beneficiaries of FONADEF were state-owned enterprises of MINAG, which received 86% of the resources; followed by farmer cooperatives (12%), and individual landholders (only 0.1%) (see Table 8-b). From 2013 to 2017, FONADEF invested more than 36 million CUP to establish 4,391 hectares of forest plantations in the PR at a relatively high cost of more than 8000 CUP/ha. Modern technologies to be introduced by IRES should reduce the establishment / management costs of planted forests and agroforestry systems and significantly increase availability of environmental public goods and services.

3.2 Previous relevant initiatives

187. FAO will ensure the project builds on previous and existing projects on climate-change adaptation and sustainable food production, including the following (for further detail, see Annex 18 of the Funding Proposal: *Appraisal, due diligence or evaluation report for proposals based on up-scaling or replicating a pilot project*).

- **Coastal Adaptation to Climate Change in Cuba through Ecosystem-Based Adaptation (UNDP/GCF in preparation):** This project integrates three lines of action for effective climate-change adaptation in coastal areas: i) strengthen existing ecosystem structures (Ecosystem-Based Adaptation, EBA); ii) build capacity at community and local government levels for EBA management; and iii) mainstream adaptation to climate change (CC) within territorial institutions responsible for coastal management. The project will enable GoC's implementation of the principal measures of the recently approved *Tarea Vida* (national climate-change-adaptation). It will respond to the CC-related threats affecting Cuban coastal communities that have been prioritized as the most vulnerable population to CC (mainly due to sea level rise and increased intensity of hurricanes). The project will directly benefit 490,773 people and indirectly benefit 1,285,322 people in 20 coastal municipalities by increasing resiliency of coastal landscapes and communities to CC. It will facilitate a shift in coastal adaptation from a traditional risk management with reactive strategies to a preventive approach based on maximizing the natural

[72] CUP: Cuban peso. Official exchange rate for cooperation projects with FAO is 1 CUP = 1 USD.

infrastructure of Cuban coastal zones and their management. Coordination and complementarity with this project will be very important for IRES.

- **Enhance prevention, control and management of invasive alien species (IAS) in vulnerable ecosystems:** This project resulted in a set of good practices, monitoring protocols and methodologies for managing IAS in Cuba. In the GCF project, the good practices to halt the spread and propagation of IAS are being considered as an input. Additionally, the monitoring protocols for *Eucaena* and *marabou* will be utilized during GCF's project implementation, and have been a basis for project design. Finally, the methodologies to apply IAS management plans have been utilized in development of the eight modules and will continue to be used during project implementation.

- **Support for strengthening the socio-productive innovation system in the livestock sector in Cuba. Demonstration actions in Las Tunas (FAO):** This project aims to support the reorganization of the dairy chain into sustainable production and efficient marketing, from creation of economic incentives and efficient distribution and consumption to meeting the basic needs of the most vulnerable population. An efficient techno-economic-productive model will be introduced in the selected demonstration areas to help construct sustainable milk/beef production, with emphasis on strengthening capacities with a gender perspective and bringing technical and research knowledge to the countryside. The project will provide a foundation for development of sustainable livestock management in the SILSOM and SILEC modules, which include livestock, especially in the case of the Las Tunas region, where the conditions of drought and salinity have already been explored by the project.

- **Introduction of New Farming Methods for Conservation and Sustainable Use of Biodiversity, including Plant and Animal Genetic Resources, in Production Landscapes in Selected Areas of Cuba (GEF):** This project will support a landscape production strategy set in agreement by stakeholders, previously identified and mapped, with particular attention to gender and youth, through application of FAO's ecosystem-based "Save and Grow" approach. The varying roles of stakeholders in conservation and use of agrobiodiversity will be analyzed and classified by value chain (agrobiodiversity food products). The project will also promote adoption of sustainable agricultural intensification practices (Save and Grow) at the farm level. And it will promote capacity-building for rural communities, cooperatives and protected areas managers on management, incentives and best practices/technologies, with a gender focus. This will include alternatives such as agro-forestry and silvopastoral systems, conservation agriculture, and sustainable forest management. The cooperatives (mainly related to conservation and use of priority species) will be strengthened by creating experimental pilots and technical services provided for the sustainable management of agricultural production. The project is expected to provide an important contribution to capacity building for planning, budgeting and enforcing the management of productive landscapes and further scaling-up from lessons learned in the project intervention areas. There will be synergies with the GCF project, since both will be working in sustainable agricultural-intensification practices in parallel, opening venues for exchange of information and lessons learned.

- **Environmental basis for local food production (BASAL) (EU):** This project builds on past and on-going experiences with a view to systematize the lessons learned and expand the effective agro-

ecological, low-input and sustainable practices, through reconciliation of three pillars: 1) applied and model-based science; 2) extension networks; and 3) the farmers. The project's objective is to reach the adequate decision-making level and the widest number of food producers, based on the experiences acquired in modernization of local agriculture. This project has set the environmental basis for local food production. This environmental basis (more specifically: adaptation measures for confronting climate change that consider the specific needs of women and men and the different impacts of climate change on both groups, with an emphasis on local food production; use of more resistant species for the purposes of CC; measures for storage, use and capture of water; of soil improvement and conservation; good agroforestry practices and silvopastoral system), as well as the resilience and adaptation measures proposed have been retaken by the GCF project, for the planning of the Modules. The experience gained during the BASAL project on training for local farmers through the "*Fincas Escuela*" [Farm Schools] will be revisited by IRES, to be applied in the farmer field schools (FFS) that will be implemented in the seven municipalities.

- **Project to Strengthen Agro-environmental Policies in Latin American and Caribbean Countries through Dialogue and Exchange of National Experiences (FAO):** This project produced a set of tools that help promote dialogue/knowledge exchange among the actors involved in formulating and implementing policies and strategies on rural development and natural resource management. The goal is to move toward an agro-environmental policy that goes hand in hand with economic/development policies through actions of remediation, mitigation and adaptation as indispensable alternatives for the sustainable development of the country. The project developed a consultative process involving around 30 public and civil-society institutions in general, and about 375 people including Cuban specialists, researchers, farmers, students, innovators, extension agents and decision-makers from 13 provinces. Some of the stakeholders consulted in this project were also part of formulation / design of the GCF FP (especially the Direction of Science, Technology and Environment; the National Company for Flora and Fauna Protection; and several research institutes, including the "Alejandro de Humboldt" Tropical Agricultural Research Institute (INIFAT)). The set of tools and indicators produced in this agro-environmental policy project can also be utilized as a basis to construct the indicators for the landscape-resilience fund.

- **Enhancing Cuba's institutional and technical capacities in agriculture, forestry and other land-use sectors for enhanced transparency under the Paris Agreement. (GCP/CUB/020/CBT) (GEF)**: The project's main objective is to improve monitoring and planning systems for agricultural-sector activities to adapt to the impacts of climate change and address the factors involved in the sector's human-produced GHG emissions in order to promote sustainable development in Cuba. It is an enabling project, which aims to enhance institutional and technical capacities in the country to report mitigation and adaptation actions in compliance with the enhanced transparency framework (ETF) and to integrate knowledge and data into policy and decision-making. All of these outcomes will take place in the agriculture, forestry and other land-use sector. The project's objectives align directly with Activity 8 of *Tarea Vida* and also with Output 3 of GCF IRES Cuba project. More specifically, the methodologies and results of the GEF project will be applied to strengthen institutional capacities to operate and monitor the Landscape Resilience Fund created by the IRES Cuba project. Synergies from both projects are increased by

the fact that both have been designed by and will have active participation of the same national institutions (including CITMA and MINAG).

Part 4. Gaps in service delivery and associated barriers

4.1 Gaps in delivery of a climate-resilient approach

188. There are recognized and consolidated achievements in development of climate-resilient agriculture and forestry, but at the same time there are shortcomings associated with the lack of culture, systematics, discipline and integral approaches. These shortcomings have limited the introduction of science-based results and technology as well as the environmental perspective in policies, plans and programs, especially in the agricultural and forestry sector in terms of achieving sustainable resilient low-carbon agroforestry development in the Cuban agrarian landscape.[73]

4.2 Key barriers

189. Cuba is facing severe *financial*, *technical and institutional* barriers that make it difficult to implement *Tarea Vida* actions and those proposed by the NDCs. In general, institutional staff and producers do not have proper awareness or knowledge of the benefits of integrated landscape management in reducing climate risk, nor do they have the skills to manage climate risk by applying resilience-based agricultural practices and systems. The financial mechanisms available to farmers and producers' organizations do not consider farmers' adaptation needs nor support resilience-enhancing initiatives to manage landscape resources for improved ecosystem services. Youth and women are disadvantaged when it comes to accessing productive resources and training that enables them to address the impacts of climate change. Another relevant factor is that Cuban agricultural and forestry institutions have extremely limited access to international finance so are unable to keep up with agricultural / information / communication technologies that would allow them to effectively support farmers and producers' organizations to implement resilient production systems and restore and enhance ecosystem services (including carbon sequestration).

190. IRES is designed to address the following **barriers** to climate-resilient landscape management and restoration to ensure productive livelihoods and food security for vulnerable people:

Financial barriers:

- Limited access to international finance, innovation and modern technology for integrated, climate-resilient landscape management and restoration at scale.

- Cuban agricultural and forest management institutions cannot implement climate-resilient practices/systems at scale due to scarce fiscal resources that limit access to sufficient equipment, technologies and other inputs.

Technical barriers:

[73] Appendix 2.7, Section 4.

- Institutional staff and producers do not have sufficient awareness or knowledge of the climate-risk-reduction benefits of integrated landscape management nor do they have the skills to manage climate risk by applying resilience-enhancing agricultural practices and systems.

- Lack of instruments and technological / logistical means for extension service workers to transfer information to farmers and local population, including methodological training, modern communication technology, vehicles, and equipment.

Institutional barriers:

- The financial mechanisms available to farmers and producers' organizations – Forest Development (FONADEF) and Soil Conservation (PNCMS) – do not take into consideration the CC-adaptation needs of farmers nor do they support resilience-enhancing initiatives to manage landscape resources for improved ecosystem services.

- Increasing land flight and migration due to lack of financial support and incentives for producers (particularly the young) leads to labor scarcity for productive landscape rehabilitation and food security.

Part 5. Recommendations

5.1 Alternative solutions and selection of the proposed alternative

191. The alternative solutions combine a number of technical interventions to address the following areas of concern:

1. ***Marabou***: Through IRES, low-impact modern machinery, successfully pilot-tested under Cuban conditions, will be introduced to clear *marabou* thickets on vulnerable soils (at high risk of desertification and degradation).[74] *Marabou* wood and biomass, ground up into wood chips, will be evenly distributed on cleared areas to form a mulch layer that will protect soils and restore organic soil content. The area will then be restored through agroforestry systems or Close-to-Nature Planted Forests (CTNPF),[75] applying modules 2–5 described in the table below. International literature has widely documented the multiple ecosystem services provided by agroforestry production systems, indicating their suitability for restoring degraded soils.[76] In addition to increasing resilience to climate change,[77] agroforests can buffer the effects of extreme climate events, lower temperatures, and provide alternative sources of food during

[74] Due to *marabou's* extremely aggressive invasive nature, total mechanical clearing of these areas is projected. Nevertheless, stripe-wise mechanical clearing and successive substitution throughout-shading have also been considered as a management innovation that would most likely increase adaptation benefits even more, but these approaches need to be tested (and up-scaled) during implementation.

[75] Close-to-Nature Planted Forests (CTNPF) are established with more than one tree species, often native, adapted to the site and its ecological conditions. These forests are often vertically structured in more than one layer and may be unevenly aged. They provide a wide range of products and environmental services and are more resilient to external disturbances (Kanowski, 1997, in FAO 2009).[75]

[76] Miccolis Andrew et al. 2017: Restoration through agroforestry: options for reconciling livelihoods with conservation in the Cerrado and Caatinga biomes in Brazil. Cambridge University Press doi:10.1017/S001447971700013

[77] Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P. and Rist, S. (2013). Agroecosystem resilience and farmer's perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. Renewable Agriculture and Food Systems 30(2):170–183.

droughts or floods.[78] Moreover, agroforests are known to improve the microclimate,[79] and are effective at controlling erosion and landslides and producing organic matter and recycling nutrients.[80] Agroforests have also been shown to regulate water quantity and availability, improve water quality, increase groundwater recharge, and provide riparian buffers.[81] They also provide socio-economic benefits: productive landscapes with multifunctional forests open promising options for sustaining livelihoods.[82] They enable diversified production systems because of various intercrops, and reduce risks associated with pests and diseases, while also enabling wider diversity of products, which reduces the ebb and flow of seasonal harvests.[83]

2. **Grasslands**: In addition, 11,565 hectares of degraded grasslands on areas at high risk of desertification and degradation have been identified in the project area, growing on compacted soils, often with a hard-pan layer, which effectively blocks root growth because of physical resistance and poor movement of moisture. These compacted soils shed rainfall, causing water runoff and erosion. During dry periods, the hard-pan is an impermeable barrier to groundwater reserves. To loosen the soil and break the hard-pan, IRES will introduce deep tillage technology designed for conservation agriculture,[84] which will restore the soils pore system, so that rainfall can be absorbed and excess moisture can be drained away, recharging groundwater tables and making groundwater accessible to roots during dry periods. Soil structure improvement, introduction of trees and improved, more drought resistant and nutrient rich pastures, as grazing rotation will be achieved through implementation of silvopastoral systems described in modules 6 and 7 in the table below.

192. Project activities will focus on the 27 CPs classified as “most vulnerable and vulnerable” where climate change affects the livelihoods of the most vulnerable households (Appendix 2.4, Tables 37–50). This area overlaps in a good part with land area covered with Marabou or degraded grassland (Figure 27 in Part 1 of this document). The selected area in which the modules will be implemented in the seven municipalities during the project execution period total 35 734 ha of this surface.

193. The modules that will be brought to scale through IRES have been assessed for their technical, financial and social feasibility[85] (Please see Appendix 2.6 for detailed information on the modules that will be implemented). They are based on local best practices, applied research results from national institutions and have been thoroughly assessed for their climate resilience and adaptation benefit. Additionally, the modules were presented, discussed and adjusted during two consultation workshops with the active

[78] Lasco, R. D., Delfino, R. J. P. and Espaldon, M. L. O. (2014). Agroforestry systems: Helping smallholders adapt to climate risks while mitigating climate change. Wiley Interdisciplinary Reviews: Climate Change 5:825–833.
[79] Kandji, S. T., Verchot, L. V., Mackensen, J., Boye, A., Noordwijk, M., Tomich, T. P., Ong, C., Albrecht, A. and Palm, C. (2006). Opportunities for linking climate change adaptation and mitigation through agroforestry systems. Chapter 13. In World Agroforestry into the Future, 113–123 (Eds D. Garrity, A. Okono, M. Grayson and S. Parrott). World Agroforesty Centre.
[80] Souza, M. de and Piña-Rodrigues, F. (2013). Desenvolvimento De Espécies Arbóreas Em Sistemas Agroflorestais para Recuperação de Áreas Degradadas na Floresta Ombrófila Densa, Paraty, RJ. Revista Árvore 37(1):89–98.
[81] Araújo Filho, J.A. de (2013). Manejo Pastoril Sustentável da Caatinga, 200. Recife, PE: Projeto Dom Helder Camara. Bargués Tobella, A., Reese, H., Almaw, A., Bayala, J., Malmer, A., Laudon, H. and Ilstedt, U. (2014). The effect of trees on preferential flow and soil infiltrability in an agroforestry parkland in semiarid Burkina Faso.Water Resources Research 50:2108–2123.
[82] Bene et al., 1977; Sinclair, 2004; Vira et al., 2015, in Miccolis A 2017.
[83] Izac, a. M. N. and Sanchez, P. a. (2001). Towards a natural resource management paradigm for international agriculture: The example of agroforestry research. Agricultural Systems. 69(1-2):5–25.
[84] Livingston and Blade. Texas A&M University System (http://publications.tamu.edu/FORAGE/PUB_forage_Paratill%20Renovations%20of%20Pastures%20and%20Hayfields.pdf), 5 May 2018.
[85] The Pre-Feasibility Study with a technical description of each module and documents from the two consultation workshops can be found in the Appendix 2.4 and 2.6.

participation of experts and stakeholder from the national, provincial and municipal institutions and stakeholders in both project areas.

194. After the onsite visits, seven potential modules were identified, which were evaluated and validated by expert criteria in two workshops held with authorities, academia, and the general public (see Supplementary Material 4 and Supplementary Material 5). Premises indispensable for the selection of the modules were the contribution to reduction of vulnerabilities of homes and people and the sustainable nature of the practices. Table 24 in Section 1.4 presented the name of the modules and the previous experiences that gave rise to them. Table 30 shows the expected climate change adaptation benefits expected with the implementation of each one of the modules. A detailed description of modules and how their implementation will take place is provided in Appendix 2.6, Section 12 (p. 74) of this document.

Table 30. Expected climate-change benefits from project modules.

Module	**Short description**	**CC adaptation objective, expected benefits, and ** mitigation co-benefits***
1. CEDPLA Agroforestry system with cedar / plantain	Plant deciduous, more drought-resistant tree species with deep roots and abundant litter production (552 trees/ha), including *Cedrela odorata, Cordia gerascanthus, Caesalpinea violacea*, *Ferruginous colubrina*, and *Spondias purpurea*; combined in rows with plantain, *Musa* spp. (625 plants/ha). Implementation area: 1754 ha More info: Appendix 2.6, Section 12.1.	Ecosystem functions restored[86] on areas at high risk of desertification and degradation actually covered with *marabou* on 13,750 ha. Precipitation runoff fell from 0.17% to 0.05%. Groundwater recharge rose to 6,000m^3/ha/year. Soil erosion fell from 46.5 to 19.2 kg/ha/year Above-ground biomass increased 3–12 times Wind speed and evapotranspiration reduced Water and nutrient cycle increased - Employment for young people and women
2. MARREG Management of the natural regeneration of native arboreal species	Harvest *marabou* thickets to produce charcoal. Identify and select saplings and natural regeneration of native tree species. Further management of succession toward a natural forest through liberation cutting and enrichment planting. Species for which there is greater experience / knowledge in the country include: *Cordia gerascanthus*, *Tabebuia angustata*, *Guazuma ulmifolia*, *Lysiloma bahamensis*, and *Ferruginous Colubrina* (Appendix 2.6 presents a list of promising native species currently present in *marabou*)(Table 24). Implementation area: 3094.7 ha More info: Appendix 2.6, Section 12.2.	
3. MARFOM Establishment of close-to-nature	Establish a CTNPF by planting mixture of native and exotic species including *Pinus caribaea*, *Cordia gerascantus*, *Colubrina ferruginosa*, *Caesalpinea violacea*, and	

[86] Adaptation impacts in IRES Módulos Agroforestales, Herrero J. 2018

planted forests close t	*Lysiloma bahamensis* on sites were *marabou* has been mechanically eliminated (a list of species to be used in the MARFOM module is presented in Appendix 2.6, Table 28). Implementation area: 8166.52 ha For more information, see: Appendix 2.6, Section 12.3.	** 4.5 million t CO_2 eq. sequestered through accumulation in biomass*
4. FRUAGR Agroforestry system with fruit trees, agricultural crops and living fences	Diverse citrus (56 trees/ha) and mango (64 trees/ha) in combination with crop rotation including manioc, sweet potato, maize, beans, and various green fence species (a detailed description of species to be introduced in the FRUARG module is provided in Appendix 2.6, Section 12.4.4). Implementation area: 2529.36 ha More information: Appendix 2.6, Section 12.4.	
5. SILLEC Silvopastoral system with arbustive leguminous	Deep tilling and establishment of *Guazuma ulmifolia*, with progressive introduction of varieties of improved pasture and forage species, more resistant to drought (*Brachiaria brizantha* and *Arachis pintoi*). In addition, surrounding green contour will be implemented with *Lysiloma bahamensis* trees and internal electrical fence to regulate the grazing of livestock and allow for recovery of pastures and conservation of soil (Section 12.5.3 in Appendix 2.6 presents a description of species included in the SILLEC module). Implementation area: 10498.6 ha For more information, see: Appendix 2.6, Section 12.5.	<u>Ecosystem functions restored on areas at high risk of desertification and degradation actually covered with natural degraded grasslands on 9,080 ha</u> - Soil organic matter increase from 4 to 6.5% (higher nutrient and water retention) - Runoff reduced to only 13% - Rainfall infiltration index increased from about 0.26 to 0.79 - Pastures stay green 2–3 weeks longer - Soil erosion reduced from 70 to 8 t/ha/yr - Animal welfare and productivity improved - Forage production increased by 20% ** Net 336,200 t CO2 eq. sequestered through accumulation in biomass discounting methane emissions generated from enteric fermentation due to an increased number of ruminants*
6. SILSOM Silvopasture with shadow trees and protein banks	Deep tilling and progressive introduction of more drought-resistant improved pasture varieties *(Brachiaria brizantha*) in combination with 30 shade trees / ha (*Samanea saman*) and contour fencing (*Bursera simaruba / Spondias purpurea / Guazuma*) and grazing rotation. This module also includes establishment of protein (*Morus alba; Moringa* spp.*)* and energy (*Saccharum officinarum*) "banks" on 15% of the area as feed reserves to be cut and harvested in dry periods (Section 12.6.3 in Appendix 2.6 presents a complete description of the species included in this module). Implementation area: 9691.2 ha	

	For more information, see: Appendix 2.6, Section 12.6.	*grazing on a better fiber/protein balanced diet.*[87]

195. At this stage, it is assumed that Modules 1–4 could be established for an average of 2.5 ha/beneficiary, and Modules 5 and 6 for an average of 5 ha/beneficiary. The MINAG database (compiled on farmers, member-based cooperatives and other entities) indicates the approximate number of farmers adopting the project-proposed modules (See Tables 25–27 in Section 1.4) but a participatory decision-making process supported by intensive technical assistance will help beneficiaries decide which agroforestry and/or silvopastoral module to implement on a given site during the implementation phase. Table 31 below presents information on site conditions for implementation of each module.

Table 31. Site conditions for module implementation.

<table>
<tr><th rowspan="2">MODULE / Criteria</th><th rowspan="2">Baseline land use; native tree species natural regeneration (NSR)</th><th rowspan="2">Slope</th><th colspan="3">Soil [88]</th><th rowspan="2">Socioeconomic factors</th></tr>
<tr><th>Fertility</th><th>Vulnerability</th><th>Depth; organic matter content</th></tr>
<tr><td>1 CEDPLA</td><td rowspan="3">Marabou-invaded agricultural land with NSR <20%</td><td>Low (<10 %)</td><td rowspan="2">Medium (II, III)</td><td>5 -6 (medium)</td><td>Medium</td><td rowspan="3">Close more labor intense</td></tr>
<tr><td>2 FRUAGR</td><td rowspan="3">Medium (>10 <25 %)</td><td rowspan="3">5 – 8 (medium and high)</td><td rowspan="3">Shallow and extremely shallow, poor</td></tr>
<tr><td>3 MARFOM</td></tr>
<tr><td>4 MARREG</td><td>Marabou-invaded rangeland with NSR >20–80%</td><td>Low (IV)</td><td>Not that close nor that labor intense</td></tr>
<tr><td>5 SILLEC</td><td rowspan="2">Degraded pastures, rangeland, compacted soils NSR <20%</td><td rowspan="2">Low (<10 %)</td><td rowspan="2">Medium (II, III)</td><td rowspan="2">5 -6 (medium)</td><td rowspan="2">Shallow and poor</td><td rowspan="2">Close, more labor intense</td></tr>
<tr><td>6 SILSOM</td></tr>
</table>

196. The areas selected for implementation of the modules are located in near populated centers with certain levels of risk and vulnerability; another factor taken into consideration was that the soils' characteristics were compatible with the proposed use and availability of work force. The trees of these agroforestry systems fulfill many purposes (such as production of wood, firewood, fodder, fruits, medicines, etc.) as well as services (shade for crops and/or animals, protection such as windbreaks, etc.)

[87] -During preparation, selected pilot cases with a potential to introduce bio-digesters and solar panels may be identified where additional mitigation co-benefits could be achieved (e.g., for larger cattle herds with diary production facilities of agricultural cooperatives).
[88] Soil fertility, vulnerability to CC, depth and organic matter content.

and increase the biological diversity of the agroecosystem by creating niches and homes for other organisms in the trees' branches, roots, and litter.

197. The following maps indicate where the different modules will be implemented in each project area:

Figure 29-a. Project-associated activities in the Eastern Region.

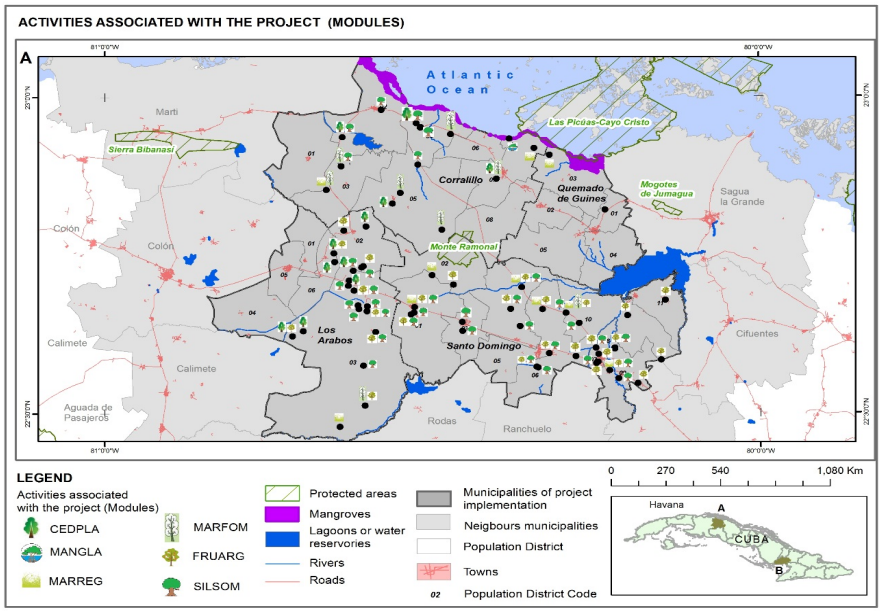
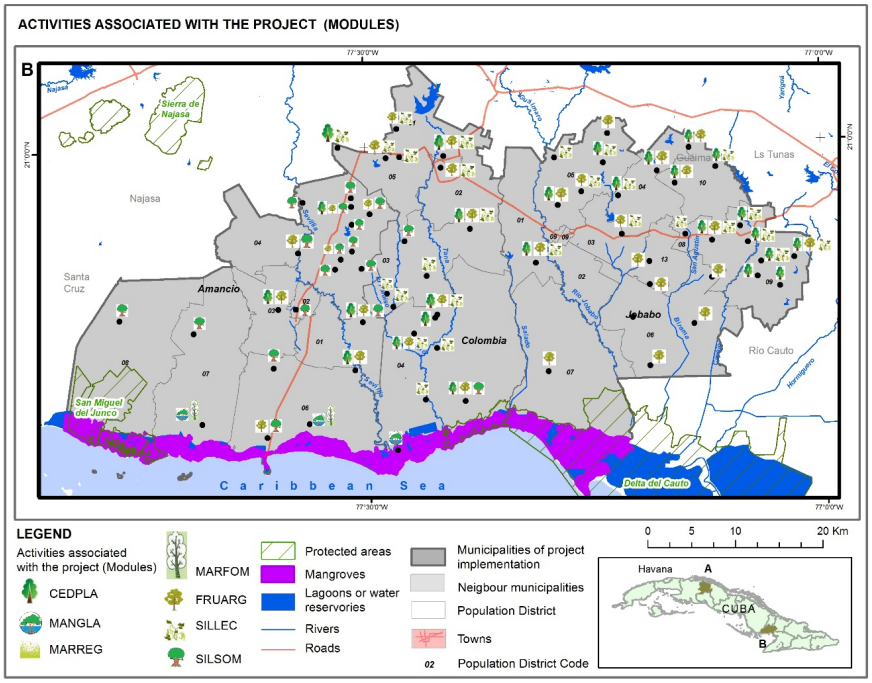


Figure 29-b. Project-associated activities in Central Region.



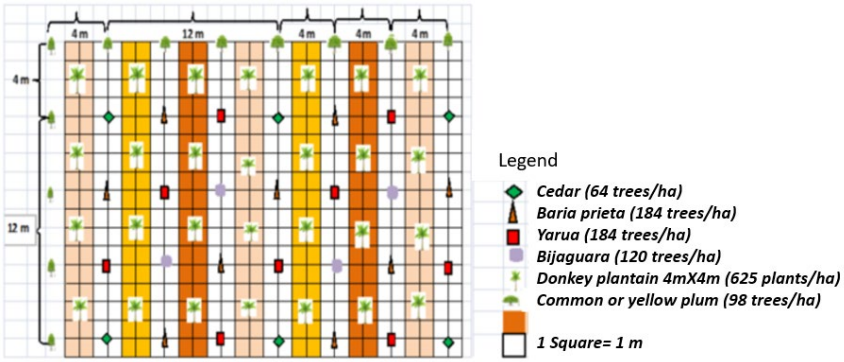
198. To standardize the modules, a structure was designed to categorize them in terms of technical, environmental, social and economic-financial factors (see Supplementary material 3 in Appendix 2.6 of this document). The information presented below provides a summary snapshot of each of the proposed modules and more in-depth explanations are provided in Appendix 2.6.

CEDPLA: AGROFORESTRY SYSTEM WITH CEDAR / PLANTAIN	
Objective	Increase resistance of communities and households to climate change through a sustainable agroforestry system that will provide sufficient financial resources to achieve adequate levels in the quality of life of individuals and families.
Description	Planting of more-drought-resistant deciduous trees with deep roots and abundant litter production (552 trees/ha), including *Cedrela odorata*, *Cordia gerascanthus*, *Caesalpinea violacea*; combined in rows with plaintain, *Musa* spp. (625 plants/ha).
Experiences in Cuba	In Cuba, through the "Tabacuba" Business Group, cedar production was promoted; considering the activity's economic and environmental benefits and recognizing the limitations that it faces.
Problem to be solved (current status)	- Water resources and degraded soils; - Attempts to establish nonspecific commercial plantations have failed in Cuba; - Reduced abundance of cedar in Cuba due to overexploitation;

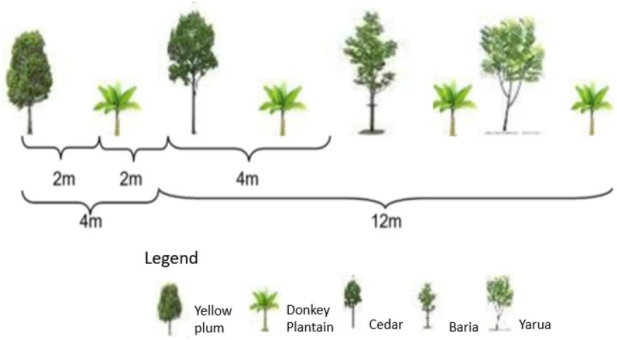
	- Unmet demand for cedar wood; - Extensive application of insecticides; - Lack of diversity of productive activities and income generation.
Benefits	- Restore functions of ecosystems in areas with high risk of desertification and degradation covered with Marabou. - Reduce runoff from rainfall. - Groundwater recharge - Reduce soil erosion. - Increase in soil biomass. - Reduction of wind speed and - evapotranspiration - Increase water and nutrient cycles. - Sequestration of CO_2 by accumulation in biomass. - Employment for young people and women. - Development of capacities and knowledge about appropriate sustainable methods for land use and management. - Increased and diversified employment sources.
Potential implementation areas	Area Villa Clara - Los Arabos (Los Arabos, Coralillo, Quemado de Guiñes~~)~~ and Area Las Tunas (Jobado, Colombia and Amancio Rodríguez), *marabou*-affected areas (1754 ha).
Technological proposal	This module's technological proposal consists of executing agricultural and forestry activities in a sustainable system under a systemic and integrating vision; that is conceived from the security of having the technical and financial resources; as well as the participation of the producers; Considering different types of forest species and a semi-permanent crop like plantain, generating economic, social and environmental benefits. For module implementation, drip irrigation is promoted, with pumps operated by solar energy, as well as the construction of small reservoirs of water, which will store the water during the winter and will be used during the dry season. It is also expected that an important (but not limiting) criterion is that producers wishing to implement the module are close to surface water sources. Use of the brush cutter and other equipment to prepare the land will be an important point in the module, since this technology is not available in Cuba.

GRAPHIC REPRESENTATION

AERIAL VIEW



Side View



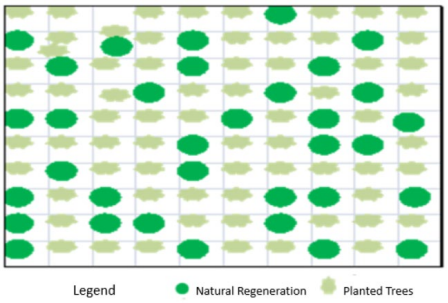
MARREG: MANAGEMENT OF NATURAL REGENERATION OF NATIVE ARBOREAL SPECIES	
Objective	To increase the resilience of communities and ecosystems to climate change by establishing forests through assisted natural regeneration to guarantee reestablishment and provision of ecosystem services, diversification of livelihoods and generation of stable employment to achieve a satisfactory standard of living for individuals and families.
Description	Establishment of forests through assisted natural regeneration in marabou-infested areas. Identify and select saplings and natural regeneration of native tree species, additional management of succession to natural forest through liberation cuts and enrichment planting. This module is characterized by soils of extremely low agro-productivity, with severe limiting factors (low effective depth, high stoniness, low organic-matter content, etc.). In

	addition to these factors, the selection criterion to define use of this module will be based on density (percentage ratio of number of individuals for natural regeneration of appropriate species present in area to number of desirable seedlings). The conversion of *marabuzales* into forests through assisted natural regeneration is a novel technique with potential to scale throughout the country given its multiple advantages in relation to other forms of rehabilitation in these areas, among them: a) shortening time for marabou elimination and replacement by a semi-natural, more resilient and productive forest; b) reduction of the initial environmental impact; c) lower implementation costs; and d) humanization of this task. Taking into account the module's economic, biological and cultural importance, 20 additional promising natives species are proposed that will have priority for their establishment. This module has the benefit of achieving forests with high species diversity in all strata compared with traditional methods (mechanically clearing and planting a nonspecific plantation) and provides greater resilience to ecosystems in addition to saving human and financial resources for its establishment.
Experiences in Cuba	Model forest Sabanas de Manacas (BMSM)
Problem to be solved (current status):	Regions have been observed in Cuba where *marabou* has been gradually replaced by natural regeneration of native trees that have developed spontaneously under *marabou* canopies. This process is undoubtedly more economically attractive, and the degree of resilience of forests achieved in this way is much greater since it is closer to the original forest; however, it has the disadvantages of delay of complete reconversion and species structure and composition that are not always the most desirable. The lands that were used decades ago for cattle activity were abandoned because of pasture loss and impoverishment caused by notorious lack of water and gradual degradation of soils. These factors resulted in poor milk and meat production and high animal mortality. When these areas were not used for other purposes, they were eventually transferred to the forestry sector. Currently, forest plantations identified as successors to *marabuzales* are found to be more than 90 percent non-specific, with very little resistant to CC and generally susceptible to pests and forest fires. Additionally, exotic species known for high water consumption, such as eucalyptus, albizia, and casuarina, etc., are often used. The "cleaning" of these areas that is still done using heavy machinery causes great impact given the use of "excavation" that affects soil surface and eliminates natural regeneration of native tree species that have been competing with marabou and that could in the future constitute multi-specific natural forest in a natural process of "ecological succession" that has the disadvantage of its time delay.
Benefits	- Restored ecosystem functions in areas at high risk of desertification and degradation caused by marabou. - Reduced rainfall runoff. - Recharged groundwater. - Reduced soil erosion. - Increased soil biomass.

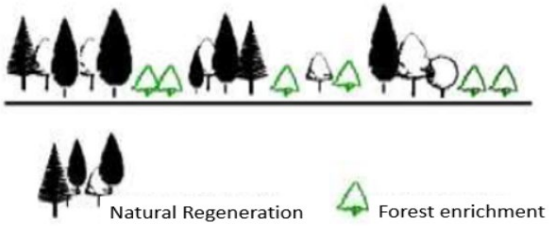
	- Reduced wind speed and evapotranspiration. - Increased water and nutrient cycles. - Sequestration of CO2 by accumulation in biomass. - Employment for young people and women. - Increased and diversified employment sources.
Potential area for implementation	Villa Clara province (Los Arabos, Santo Domingo, Corralillo, Quemado de Guines); Las Tunas province (Jobado, Colombia, Amancio Rodríguez); marabou affected areas (3 095 ha).
Technological proposal	In addition to being a novel technique with the potential to scale throughout the country because of its multiple advantages, the starting point for implementation of technology enabling reconversion of *marabuzales* in forests through assisted natural regeneration is based on an inventory of the area to evaluate species present, density and status of natural regeneration, and other indicators that will eventually define species to be used in plantations and their corresponding management. This technique places great emphasis on the production of seedlings of promising tree species present in the area. The seeds will be harvested from trees that show a better phenotype, and selected in the same areas, in protected areas or in nearby seed stands. These seeds will be revived with tube technologies that increase the quality of the planted material at lower cost.

GRAPHIC REPRESENTATION

AERIAL VIEW



SIDE VIEW

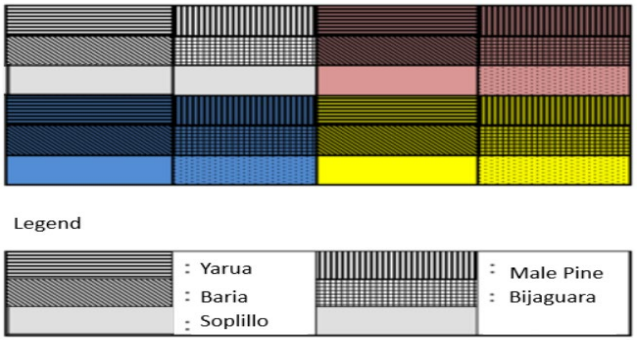


MARFOM: ESTABLISHMENT OF CLOSE-TO-NATURE PLANTED FORESTS	
Objective	To increase the resilience of communities and households to climate change by establishing close-to-nature planted forests to guarantee reestablishment and provision of ecosystem services and generation of stable employment to achieve an adequate standard of living for individuals and families.
Description	The multifunctional-planted forests are established by achieving a combination of forest species where the natives predominate over the exotic species and offer important ecosystem services for the general benefit of communities and their inhabitants. The objective of this module is to achieve the establishment of close-to-nature planted forests by planting mixtures of native and exotic species, such as pines, cordia, colubrina, caesalpinea and lysiloma spp. where *marabou* has been mechanically removed. The plan is to use these species based on their adaptability to existing soils and to the objectives of the plantations, that they are resistant to droughts and fires, and that the wood has economic value.
Experiences in Cuba	Experiences in Model Forest Sabanas de Manacas and Agroforestry Las Tunas Company
Problem to be solved (current status):	Massive reforestation activities in Cuba began in 1959, with significant impact on the country's economy, environmental protection and society in general. By 2016, 64 percent of forests planted correspond to native species, 33 percent to forests with exotic species and 3 percent of fruit trees with no commercial value. Without exception, all native species proposed in the project are represented in areas of planted forests, and there is experience on their management. When assessed at the country level, this situation could be satisfactory, but when problems of diversity of species used at the grassroots level of reforestation is analyzed, the reality is different. In general, there is only one species used in the same area, even on those plantations with protection and conservation objectives. In light of problems related to effects of CC, a conceptual change is required in current Cuban forestry, which must necessarily be governed by ecosystem-based adaptation principles. The establishment of mixed forests, care of natural regeneration, propitiation and maintenance of forest vertical structure, and effective protection against forest fires are aspects that enable commercial planted forests to ensure the numerous and varied eco-systemic services the forests offer. In recent years, the reforestation rate has decreased, mainly due to lack of heavy equipment for "bulldozed" clearing of areas invaded by *marabou*. However, these techniques have shown aggressive effects on soils and vegetation, so they must be replaced by other less aggressive systems with reduced environmental impact. Implementation of nonspecific plantations, as is common practice today, is a serious problem from the point of view of increasing resilience in households, people and ecosystems. The intervention area has tree nurseries and fruit trees with obsolete technology, where the plastic containers used do not encourage proper development of seedlings;

	these exhibit high mortality when taken to the field. The few nurseries of existing pipe plants, a technology far superior to polyethylene containers, have not generally been assembled with the complete system, resulting in less effectively.
Benefits	- Restored ecosystem functions in marabou-covered areas at high risk of desertification and degradation. - Reduced rainfall runoff. - Recharged groundwater. - Reduced soil erosion. - Increased soil biomass. - Reduced wind speed and evapotranspiration. - Increased water and nutrient cycles. - Sequestration of CO_2 by accumulation in biomass. - Employment for young people and women. - Increased and diversified employment sources.
Potential area for implementation	Villa Clara province (Los Arabos, Santo Domingo, Corralillo), Las Tunas province (Jobado, Colombia and Amancio Rodríguez), and *marabou* affected areas (8 167 ha).
Technological proposal	Technology defines that the maximum area (block) to be cleared for plantations of 60 hectares, alternately leaving the same area without clearing. The blocks of 60 hectares consist of six nonspecific stands, from 1 hectare up to maximum of 10 hectares. When the plantation has been established, which generally occurs within two or three years, adjacent marabou-infested areas will be cleared and planted. The stands without rigid designs respecting channels, fluvial currents and any other type of geographical feature will be separated by interior firewalls. In addition, internal blocks will be separated by masterful paths and green stripes. These multifunctional-planted forests are established by achieving a combination of forest species where native species predominate over exotic species and offer important ecosystem services for communities and residents in general. As was the case for the modules mentioned above, use of the machinery for clearing and preparation of the land will be extremely important.

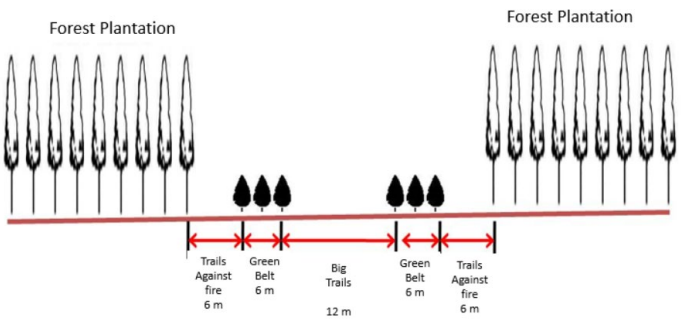
GRAPHIC REPRESENTATION

AERIAL VIEW



Note: Each color is a block composed of six stands of variable size, with a minimum of one hectare.

SIDE VIEW



FRUAGR: AGROFORESTRY SYSTEM WITH FRUIT TREES, AGRICULTURAL CROPS AND LIVING FENCES

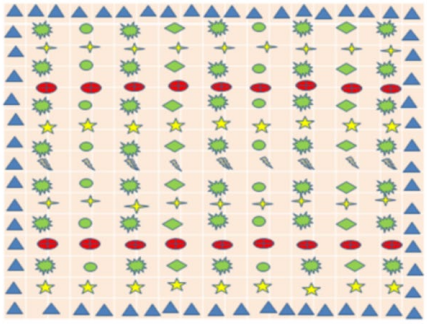
Objective	To increase CC resistance in communities and households through a sustainable agroforestry system that guarantees food security and generates income to achieve an adequate standard of living for individuals and families.
Description	Agroforestry system with fruit trees, agricultural crops and live fences. There will be several citrus fruits (56 trees/ha) and mango (64 trees/ha) in combination with crop rotation, which include cassava, sweet potato, corn, beans and several species of green fences. The fruit species to be used are sweet orange or Chinese orange (***Citrus sinenis***), mandarin (***Citrus reticulata***), and mango (***Manguifera indica***). The crop species are

	beans (**phaseolus vulgaris**), beans (**vigna spp**), sweet potatoes (***Ipomoea batatas***), cassava or manioc (***Manihot esculenta***) and corn (***Zea mays***). The species for live fences are naked indian (***Bursera simaruba***) and common plum (***Spondias purpurea***). The proposed system is based on agro-ecological practices such as polyculture and crop rotation for increased recovery capacity and, at the same time, for maintenance and increased soil fertility and reduced incidence of pests and diseases. This module can have numerous variations, depending on the villagers' interests, local demand for products, market prices and soil conditions of the farm.
Experiences in Cuba	Experiences on family farms in the Velásquez, Las Tunas, Avocado and Santo Domingo.
Problem to be solved (current status):	In general, in Cuba and specifically in the area of interest, agroforestry systems (mix of fruit trees, agricultural crops and living fences) are not widespread despite numerous examples in the country demonstrating the multiple benefits of these systems. In rural areas, the erroneous but deeply-rooted concept of advantages of monoculture and concept of trees as competitors (enemies) of crops are obstacles that have impeded development of systems such as those proposed by this project. In recent years, however, there has been a change in attitude to these systems by farmers, usufructuaries, technicians and officials. Currently food production in Cuba does not meet the demand of per capita consumption requirements of food, grains, fruits and vegetables. In the history of production, these crops are in high demand by the population.
Benefits	- Restored ecosystem functions in *marabou*-covered areas at high risk of desertification and degradation; - Reduced rainfall runoff; - Recharged groundwater; - Reduced soil erosion; - Increased soil biomass; - Reduced wind speed and evapotranspiration; - Increased water and nutrient cycles; - Sequestration of CO_2 by accumulation in biomass; - Employment for young people and women.
	Villa Clara province (Los Arabos, Santo Domingo, Quemado de Guiñes), Las Tunas province (Jobado, Colombia and Amancio Rodríguez), and *marabou*-affected areas (2 529 ha).
Potential area for implementation	The proposed system is based on agro-ecological practices such as polyculture and crop rotation to increase soil recovery capacity and, at the same time, maintain and increase soil fertility and reduce incidence of pests and diseases and promote food and nutrition security. To implement this module, drip irrigation will be promoted, with solar-operated pumps, as well as construction of small reservoirs, which will store water during winter for use during dry season. An important but not limiting criterion is that the farms of producers who want to implement the module are close to surface water sources.

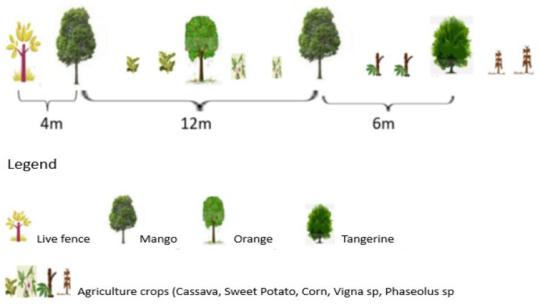
	Use of brush cutters and other equipment for land preparation will be important in the module since this technology is not available in Cuba.

GRAPHIC REPRESENTATION

Legend	Specie	Plantation Arrangement (m)	Number of plants
	Mango	12 x12	64
	Orange	6 X 24	32
	Tangerine	6 X 24	24
	Phaseolus sp	0,30 X 0,70	
	Sweet Potato	0,15 X 0,25	
	Cassava	0,90 X 0,90	
	Corn	0,25 X 0,50	
	Live fence	1,5	266



AERIAL VIEW



SIDE VIEW

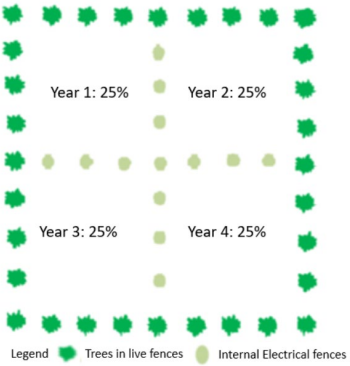
SILLEC: SILVOPASTORIL SYSTEM WITH ARBUSTIVE LEGUMINOUS

Objective	To increase CC resilience of communities and households by establishing silvopastoral practices to improve low yields of animal production (milk and meat) and guarantee positions of stable employment to achieve satisfactory standard of living for individuals and families.
Description	Due to CC effects, silvopastoral practices are required in Cuban cattle activity to improve low yields of animal production (milk and meat), low birth rates, and reduce high mortality rates. This module will be developed in degraded natural savannas with little precipitation, no flooding, prolonged drought, high animal load, low plantation, and

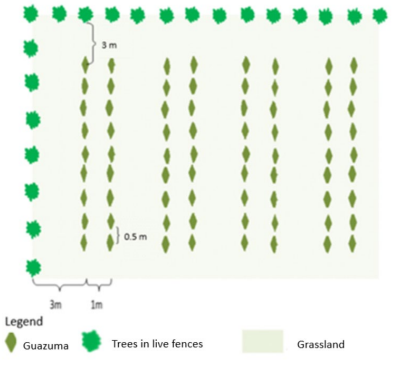
	low agro- productivity soils. It will focus on farming (under perturbation fouling) and establishment of *Guazuma ulmifolia* in double strips every 3 meters as well as progressive introduction of varieties of improved pasture species, more resistant to drought (*Brachiaria brizanta* and *Arachis pintoi).* In addition, it will develop green contour surroundings with *Bursera simaruba* and *Spondias mombim* trees and an internal electrical fence to regulate livestock grazing and enable pasture recovery and soil conservation.
Experiences in Cuba	Experiences at the Institute of Animal Science (ICA)
Problem to be solved (current status):	The scenario is where livestock farming occurs in natural pastures degraded by continuous pasture, lack of free pasture, prolonged drought and high animal charge. In general, soil has very low agro productivity and numerous limiting factors, such as: compaction, low organic matter content, rockiness, and low effective depth, among others. It maintains pastures of spontaneous natural grasses of low yield and quality, no legume presence, low or no presence of trees and low level of mineral or organic fertilization and generally low birth rates and high mortality. Cattle productivity is an indicator of marked variability in the country, but mostly with low levels; on average, two liters of milk / cow / day are produced and a weight gain of 200 g / animal / day is obtained.
Benefits	- Restored ecosystem functions in areas at high risk of desertification and degradation and covered with natural degraded pastures; - Increased soil organic matter (greater retention of nutrients and water); - Reduced run-off; - Increased rainfall infiltration; - Improved pastures (stay green for longer); - Reduced soil erosion; - Improved animal welfare and productivity; - Increased forage production; - Increased soil porosity with improved and stabilized structure; - Sequestration of CO_2 by accumulation in biomass.
Potential areas for implementation	Villa Clara province (Los Arabos, Santo Domingo, Corralillo), Las Tunas province (Jobado, Colombia and Amancio Rodríguez), and areas with degraded natural savanna (10 499 hectares).
Technological proposal	The technology proposed is more effective when carried out in degraded natural pastures and proposes actions that combine species to produce fodder (*Arachis pintoi*), the planting of *Guazuma ulmifolia* and grazing grass. These components interact within the system with a dynamic different from only animal-grass interaction because trees effect pastures, animals and soil. In turn the soil will have an effect on pastures and animals. Additionally, construction of small reservoirs of water is envisaged for drinking troughs, along with electric fences using photovoltaic panels. These electric fences

	will be combined with live fences to create a new way to manage livestock and pastures. At the same time, electric fences are innovative and improve producer resilience to CC, especially by improving livestock distribution and pasture growth while decreasing use of conventional wire, which is both difficult and expensive in Cuba. Electric fences will allow for easy installation and rotation if necessary. Producers also believe it will improve milking systems and cold milk maintenance.

GRAPHIC REPRESENTATION



AERIAL VIEW



AERIAL VIEW (distances)

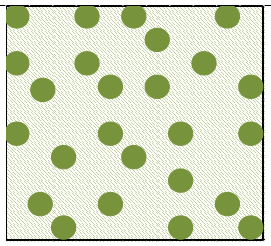
SILSOM: SILVOPASTURE WITH SHADE TREES AND PROTEIN BANKS

Objective	To increase resistance of communities and households to climate change by establishing silvopastoral practices to improve low yields of animal production (milk and meat) and guarantee generation of stable employment to achieve an adequate standard of living for individuals and families.
Description	This module will be implemented in degraded natural pastures via continuous management of little rainfall, lack of afforestation or free pasture, prolonged drought and high-loaded animals. In general, since soils have a very low agro-productivity (category IV) with severe limitations, this will focus on farms for plots (low subsoil) and the progressive introduction of more resistant grass varieties (*Brachiaria brizantha*) in combination with 30 shade trees / hectare (*Samanea saman*) and contour fences (*Guazuma ulmifolia*, *Spondias purpurea*, *Bursera*, Spondias) and pasture rotation. Protein "banks" (*Morus* spp, *Moringa oleifera*) and energy (*Saccharum officinarum*) will be established in 15 percent of area as food to be cut and harvested in dry periods.
Experiences in Cuba	Experiences from the Pasture and Fodder Research Institute (IIPF)

Problem to be solved (current status):	The scenario is where livestock farming in natural pastures is degraded by continuous pasture, lack of free pasture, prolonged drought and high animal charge. Soil in general has very low agro-productivity and numerous limiting factors, such as compaction, low organic matter content, rockiness, and low effective depth, among others. Pastures of spontaneous natural grasses of low yield and quality are maintained without legumes, low or no presence of trees and low level of mineral or organic fertilization and, in general, low birth rates and high mortality. Cattle productivity is an indicator of marked variability in the country, but, in general, with low levels; on average, two liters of milk / cow / day are produced and a weight gain of 200 g / animal / day is obtained. Soils generally have extremely low agro-productivity (category IV) with severe limitations. Overgrazing accelerates erosive processes by surface compacting caused by cattle trampling, leading to reduced infiltration capacity. Cattle are agents of geomorphological changes since their helmet-shaped heads physically reconfigure the surface of the soil, especially in plastic soils.
Benefits	- Restored ecosystem functions in areas at high risk of desertification and degradation and covered with degraded natural pastures; - Increased soil organic matter (greater retention of nutrients and water); - Reduced run-off; - Increased rainfall infiltration; - Improved pastures (stay green for longer); - Reduced soil erosion; - Improved animal welfare and productivity; - Increased forage production; - Increased soil porosity with improved and stabilized structure; - Sequestration of CO2 by accumulation in biomass; - Production of biogas for home use.
Potential areas for implementation	Villa Clara province (Los Arabos, Santo Domingo, Corralillo, Quemado de Guines), Las Tunas province (Jobabo, Colombia and Amancio Rodríguez), and areas of degraded natural pastures (soils of low agro-productivity (9 691 ha).
Technological proposal	Multiple land use and the presence of the arboreal component in grasslands in the initial stage enables phasing in improved biophysical and socioeconomic conditions for extreme events such as prolonged and frequent droughts, increased temperatures and strong winds. Given the agro-ecosystem this creates, it will be possible to continue food production in a sustainable manner due to greater availability of water and an appreciable increase in soil fertility levels. Plantation grazing is gradual and as the trees grow and receive silvicultural management, they tolerate the presence of cattle better. Additionally, construction of small reservoirs of water is envisaged to work as drinking troughs, along with introduction of electric fences using photovoltaic panels. These electric fences, combined with live fences, will create a new way to manage livestock and pastures. At the same time, electric fences are innovative and improve

	producer resilience to CC, especially through improved livestock distribution and pasture growth while decreasing use of conventional wire, which is both difficult and expensive in Cuba. Electric fences will allow for easy installation and rotation if necessary. Producers also believe it will improve milking systems and milk-refrigeration maintenance.

GRAPHIC REPRESENTATION



AERIAL VIEW

SIDE VIEW

199. A total of 28 different species were selected for these modules. Native and naturalized species account for 54% of the total while alien species represent 20% (five species). The rest are crop species (such as maize [*Zea mays* **L**.]) that are widely cultivated elsewhere. The species were arranged following classification indicated below in Table 32. All species to be introduced in the proposed modules are listed in Section 11 of Appendix 2.6) along with information on selection criteria, invasiveness risk and risk reduction measures.

Table 32: Recommended terminology in plant invasion ecology

Alien plants	Plant taxa in a given area whose presence is due to intentional or accidental introduction as a result of human activity (synonyms: exotic plants, non-native plants, nonindigenous plants).
Casual alien plants	Alien plants that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and rely on repeated introductions for their persistence.
Naturalized plants	Alien plants that reproduce consistently (*casual alien plants*) and sustain populations over many life cycles without direct intervention by humans (or in spite of human intervention). They often recruit offspring freely, usually close to adult plants, and do not necessarily invade natural, semi-natural or human-made ecosystems.
Invasive plants	Naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants (approximate scales: > 100 m; < 50 years for taxa spreading by seeds and other propagules; > 6 m/3 years for taxa spreading by roots, rhizomes, stolons, or creeping stems), and thus have potential to spread over a considerable area.
Weeds	Plants (not necessarily alien) that grow in sites where they are not wanted and usually have detectable adverse economic or environmental effects (synonyms: *plant pests*, *harmful species*, *problem plants*). *Environmental weeds* are alien plant taxa that invade natural vegetation, usually adversely affecting native biodiversity and/or ecosystem functioning.

Transformers	A subset of invasive plants which change the character, condition, form or nature of ecosystems over a substantial area relative to the extent of that ecosystem.

Source: Richardson *et al.*, 2000[89]

200. From earliest stages of project formulation there were serious discussions with national and international experts on use of alien species. Following these discussions and analysis with Cuban government authorities, species such as neem (*Azadirachta indica*), acacia (*Acacia mangium*), guinea grass (*Megathyrsus maximus*), which have great potential to be invasive, were excluded from first module design. Likewise, it was agreed to keep some alien species with lower potential levels of invasiveness risk, but to provide control management measures to develop more diversified production alternatives, including agricultural and cattle diversity, which will be more viable in the face of climate change effects.

201. The four alien species included are well known by farmers and the scientific community; they have a long history of use in Cuba with no reports of invasiveness behavior. Species selection has been made in consultation with different stakeholders (national and international experts, Cuban government officials and FAO staff) in an effort to keep the number of alien species to a minimum. They were included because there are not native species but could perform equally well as the alien species and already exist in implementation areas.

202. The project modules managing alien species are those of silvopastoralism. It is noteworthy that, for the effects of CC, they are favorable to carbon capture capacity and emissions balance, contributing to improved water balance, reduced vulnerability to drought and prevention of soil erosion, while at the same time assist with thermal regulation and improve animal welfare before temperature increases and evapotranspiration. In this way, sufficient feed is guaranteed for cattle throughout the year, including the dry period, eliminating dependence on imported grains and increasing incomes and promoting better livelihoods for producers. Due to characteristics such as size, growth speed, protein intake and usable mass, Cuban herbaceous species are not capable of sustaining efficient livestock systems.

203. The silvopastoral modules have been designed based on more than 25 years of research by the Institute of Animal Sciences (ICA) of Ministry of Higher Education, and of the Pastures and Forages Research Institute of Ministry of Agriculture, and also incorporates experiences of the Pastures and Forages Station of Ministry of Science, Technology and Environment (CITMA).

204. The four alien species included are listed below along with an additional rationale:

Manicillo (*Arachis pintoi*): Species not reported as invasive, widely cultivated. CABI (2019a)[90]
Bread grass (cv Marandu) (*Brachiaria brizantha* [Hochst. ex A. Rich.] Stapf): These species have not been reported as invasive (CABI, 2019b)[91] and its caespitose habitat might hinder species dispersal.

[89] Richardson, D.M., Allsopp, N., D'Antonio, C.M., Milton, S.J. & Rejmánek, M. (2000) Plant invasions — the role of mutualisms. *Biological Reviews*.

[90] CABI. 2019a. Invasive Species Compendium. Wallingford, United Kingdom: CAB International. www.cabi.org/isc

[91] CABI. 2019b. Brachiaria brizantha. In: Invasive Species Compendium. Wallingford, United Kingdom: CAB International. www.cabi.org/isc

Morus (*Morus alba*): Multipurpose tree widely planted in tropical, subtropical and mild temperate regions of the world for fodder, silkworm rearing, and fruit and timber production. According to CABI (2019c),[92] this species is widely cultivated and has shown low rates on invasion reports.

Moringa (***Moringa oleifera* Lam**.): Currently, CABI (2019d)[93] indicates *moringa* is a widely cultivated species with low invasive potential.

See Section 11 of Appendix 2.6 for detailed information on species to be used in the productive modules and for measures to manage potential risk of these four alien species.

205. Annex 6 of the FP Environmental and Social Management Framework provides an analysis of potential environmental risks and impacts of the above-described modules. Management and early action plans have been designed to ensure that risk of invasion in all project areas and adjacent territories is constantly monitored and reduced to a minimum (see Appendix 2.6, Section 11). In addition to the proposal for risk mitigation measures, these facts were highlighted in the analysis of invasive alien species management in the project proposal:

- The species of concern (IAS) are concentrated in modules of silvopastoral systems (SILLEC and SILSOM).
- National milk and beef production is deficient and identified by the government as high priority for development in the main program and policy documents (including Economic and Social Policy Guidelines and Economic and Social Development Program to 2030). These products, which have limited market presence and high prices, are highly demanded by the population. The Livestock and National Forestry Program has made a political decision to develop silvopastoral systems as a way to guarantee sustainable animal feed in the face of the impossibility of producing food based on grains that are deficient at the national level. Those must be imported and compete with demand for human consumption in a national scenario of financial resource deficits to guarantee imports of animal feed or raw materials for processing. Amid financial shortages, powdered milk and beef importation are part of Cuba's large import expenditure of more than USD 1.5 billion.
- The silvopastoral modules have been designed based on more than 25 years of research at the Institute of Animal Sciences (Ministry of Higher Education) and the Institute of Pasture and Forage Research (Ministry of Agriculture), and incorporate experiences of the Station of Pasture and Forage (Ministry of Science, Technology and Environment). Research in Cuba has been based on a systemic approach, resilience to climate change and on agro-ecological bases and use of phyto-fodder resources from perennial plants and pastures. These are selected for each edaphoclimatic condition, with high efficiency in solar energy collection, and are adaptable, multifunctional and have high yields based on minimum resources and imported inputs.

[92]CABI. 2019c. Morus alba. Invasive Species Compendium. Wallingford, United Kingdom: CAB International. www.cabi.org/isc.
[93]CABI. 2019d. Moringa oleifera. Invasive Species Compendium. Wallingford, United Kingdom: CAB International. www.cabi.org/isc.

Likewise, timber, fruit and melliferous trees are considered as options to generate income for the communities and because they are the main CO2 capture sinks.

- There are different approaches and visions on invasive alien species, their determination and management, between a certain sector of science associated with conservation and the study of Cuban Flora and Vegetation and the research sector associated with agricultural sciences and part of the environmental sector. The first group proposes maximum precaution and limitations and the second controlled management but exploitation.

- Although Cuba having more than 7000 species of plants with flowers, there are no native species among grasses, legumes and other families that are optimal for livestock feed. Consequently, these species have been imported for centuries to compensate these shortages. Cuban native herbaceous species, due to characteristics such as size, growth speed, protein content and usable mass, are not capable of sustaining efficient livestock systems. All cattle species and other animal species that constitute RZG in Cuba are introduced, and the use of introduced species for pasture and fodder is not a matter of choice, but rather of necessity for Cuban livestock. Since the beginning of the 20th century, Cuban cattle ranching has been based mainly on introduction of exotic species such as grass. A good part of the pasture species that abound in pastures are invasive species, such as the genera *Dichanthium* (*Pitilla americana* and *jiribilla*) and *Paspalum*, in addition to some native species that have extended distribution beyond their natural habitats.

- Cuban vegetal formations that are characterized by important herbaceous strata (grammies) are savannas of *júcaros* and palms, savannas of palms (discussed as type of natural vegetation), *herbazales* of marsh and complexes of vegetation associated with coastal areas. These are developed on soils with very specific characteristics and in areas where special conditions are combined.

- Livestock systems developed on the basis of spontaneous pastures (with exotic and native species) are GHG emitting systems and provide low dividends to producers (four liters of milk per cow per day and half in drought). Use of adapted species that respond well to solar energy, guarantee high biomass yields, are efficient in the capture of CO2, and have a minimum of conditions that guarantee an adequate management of grazing and areas for cutting and carrying, can contribute to solving some problems that Cuban pastoral systems are facing (such as soil erosion, monocultures, bad animal diets, high water demand, low yields). The systems proposed can have similar intensification to conventional systems, but with another concept in diversity. With interventions proposed by the project, some benefits are expected.

- Due to improved energy-protein balance of the ration and consequent optimization of ruminal fermentation, methane emissions per animal can be reduced by up to 20 %, whereas reduction in methane emissions per kilogram of milk produced could be up to 50 percent in the proposed SSPs. Reductions of 36% in nitrous oxide are calculated due to improved livestock nutrition and a reduction in fertilizer use (see Appendix 2.6, Section 12).

- Greater richness of organisms has been detected compared to traditional systems (with predominance of oligochaetes, earthworms, dung beetles, ants, springtails, centipede worms

and millipedes, fungi and microorganisms). The presence of trees in grasslands together with forage enables enhanced biological activity of soil and its productivity, in addition to improving water cycles. SSPs provide nesting sites for numerous bird species (such as columbiform and passeriform) and habitat for numerous invertebrates and small vertebrates such as amphibians and reptiles, creating ecosystems that are much more complex and biodiverse than current livestock systems. In addition, conditions of greater variability of food and grazing in shaded areas can reduce the risk of diseases and pests in livestock.

- All species proposed for the project are already present in all areas of implementation but lack adequate management. The methodology documents and current livestock management guidelines (*Manual de Tecnologia Ganadera*, 28 July 2014, MINAG) indicate use of all species proposed by the project.

- There is a livestock tradition in project areas and producers are willing to reactivate it.

- Protected areas have highest biodiversity values and are, at the same time, areas most vulnerable to effects of IAS. For this reason, a correlation analysis of the location of implementation areas and their proximity to protected areas was carried out (for further detail, see Annex 6 of the Funding Proposal: *Environmental and Social Management Framework*).

Table 33. Commercial crops resilient to effects of climate change [25]

No.	Crops (species)	RESILIENCY FEATURES
1	**YUCCA (*Manihot esculenta* Crantz)**	Resilient and strategic cultivation in adverse conditions, with tolerance to diseases and drought, with capacity to produce in degraded and acidic soils, and flexibility at planting and harvesting. It has high photosynthetic efficiency and is able to express good yield in favorable or unfavorable production conditions. Easy association in different ecosystems.
	'SEÑORITA'	Tolerance to diseases and drought. Superficial roots that favor the harvest. Erect or semi-erect stem that allows a greater density of plants per area.
	'INIVIT Y- 80+1'	Short cycle (seven to ten months) that allows cyclone effect mitigation if planted at optimum time. Erect or semi-erect stem that allows greater density of plants per area.
	'CEMSA 74-725'	Tolerant to disease, drought and salinity.
	'CEMSA 74-6329'	Tolerant to diseases and drought.
	'INIVIT Y-93-4'	Short cycle that allows cyclone effect mitigation if planted in optimal season.
	'JAGÜEY DULCE'	Adaptable to saline soils, with high agricultural yields in soils ranging from 1 100 to 2 600 ppm of total soluble solids. Susceptible to humidity excesses.
	'CMC-40'	Short cycle (seven to ten months) that allows cyclone effect mitigation if planted in optimal season.

2	**'INIVIT Ñ-2008' (*D. alata* L.)**	In addition, it is susceptible to anthracnose (*C. gloeosporoides* Penz.), produces aerial bulbils that provide reproductive advantages free of nematodes, requires tutors, is susceptible to nematodes (*Scutellonema bradys* and *Pratylenchus coffeae*).
	'AMARILLO BLANCO' (*D. cayenensis* Lam.)	It does not produce aerial bulbils, is tolerant to Anthracnose (*C. gloeosporoides* Penz.), can be cultivated without tutors, susceptible to nematodes (*Scutellonema bradys* and *Pratylenchus coffeae*).
	'BLANCO O ÑAME DE GUINEA' (*D. rotundata* Poir)	It does not produce aerial bulbils, is tolerant to Anthracnose (*C. gloeosporoides* Penz.), can be cultivated without tutors and is susceptible to nematodes (Scutellonema bradys and Pratylenchus coffeae). It has a tuber production time between seven and eight months and good adaptation to erratic humidity conditions. Its corrugated skin provides protection from damage during transport and storage. It has productivity and quality of the tubers.
	'ÑAME PAPA' (*D. esculenta* Burk.)	It is also tolerant of anthracnose (*C. gloeosporoides Penz*.) and nematodes (*Scutellonema bradys* and *Pratylenchus coffeae*), does not produce aerial bulbils, and can be grown without tutors.
3	**BANANAS (*Musa* spp.)**	Resilient crop, strategic in adverse conditions. Crop suitable for plant in plain, pre-mountain and mountain. Easy association in different ecosystems.
	VIANDA (AAB) (Plantain Subgroup)	Susceptible to black sigatoka (*Mycosphaerella fijiensis Morelet*) and mainly injurious nematodes (*Pratylenchus coffeae*). Crop management favors better yields.
	'CEMSA ¾'	Susceptible to black sigatoka (*M. fijiensis Morelet*) and nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne* spp.), tolerant to the Panama disease (*Fusarium oxysporum* f. sp cubense (Foc)).
	'INIVIT PV 06-30'	Not very vulnerable to wind action due to good anchorage and low height, tolerant to lesioning nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne* spp.).
	'INIVIT PV-2011'	Higher performance and lower height than the 'CEMSA ¾.'
	VIANDA (AAB) (Silk Subgroup)	In general terms, clones in this group are susceptible to black sigatoka (*Mycosphaerella fijiensis Morelet*), but genetic improvement has led to the allowance or cloning with some tolerance to this disease.
	'APPLE TREE INIVIT'	It is type of VIAND, but consumed as type of FRUIT, and is tolerant to black sigatoka (*M. fijiensis Morelet*) and Panama disease (*F. oxysporum* f. sp cubense (Foc)) and winds for its rusticity and good anchorage. It is resistant to nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne* spp.).
	Tipo Burro (ABB)	Tolerant to black sigatoka (*M. fijiensis Morelet*), very tolerant to lesioning nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne* spp.) due to its abundant and deep root system.

	'BURRO CEMSA'	Tolerant of black sigatoka (*M. fijiensis Morelet*), nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne* spp.), winds and drought.
	'BURRO ENANO'	Tolerant to winds and black sigatoka (*M. fijiensis Morelet*).
	'INIVIT PB-2012'	Yellow mass rhizomes, produces more corms than cormels. Suitable for hurricanes and cyclones, contains high content of beta-carotene, precursor of vitamin A and high dry-matter content.
4	**MALANGA (*Colocasia esculenta* Schott.)**	Resilient crop, strategic to adverse conditions (cyclones, conflicts, others), suitable for situations of heavy rains and cyclones. It can be preserved under natural conditions. Cultivation suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'CAMERUM 14'	In addition, it presents high yield of rhizomes or corms.
	'INIVIT MC-2001'	In addition, it has a low height, short cycle (seven months) that allows it to mitigate the effects of water stress). It produces abundant tillering or formation of secondary rhizomes.
	'INIVIT MC-2006'	In addition, it presents high yield of rhizomes or corms.
5	**MALANGA (*Xanthosoma* spp.)**	Resilient crop, strategic to adverse conditions (cyclones, conflicts, others), suitable for situations of heavy rains and hurricanes. It can be preserved under natural conditions. Cultivation suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'MORADA' (*X. sagittifolium* (L.) Schott)	Rhizomes of purple mass, suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'AMARILLA ESPECIAL' (*X. sagittifolium* (L.) Schott)	Yellow mass rhizomes, produces more corms than cormels, suitable for hurricanes and cyclones, contains high beta-carotene content, precursor of vitamin A and high content of dry matter.
	'MÉXICO 1' (*X. sagittifolium* (L.) Schott)	Pink mass rhizomes, strategic in adverse conditions, suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'MÉXICO 8' (*X. sagittifolium* (L.) Schott)	Pink mass rhizomes, strategic in adverse conditions, suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'INIVIT MX-2008' (*X. sagittifolium* (L.) Schott)	Clone with white mass rhizomes and high yield potential, suitable for situations of intense rains and floods and cyclones, suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.
	'BLANCA INIVIT' (*X. sagittifolium* (L.) Schott)	Clone with rhizomes of white mass, strategic to adverse conditions, suitable for planting in plain, pre-mountain and mountain. Easy association in different ecosystems.

6	**BONIATO (*Ipomoea batatas* (L.) Lam.)**	Resilient crop adapted to plantations throughout the year, strategic to adverse conditions. Due to its short cycle compared with other crops, it is considered suitable for planting after intense rains, floods and hurricanes. It has a wide range of post-harvest conservation under natural conditions. *boniato* is suitable for planting in the plains, pre-mountain and mountain. Easy association in different ecosystems.
	'CEMSA 78-354'	Adapted to plantations throughout the year. It presents abundant foliar development. Resistant to nematodes of the genus *Meloidogyne*.
	'INIVIT B 98-2'	Adapted to plantations throughout the year. Presents abundant foliar development. Its tuberization is deep, reducing the possibility of being affected by tetuan (*Cylas formicarius Fab*.).
	'CEMSA 78-354'	Adapted to plantations throughout the year. It presents abundant foliar development. Resistant to nematodes of the genus *Meloidogyne*.
	'INIVIT B 98-2'	Adapted to plantations throughout the year. It presents abundant foliar development. Its tuberization is deep, reducing possibility of being affected by tetuan (*Cylas formicarius Fab*.).
	'CEMSA 78-326'	Adapted to plantations throughout the year. Clone demanding high technology.
	'CEMSA 74-228'	Adapted to plantations throughout the year.
	'CAUTILLO'	Adapted to plantations throughout the year.
	'INIVIT B2-2005'	Adapted to plantations throughout the year, presents tolerance to drought and damage caused by bright black (*Typophorus nigritus F*.).
	'INIVIT 98-3'	Adapted to plantations throughout the year, its deep tubing shows tolerance to tetouan (C*. formicarius Fab*.) and bright black (*T. nigritus F*.). It produces little foliage.
	'INIVIT BS-16'	Adapted to plantations throughout the year, it is tolerant of drought and damage caused by tetouan (*C. formicarius Fab.)* and those caused by bright black (*T. nigritus F*.).
	'INIVIT B 16-2010'	Adapted to plantations throughout the year.
	'INIVIT B 240-2006'	Adapted to plantations throughout the year for its precocity (cycle 110 to 120 days), shows tolerance to damage caused by tetouan (*Cylas formicarius Fab*.).
7	**PAPAYA (*Carica papaya* L.) 'MARADOL ROJA'**	Fruits resistant to post-harvest handling. Early ripening (six to seven months after transplant). Very productive and has excellent aroma and flavor.
8	**CALABAZA (*Cucurbita moschata* Duch)**	Cultivation with potential to mitigate effects of hurricanes.
	'INIVIT C-2000'	Tolerant to downy mildew (*Pseudoperonospora cubensis* (Berk. and Curt.) Rostov) and powdery mildew (*Erysiphe cichoracearum* D.C.).
	CUCUMBER	Due to its short cultivation cycle (45 days) it is ideal for planting after

	(*Cucumis sativus* L.)	hurricanes.
9	**'INIVIT P-2000'**	Tolerant to downy mildew (*Pseudoperonospora cubensis* (Berk. and Curt.) Rostov) and powdery mildew (*Erysiphe cichoracearum* D.C.).
	'INIVIT P-2007'	Tolerant to downy mildew (*Pseudoperonospora cubensis* (Berk. and Curt.) Rostov) and powdery mildew (*Erysiphe cichoracearum* D.C.).
10	**VIGNA (*Vigna unguilata* (L.) Walp.)**	Cultivation that enables production of grains in conditions tolerant to the caupi mosaic virus (black-eyed cowpea mosaic virus), drought and abundant rainfall, although it does not permit flooding. It can be sown year round.
	´Guariba'	Can be sown year round, allows grain production in summer conditions, is tolerant to drought and abundant rainfall but it does not permit ponding; excellent culinary quality. It is tolerant to the caupi mosaic virus (black-eyed cowpea mosaic virus).

Source: Tropical Root and Tuber Crops Research Institute (2013).

206. Section 12 of Appendix 2.6 presents further information on fruit, fences and crop species to be implemented in each module; the tasks for module implementation (seedlings, land preparation, planting, sowing, fertilization, etc.); how seeds will be acquired; schedule, and expected outputs.

Machinery

207. The proposal for mechanization of activities to be developed in the implementation of sustainable agroforestry systems includes acquisition of agricultural machinery of different power ranges and equipment (implements) for restoration of lands invaded by marabou; low impact technology in soil preparation; application of cultural practices that enable development of agroforestry systems and harvesting. Based on the design of the agroforestry modules, the necessary inputs to combine with the machinery have been established, taking into account minimum tillage with benefits for the soil, humanized work and increased productivity - a combination that helps reduce atmospheric carbon. Table 8 in Section 6.3.3 of Appendix 2.6 presents a summary of all machinery to be used to implement the module (a detailed description of the machinery to be purchased is provided in the *Supplementary material 5: Technical description of the machinery and equipment to be procured*, Appendix 2.6).

208. The machinery and respective tools to be acquired will be distributed between two participating project stakeholders to enable expansion and improvements to the mechanization and technical assistance services, use of machinery according to power required to develop mechanized work, and guaranteed maintenance and repair activities.

209. The stakeholders involved in implementation of agricultural mechanization have been selected based on experience developed in Cuba, with two key stakeholders. The productive types considered in the project are: credit and services cooperatives (CCS), agricultural production cooperatives (CPA), basic cooperative production units (UBPC) and state farms. These are directly responsible for implementation of agroforestry and silvopastoral production system. The Integral Base Business Units of Technical Services (UEBIST) are specialized units that will be responsible for provision of machinery, maintenance and repair services for agricultural machinery, irrigation and transport equipment, operating throughout different municipalities, including those in the project. The Agricultural Engineering Research Institute (IAgric), a MINAG institution, has participated in the

proposal formulation process and will be responsible for providing advice for coordinated implementation of mechanization technologies based on sustainable use of natural resources to contribute to the country's food security. Section 6.3.4 of Appendix 2.6 presents detailed information on machinery to be assigned to different stakeholders, and Annex 20. Operations and Maintenance (O&M) describes strategy and responsibilities for machinery during project execution and after project completion.

Irrigation

210. In the design framework of agroforestry and silvopastoral modules included in IRES Project, the concept of irrigation-based agriculture is incorporated for production of bananas, annual crops (grains and food), and fruit species (citrus and mango) included in the CEDPLA and FRUAGR modules as well as milk production, which requires water resources for animal consumption, in the SILLEC and SILSOM modules.

211. In designing the modules (specifically those related to irrigation systems), the technical team of the IAgric-MINAG verified the water and irrigation policies (see Section 2.1.4) and alternative water sources for irrigation and animal consumption, and determined water sources that would be used.

212. The installation of drip irrigation systems is proposed to implement agriculture under irrigation, taking into account availability of surface water in different forms (well, river, dam, etc.) using irrigation units with coverage of 6.0 ha / unit for CEDPLA and FRUAGR modules, and construction and equipment of reservoirs with capacity to cover one hectare of crops. In the case of livestock, 500-liter drinking fountains will be installed per productive unit of 2.5 cows, based on the availability of surface water in different forms and construction of 1000 reservoirs, to supply and store water for the summer, based on SILLEC and SILSOM modules design. Information on water use technology for agricultural production modules is summarized in Appendix 2.6, Section 6.4.3.2, Table 12. Supplementary Material 6 in Appendix 2.6 includes a description of irrigation by aspersion systems and reservoirs to be constructed.

5.2 Theory of Change: project objective against baseline

213. The project's **Theory of Change** starts with recognition of Cuba's increasing vulnerability to CC due to: its geographic location in a hurricane-prone region; increasing hurricane strength; increasing variability in rainfall (periodicity, timing and intensity) which leads to flooding; land degradation from soil erosion, droughts and dry periods (periods within the historic pattern of rainy seasons); sea-level rise leading to salinization of coastal groundwater and soils; and increasing damage to coastal infrastructure and vegetation. While vulnerability varies somewhat across the island as a result of heterogeneous topography, vegetative cover, and meteorological patterns, etc., the entire country is correctly considered vulnerable or highly vulnerable to climate change, particularly in rural populations.

214. Current agro-ecosystems degrade rapidly, losing productivity and sustainability due to maladaptive land preparation; cultivation and irrigation techniques for monocultures leading to exposed soils; rapid runoff; invasive species infestation, particularly marabou; soil erosion and sediment transport to coastal areas; salinization and increased risk of flooding, loss of life and property. This business-as-

usual scenario increases producer vulnerability to extreme weather events and climate variability and reduces the country's capacity to maintain food security.

215. CC adaptation in this context requires land management to mitigate rainfall variability and precipitation extremes, either too much (e.g. dramatic torrential downpours from hurricanes and tropical storms) or too little (periodic droughts and dry periods). The overarching framework for adaptation then is land use management aimed at maintaining / enhancing hydrological regulation as a primary ecosystem service in the production landscape. As such, primary management objectives for resilient agro-ecological landscapes in Cuba are to reduce rainfall impact on soil, slow water flow across it, and to enhance infiltration into and through the soil profile, all while maintaining or enhancing production for food security, well-being and livelihoods. Reduced impact and velocity of flow decrease erosion, while improved water infiltration into the soil increases groundwater – vital for irrigation during drought and, in coastal areas, a factor against saltwater intrusion.

216. Management to enhance CC resilience of agro-ecosystems therefore focuses on establishing and managing vegetative cover appropriate to a strategy of both optimizing ecosystem function and meeting sustainable production and food security needs while minimizing GHG emissions. As such, suitable production systems for different areas of the production landscape will combine trees and/or shrubs with crops and livestock. These agroforestry and silvopastoral systems diversify production, thereby reducing risk to farmers and livestock producers from climate extremes. With widespread adoption and implementation of climate-adapted, resilience-enhancing agroforestry and silvopastoral systems, production landscape vulnerability to CC is reduced.

217. To decrease vulnerability and enhance resilience of farmers to climate-driven impacts such as drought and rainfall variability, Cuba intends to strengthen ecosystem functions and services aimed primarily at water regulation to maintain and improve agricultural production. This includes reforestation of key areas less suitable for agriculture to create close-to-nature planted forests (CNPFs) and assisted natural regeneration of degraded forests and over-logged areas.

218. It is worth noting that this strategy to integrate trees and bushes into production landscape through proposed agroforestry, silvopastoral and forestry systems also results in generation of significant mitigation co-benefits over and above the current baseline values in maladaptive production systems and degraded and abandoned areas subject to marabou invasion.

219. The Cuban government has adopted a three-phase strategic approach to improve resilience of agricultural landscapes to increased climate risk while generating mitigation co-benefits: a first phase of research and piloting; a second of upscaling based on lessons learned from phase one; and a third of upscaling countrywide based on lessons, capacities and financial mechanisms while enabling policies resulting from phase two implementation.

220. In the now-concluded first phase, the Ministry of Agriculture supported research on optimal agroforestry systems for wetter and drier areas of Cuba and identified and tested a number of options, leading to the six agroforestry, silvopastoral and forestry modules proposed here (see Appendix 2.6 for detailed description) for initial out-scaling to two representative vulnerable regions located in *Las Tunas* and *Villa Clara/Matanzas* provinces. By implementing these modules at selected project sites, in the second phase, the project will reduce climate vulnerability for approximately 51 098 lower income producers, strengthen climate resilience in approximately 35 734 ha of production landscapes, increase

producer and institutional capacities to manage climate risk, and generate additional detailed knowledge of performance of these agroforestry systems at scale. This will include the corresponding institutional and producer capacity and other requirements for a future third phase of out-scaling countrywide. This strategy builds on Cuban national policies, programs and legislation encompassing climate adaptation and mitigation priorities (including Cuba´s NDCs), ensuring coherence between the proposed project and national objectives.

221. However, there are significant barriers to effective implementation of this strategy for climate adaptation and mitigation. In general, institutional staff and producers do not have sufficient awareness or knowledge of climate risk reduction benefits of integrated landscape management or skills needed to manage climate risk by applying resilience-enhancing agricultural practices and systems. Financial mechanisms available to farmer and producer organizations do not consider farmer adaptation needs or support resilience-enhancing initiatives to manage landscape resources for improved ecosystem services. Youth and women are disadvantaged when accessing productive resources and training for addressing CC impacts. At the same time, Cuban agricultural and forest management institutions have limited access to international finance and thus are unable to acquire agricultural, information and communication technologies that would allow them to effectively support farmer and producer organizations to implement resilient production systems and restore and improve ecosystem services, including carbon sequestration.

222. The project's second phase will overcome these barriers by focusing on three fund level impacts: A1.0 - Increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions, by targeting farmer and producer associations in areas experiencing significant drought or other climate-driven impacts; A4.0 - Improved resilience of ecosystems and ecosystem services, particularly improved hydrological regulation through widespread implementation of agroforestry systems; M4.0 - Reduced emissions from land use, reforestation, reduced deforestation and sustainable forest management, conservation and enhancement of forest carbon stocks, through the use of trees and shrubs in agriculture and livestock production systems, establishment of close-to-nature forests and assisted natural regeneration of forest plots.

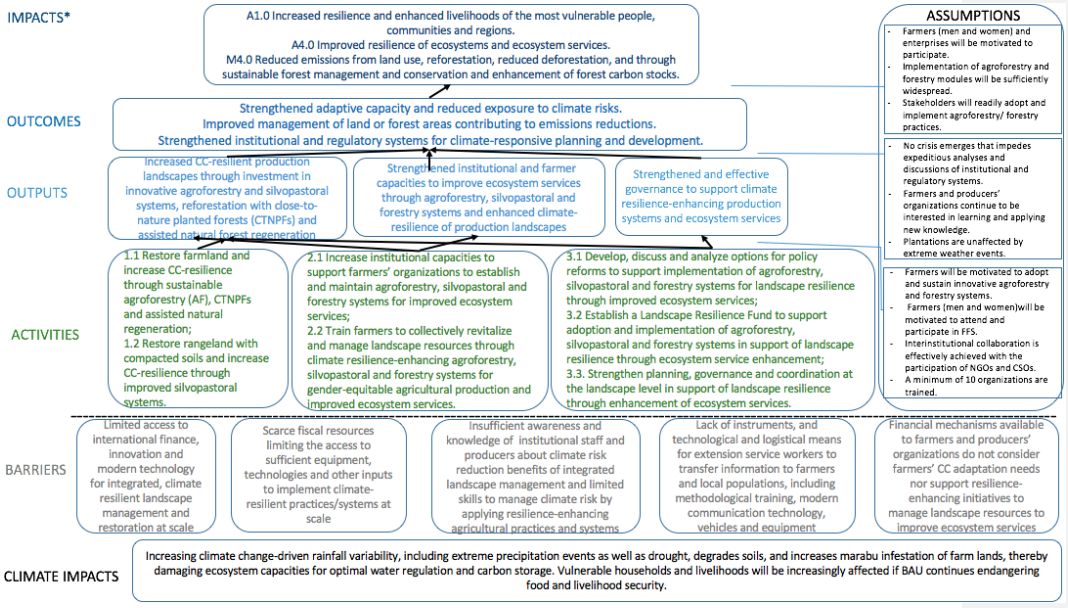
223. These impacts will be the result of the corresponding fund level outcomes: M9.0 - Improved management of land or forest areas contributing to emissions reductions, corresponding to increased CC-resilient production landscapes through investment in innovative agroforestry and forestry systems, and close-to-nature planted forests; A7.0 - Strengthened adaptive capacity and reduced exposure to climate risks, by training for producers and institutional staff and equipping them to manage climate risk; and A5.0 - Strengthened institutional and regulatory systems for climate responsive planning and development, through analysis, discussion and potential reform of current policies, regulatory and planning instruments including establishment and operationalization of an explicit funding mechanism – the Landscape Resilience Fund - to provide incentives to producers to adopt and maintain resilience-enhancing practices and systems.

224. To achieve increased CC-resilient production landscapes through investment in innovative agroforestry and forestry systems, it will be necessary to strengthen ecosystem services of landscapes that have been infested with marabou (*Dichrostachys cinerea*), a non-native invasive woody bush species that dominates other plant species and damages or displaces crops and livestock. The spread of marabou is driven by decreasing and more erratic rainfall resulting from CC and enabled by maladaptive farmer practice. As marabou invades agricultural and pasture land, farmers struggle to cope without required

tools and equipment. This project will support farmer and producer associations to eradicate marabou from agricultural landscapes and replace it with agroforestry, silvopastoral or forestry systems selected from the six tested options. These will be established and implemented with their producers receiving technical support and instruction from specialized trainers from the Ministry of Agriculture to be trained by this project. Producer adaptive capacities will be strengthened through Farmer Field Schools,[94] farmer-to-farmer exchanges, and specialized training. The efficiency and effectiveness of institutional and regulatory systems to assist farmers in building resilience into their agro-ecosystems will be improved through awareness and technical training on ecosystem services and agroforestry systems; farm enterprise planning and value-chain development to generate the revenue farmers require to continually invest in resilience-enhancing practices and equipment; and improved monitoring and evaluation instruments and technologies. Finally, the project will support development and operationalization of a Landscape Resilience Fund, to be financed from GoC fiscal resources, on an annual basis, which will provide a mechanism for financial support in a third phase for countrywide scaling of lessons learned. The project proposed here upscales a proven approach based on research and piloting of agroforestry, silvopastoral and forestry modules in-country; knowledge, skills, capacities and financial mechanism resulting from this second phase will provide the foundation for future national upscaling.

225. The following diagram illustrates this Theory of Change:

Figure 30. Theory of Change diagram.



[94] See Farmer Field Schools description under Activity 2.2.

5.3 Detailed description of project framework and activities

226. The project's objective is *to increase climate-change resilience of agricultural production and ensure food security through improved ecosystem services from agroforestry, silvopastoral systems, reforestation and assisted natural-forest regeneration in seven CC-vulnerable municipalities*. Critical ecosystem services will become more CC resilient, especially in terms of regulation of water flows into and through the production landscape, through landscape rehabilitation and management that increases agro-ecosystem productivity and sustainability by improving water infiltration rates and reducing or preventing run-off and soil erosion. There will also be significant mitigation benefits from integration of trees / bushes into agroforestry and silvopastoral systems as well as through reforestation with close-to-nature planted forests and assisted natural regeneration.

227. The project ensures resilience of agricultural production systems as part of a broader strategy to reduce vulnerability by improving ecosystem services and enabling farmers to apply resilience-enhancing agricultural practices and cropping systems in line with GCF's objectives and in full compliance with relevant Cuban national policies, strategies and NDCs, as described above. The project is structured in three mutually reinforcing and interdependent Components: In Component 1, the project will invest in use of modern technologies to rehabilitate production landscapes through agroforestry, silvopastoral systems, reforestation and previously tested and evaluated assisted natural regeneration modules tested. Rehabilitation of these landscapes will involve removal of *marabou*, a non-native invasive tree, as an essential first step. In Component 2, technical assistance, capacity building and know-how will be provided to ensure farmers know how to replace maladaptive production practices with new resilience-enhancing production practices necessary for effective implementation of landscape rehabilitation modules under Component 1. Component 3 will support analysis, discussion and development of proposals for transformation of policy and planning frameworks required to shift prevailing paradigm of production maximization to a new paradigm of economically viable climate-resilient production systems. This paradigm shift will include analysis of / reforms to current financial mechanisms, such as National Forestry Development Fund and Soil Conservation Fund, and economic incentive instruments. The project will target members of agricultural cooperatives and individual landholders who have not received sufficient support under current public policy in order to unleash their potential and initiative (see Component 3 below for details). GCF funds will be used to purchase essential machinery, equipment, and inputs (e.g., seedlings), train institutional staff and farmers in climate-resilient agricultural practices and systems, and help the government to analyze and enable appropriate reforms to relevant political / legal / financial framework. Government co-financing will cover costs of technical and logistical support to establish CC-resilient production modules, train farmers, and assist farmers with business planning and access to credit and markets.

228. As explained above in Section 1.4, project beneficiaries were selected using three criteria: 1) families most affected by climate change, starting with increased temperatures at local level and its link to extreme weather events, particularly hurricanes; 2) income level, with priority given to those with less income; and 3) emigration rate at municipal level.

229. The project will directly benefit about 51 713 people in the seven target municipalities (see Section 1.4 of this document and Section E.6 in the Funding Proposal); an additional 240 117 inhabitants of target areas will benefit indirectly from increased food security from augmented and more stable production, improved hydrological regulation, and increased opportunities for employment in agricultural tasks and value addition.

Component 1: Climate resilient agricultural systems

Output 1: Increased CC-resilient production landscapes through investment in innovative agroforestry systems, reforestation with close-to-nature planted forests (CTNPFs) and assisted natural forest regeneration.

230. Agroforestry and forestry concepts, methodologies and low-impact modern technology will be applied to restore vital ecosystem services for water regulation, livelihood protection and food security on approximately 35 734 hectares of productive landscapes across the project's seven municipalities. This application of technology will be accomplished by bringing to scale six CC-resilient production modules described in Appendix 2.6 of the Feasibility Study, which have been evaluated for their technical, financial and social feasibility. They are based on local best practice, applied research results from national institutions, and thorough assessment of each module's benefits in terms of climate resilience, adaptation and mitigation. The modules were presented, discussed and adjusted during two consultation workshops with active participation of experts and stakeholders from national, provincial and municipal institutions, as well as social actors in both project areas.[95] Implementation of these modules will result in improved water regulation, decreased soil erosion, augmented soil moisture capacity and groundwater, and improved root penetration, as well as substantial increase in carbon storage in soils and biomass. Crop yields will improve as will farmers' health and well-being by reducing water scarcity and food insecurity.

231. Land productivity will be reconditioned through use of agroforestry systems, silvopastoral or forestry systems (Modules 1–6, described in Appendix 2.6 of the Feasibility Study). The GCF will cover costs of equipment and training for producers to set up and establish the modules but not pay them for operation once established. The government and FAO will coordinate purchase and distribution of machinery and equipment, and the government will guarantee implementation and efficient use of these resources. The GoC has established Integrated Base Enterprises for Technical Services (UEBIST) in each municipality to provide agricultural mechanization services and technical assistance to producers (see Appendix 2.6 for more detailed information). Direct beneficiaries of services will be farmers and other individual producers or small-scale entities of MINAG and ANAP. The UEBIST will continue to provide mechanization and technical assistance services to farmers after the project lifetime and will be an essential part of countrywide scaling-up in Output 3.

232. The multiple ecosystem goods and services provided by agroforestry, silvopastoral, and forestry systems (CTNPFs and assisted natural regeneration) have been extensively documented, indicating their suitability for restoring degraded soils[96] and increasing resilience to climate change[97] (see section 5.1 of the FS). Implementation of these systems will also produce significant mitigation benefits over the 20-year span of growth and utilization of agroforestry, silvopastoral and forestry systems (see section 5.5 of the FS for methodology and results regarding carbon calculations).

[95] The technical description of each module, as well as documentation of two consultation workshops, can be found in Appendices 6 and 10.

[96] Miccolis Andrew et al 2017: Restoration through agroforestry: options for reconciling livelihoods with conservation in the Cerrado and Caatinga biomes in Brazil. Cambridge University Press doi:10.1017/S001447971700013.

[97] Jacobi, J., Schneider, M., Bottazzi, P., Pillco, M., Calizaya, P. and Rist, S. (2013). Agroecosystem resilience and farmer's perceptions of climate change impacts on cocoa farms in Alto Beni, Bolivia. Renewable Agriculture and Food Systems 30(2):170–183.

233. With respect to socioeconomic benefits, production landscapes with multifunctional forests provide promising options for increasing incomes and sustaining livelihoods.[98] They enable diversified production systems because of various intercrops, and reduce risks associated with pests and diseases, while also enabling a wider diversity of products, which reduces the ebb and flow of seasonal harvests.[99]

***Activity 1.1**: Activity 1.1 Restore approximately 15,544 ha of farmland, and increase CC-resilience through sustainable agroforestry (AF), CTNPFs and assisted natural regeneration (mitigation co-benefit 833,950.60 million tCO^2-$_{eq}$. in 7 years of implementation)*

234. While *marabou* provides some soil cover and fixes atmospheric nitrogen, it accumulates only a fraction of the biomass of forests or agroforestry systems.[100] From the climatic and hydrological perspective, replacement of *marabou* by planted forests has these advantages:

- Forests can buffer effects of extreme climate events and higher temperatures and provide alternative sources of food during droughts or floods.[101] Agroforestry systems and CTNPFs are also known to improve microclimates.[102]

- Forests contribute a greater volume of biomass (litter, branches, fruit, etc.) to soil, which, when decomposed, constitutes a key factor in improvement of soil hydro physical properties (structure and porosity, among other factors). In addition, a planted-forest root system is deeper and more expansive so that when penetrating the ground, it opens tunnels through which water filters downward to lower levels, influencing infiltration capacity and soil moisture retention.

- Planted forests have also been shown to regulate the quantity and availability of water, improve water quality, increase groundwater recharge and provide riparian buffers.[103] *Marabou's* influence on water regime is considered comparable to a permanent crop such as fruit trees (mango or citrus), which uses soil similarly to *marabou*. In this case, forest-covered soil has an average runoff coefficient 3.4 times lower and an erosion rate 13 times lower than *marabou*-dominated soil (see Appendix 2.1). They are also effective at controlling erosion and landslides as well as producing organic matter and cycling nutrients. [104]

- Planted forests decrease wind speed and increase the distance over which this influence occurs. This is important for managing water economy in production systems (decreasing losses by evaporation in pastures and agricultural crops). The planted forests, even those not designed as windbreaks, fulfill these functions:

[98] Bene et al., 1977; Sinclair, 2004; Vira et al., 2015, in Miccolis A 2017.
[99] Izac, a. M. N. and Sanchez, P. a. (2001). Towards a natural resource management paradigm for international agriculture: The example of agroforestry research. Agricultural Systems. 69(1–2):5–25.
[100] Only 2–3% of marabou biomass is actually used for poles or charcoal (Herrero J. 2018).
[101] Lasco, R. D., Delfino, R. J. P. and Espaldon, M. L. O. (2014). Agroforestry systems: Helping smallholders adapt to climate risks while mitigating climate change. Wiley Interdisciplinary Reviews: Climate Change 5:825–833.
[102] Kandji, S. T., Verchot, L. V., Mackensen, J., Boye, A., Noordwijk, M., Tomich, T. P., Ong, C., Albrecht, A. and Palm, C. (2006). Opportunities for linking climate change adaptation and mitigation through agroforestry systems. Chapter 13. In World Agroforestry into the Future, pp 113–123 (Eds D. Garrity, A. Okono, M. Grayson and S. Parrott). World Agroforesty Centre.
[103] Araújo Filho, J.A. de (2013). Manejo Pastoril Sustentável da Caatinga, 200. Recife, PE: Projeto Dom Helder Camara. Bargués Tobella, A., Reese, H., Almaw, A., Bayala, J., Malmer, A., Laudon, H. and Ilstedt, U. (2014). The effect of trees on preferential flow and soil infiltrability in an agroforestry parkland in semiarid Burkina Faso. Water Resources Research 50:2108–2123.
[104] Souza, M. de and Piña-Rodrigues, F. (2013). Desenvolvimento de Espécies Arbóreas em Sistemas Agroflorestais para Recuperação de Áreas Degradadas na Floresta Ombrófila Densa, Paraty, RJ. Revista Árvore 37(1):89–98.

a. Planted forests can grow to three times the height of *marabou* and thereby lengthen the distance of influence of winds; and

b. Planted forests have a complex vertical structure composed of herbaceous, shrub and other strata that serve as obstacles and barriers to passage of prevailing winds in the area. These characteristics are absent in *marabou*.

- Planted forests are superior in provision of other services, such as CO_2 sequestration, which is much lower in marabou, given its slow increase in biomass (Vidal *et al*. 2015 in Appendix 2.6); the increase in biomass in the planted forest is 12 times higher than in *marabou*. The conversion of *marabou* to planted forests provides a notable contribution to CC mitigation.

235. Through this project, GCF funds will be used to purchase low-impact modern machinery, such as a mulching tractor,[105] successfully pilot tested under Cuban conditions, which will be applied at scale to clear *marabou* thickets on soils at high risk of climate-driven desertification and degradation. *Marabou* wood and biomass will be ground to wood chips to form a mulch layer that in the short-term will protect soils from rain and sun and eventually restore soil organic matter. The land will then be reconditioned through application of agroforestry systems or CTNPF (Modules 1–4, described in Appendix 2.6 of the Feasibility Study). The GCF will provide equipment and training to producers to establish the modules but not pay them for implementation once established. The government and FAO will coordinate procurement and distribution of machinery and equipment, and the government will guarantee implementation and efficient use of these resources through its Integrated Base Enterprise Units for Technical Services (UEBIST).

236. GCF will finance acquisition of identified technologies, development of training materials, and training of machinery operators, implementation of marabou eradication and soil preparation, establishment of agroforestry and CTNPF modules, and O&M of *marabou* eradication and soil preparation technologies during the project life cycle. The GoC will finance logistical and technical support to trainees during and after training, implementation of agroforestry and CTNPF modules once established and O&M of marabou eradication and soil preparation technologies after project end. The average implementation area for each beneficiary is estimated to be 2.5 ha. Please see Appendix 2.6 of the Feasibility Study for further information on the agroforestry modules.

237. GCF investments to support of this activity will consist of these sub-activities:

1.1.1: Procure identified technologies and equipment;

1.1.2: Develop training materials for operations and maintenance;

1.1.3: Train 74 machinery operators;

1.1.4: Eradicate marabu on 15 544 ha;

Activity 1.2:uct/ Install 452 water reservoirs for the agroforestry systems of a capacity of no more than 4900 m3 and 440 irrigation systems and;

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[105] An example of a mulching tractor can be seen at https://www.youtube.com/watch?v=fVygSS7i3kA.

1.1.6: Establish and implement agroforestry, reforestation and assisted natural regeneration modules.

Activity 1.2: ***Restore approximately 20,189 ha of rangeland with compacted soils and increase CC-resilience through improved silvopastoral systems (mitigation net co-benefit 381,311.51 million t CO^2_{eq} in 7 years of implementation).***

238. There are 20 189 hectares of degraded grasslands in the two project regions with compacted soils, often with a hardpan layer, where root systems grow poorly because of physical resistance and poor moisture movement. These compacted soils do not absorb rainfall, causing accelerated runoff and erosion. During dry periods, the hardpan is an impermeable barrier blocking plant roots from reaching groundwater reserves. To loosen soil and break the hardpan, the project will introduce low-disturbance sub-soiling, designed for conservation agriculture,[106] which will restore the soil pore system, so that rainfall can be absorbed and excess moisture drained downward, recharging groundwater tables and making groundwater accessible to roots during dry periods. Soil structure improvement and stabilization, introduction of improved, more drought-resistant trees, deep-rooted and nutrient-rich pastures, as well as grazing rotation will be achieved through implementation of the two modules for CC-adapted silvopastoral systems described in Appendix 2.6. The average implementation area for each beneficiary is estimated to be 5.0 hectares.

239. GCF will finance acquisition of identified technologies (e.g. sub-soilers, rippers), development of training materials, training of trainers and training of farmers to carry out soil restoration, implementation of sub-soiling of compacted area, establishment of silvopastoral modules, O&M of the soil preparation technologies during the life of the project and resilience-enhancing farm management plans. The Government of Cuba will finance logistical and technical support to trainees during and after training, implementation of silvopastoral modules following initial established and O&M of sub-soiling technologies, water storage, and livestock drinking stations after project end.

240. The project will ensure effective establishment of silvopastoral systems by guaranteeing their water security through improved small-scale water reservoirs and livestock drinking facilities (fountains). The project will construct a reduced number of new water-harvesting and storage facilities. These structures and facilities will be fed from rainwater harvesting and runoff water and conditioned to maximize their efficiency and sustainability through appropriate soil conservation and landscaping. GCF will also finance acquisition of water provision equipment and materials for these modules. The Government of Cuba will cover the costs of labor and other locally available materials for construction of these small water reservoirs, as well as their Operations and Maintenance.

241. GCF investments in support of this activity will consist of the following sub-activities:

1.2.1: Acquire and install in field selected technologies;

1.2.2: Develop training materials;

1.2.3: Train 68 machinery operators;

1.2.4: Implement sub-soiling of 20 189 hectares of compacted rangeland;

[106] Livingston and Blade. Texas A&M University System (http://publications.tamu.edu/FORAGE/PUB_forage_Paratill%20Renovations%20of%20Pastures%20and%20Hayfields.pdf).May 5th 2018.

1.2.5: Construct 700 water reservoirs for livestock (no more than 63m3) and;

1.2.6: Establish and implement silvopastoral modules, including improved grazing systems.

Component 2: Strengthened institutional and technical capacities

Output 2: Strengthened institutional and farmer capacities to improve ecosystem services through agroforestry and forestry systems and enhance the climate-resilience of production landscapes.

242. To catalyze the shift from a tightly focused production maximization paradigm to one of climate resilient production systems that improve ecosystem services, farmer and producer organizations and institutional staff require significant capacity building. These stakeholders require technical training to understand climate change and its effects on agro-ecosystems and production landscapes; the role of forests, agroforestry and silvopastoral systems in production of ecosystem goods and services; and climate-change adaptation in agricultural production. In addition, farmers need to develop skills to adopt and apply resilience-enhancing agricultural practices and systems. Motivation to adopt and apply these systems stems from interest in sale under contract of agricultural products to government programs and the possibility of accessing the supply-and-demand markets. As part of capacity development activities under this output, farmers will receive training on how to access secondary supply-and-demand markets, and producer organizations will work with MINAG to analyze and develop value chains for specific products from climate-resilient production systems. Government will ensure that production contracts are provided to producer organizations for adequate sale of harvests, and will provide technical assistance to producers to access supply-and-demand markets.

Activity 2.1: Increase institutional capacities to support farmer and producer organizations to establish and maintain agroforestry, silvopastoral and forestry systems for improved ecosystem services.

243. The project will apply a comprehensive approach to agro-ecosystem management in order to maximize the ability of agroforestry, silvopastoral and forestry systems to mitigate extremes in water availability and volumes while maintaining productivity. This approach builds on farmers' knowledge and experience of actual climate conditions, cropping and livestock production systems and water management; incorporates use of resilience-enhancing soil, water and crop cultivation technologies (sub-soiling, zero-till, precision fertilization, drip irrigation, etc.); and promotes application of a package of low-cost agricultural practices based on agro-ecological principles that reduce risk from drought. Adoption of this approach by farmer and producer organizations will be supported through training, coaching and technical advice by institutional staff from MINAG and its affiliated institutes and agencies.

244. MINAG will strengthen and intensify its train-and-visit system, coupling off-site instruction and participatory research with onsite farm visits to provide technical assistance. MINAG extensionists and "champion farmers" will be trained to support farmer and producer organizations to acquire the skills needed to establish, maintain and operate resilience-enhancing agroforestry, silvopastoral and forestry systems across production landscapes. The project will train extension workers from MINAG to train farmers in Farmer Field Schools (FFS) in the seven municipalities, according to the type of agroforestry, silvopastoral or forestry system to be implemented and provide technical expertise to help farmer groups maintain agroforestry, silvopastoral and forestry systems established under Output 1, above. Trainers of

extensionists will be identified from an in-house roster of qualified MINAG experts. Extension workers will promote farmer-to-farmer exchanges in FFS and through farmers' markets and agricultural fairs.

245. Extensionists will also receive necessary logistical and technological support from MINAG to monitor out-scaled agroforestry, silvopastoral and forestry systems, collect and store data, provide onsite advice / training and build an interactive network of agroforestry / silvopastoral / forestry practitioners.

246. GCF will finance acquisition or development of substantive pedagogical materials, training of trainers and training of extensionists. The GoC will finance logistical and technical support to trainees during and after training.

247. GCF investments to support this activity will consist of these sub-activities:

2.1.1 Develop training materials;

2.1.2 Train 443 extension service technicians, agricultural technicians, and cooperative leaders / administrators to lead farmers in gender- and age-sensitive learn-by-doing on implementation, operations and maintenance of their agroforestry or forestry systems. Topics covered may include no-till cultivation, inter-cropping, cut-and-carry forage feeding, sub-soiling, soil conservation with gabions, gully plugs, bunds, contour farming, agroforestry and silvopastoral system design, application of efficient irrigation technologies, water harvesting and storage systems, among others; and

2.1.3 Development of supplementary learning materials and information on CC, ecosystem function and services, agro-ecology, agroforestry and forestry systems, and farm economics.

Activity 2.2: Train agricultural producers to collectively revitalize and manage landscape resources through climate resilience-enhancing agroforestry, silvopastoral and forestry systems for gender-equitable agricultural production and ecosystem services.

248. The long-term construction of climate-resilient production landscapes requires farmers to adopt and apply cropping and livestock systems that improve and maintain ecosystem services and agricultural productivity as they adapt to evolving climate hazards. Aside from concrete inputs and activities provided under Component 1 above, to establish agroforestry and forestry systems, farmers require a substantial body of knowledge of agro-ecology, CC adaptation and mitigation, agroforestry, silvopastoral forestry systems management, and basic business economics to generate revenue needed to sustain adopted practices and systems. Given their day-to-day activities, farmers possess a solid basis of experience and knowledge to build on and complement. At the same time, farmers also need to acquire practical skills to apply new knowledge to strengthen climate resilience in their production systems. Farmer Field Schools (FFS) are the most effective ways to carry out farmer training. The project will establish an integrated FFS program to cover the seven municipalities and their different agroforestry, silvopastoral and forestry systems. FFS programs work at multiple scales to build social capital by helping to strengthen producer organizations and contribute to greater organizational capacity along the entire value chain – from financing, post-harvest processing and marketing, to investments.

249. The Farmer Field Schools (FFS) approach[107] was developed by FAO and its partners over 20 years ago as an alternative to the then-prevailing top-down extension method of the Green Revolution, which failed to work in situations where more complex and counter-intuitive problems existed.

250. This project will establish 17 FFS in appropriate locations in the seven project municipalities based on the agroforestry, silvopastoral or forestry systems to be implemented, and logistical and other considerations such as market availability and disposition. These FFS will provide farmers with information and knowledge on CC, ecosystem function and services, agro-ecology, agroforestry, silvopastoral and forestry systems, and farm economics, as well as knowledge and information on practical consequences and applications for their farming practice. In order to generate revenue to pay for ongoing adaptation to climate change, farmers will learn farm and business planning, as well as new practices, such as no-till cultivation, inter-cropping, cut-and-carry forage feeding, sub-soiling, soil conservation with gabions, gully plugs, bunds, contour farming, agroforestry system design, application of efficient irrigation technologies and water harvesting and storage systems, etc.

251. The FFS will pay particular attention to specific needs of women farmers and youth, devising gender- and age-sensitive curricula and learning-by-doing methodologies.

252. The GCF will finance establishment of the Farmer Field Schools – generally agroforestry, silvopastoral and/or forestry plots, and irrigation and soil preparation technologies where training and experience of new systems and technologies can take place. GCF resources will also cover costs of training farmers throughout the seven target municipalities. The Government of Cuba will finance logistical and technical support for trainees during and after training.

253. GCF investments in support of this activity will consist of these sub-activities:

2.2.1 Establish or strengthen 17 Farmer Field Schools in appropriate locations in the seven municipalities based on type of agroforestry, silvopastoral or forestry system to be implemented and logistical and other considerations; and

2.2.2 Implement 17 Farmer Field Schools and training for 15 549 farmers using a learn-by-doing approach.

Component 3: Strengthened governance, legal and regulatory framework

Output 3: Effective governance to support climate-resilience-enhancing production systems and ecosystem services.

Activity 3.1: Develop, discuss and analyze options for policy reforms to support implementation of agroforestry, silvopastoral and forestry systems for landscape resilience through improved ecosystem services.

Transform policy instruments and incentive mechanisms to promote adoption and implementation of agroforestry, silvopastoral and forestry systems for climate-change adaptation and mitigation.

[107] The following description of FFS is adapted from http://www.fao.org/agriculture/ippm/programme/ffs-approach/en/

254. The project will facilitate policy-review processes to determine adjustments or modifications that should be made in existing land use, development, environmental or other policy instruments to enhance national scale adoption of agroforestry and forestry systems for climate change adaptation and mitigation. This will be achieved through a combination of expert-led desk reviews of instruments and their implications and provisions, multilevel and multisectoral workshops informed by the desk reviews to discuss and prioritize needs for adjusting policy instruments, and institution-specific analytical, advisory and orientation support. An inter-institutional working group will be established and an operational plan developed to adjust public policies and regulatory frameworks as necessary. Corresponding discussion spaces will be established at technical, institutional / ministerial and legislative levels, as well as at local / municipal levels.

255. GCF investments to support this activity will include the following sub-activities:

3.1.1 Ten workshops and expertise (three international and national experts) to facilitate inter-institutional analyses and discussions regarding needs and options for modification / reform of agricultural and land-use policy;

3.1.2 Definition and discussion of institutional modifications / adaptations to support different options for policy reforms for landscape resilience through improved ecosystem services;

3.1.3 Development of specific proposals for policy reforms; and

3.1.4 Discussion of reform proposals at the national level.

Activity 3.2: Establish a Landscape Resilience Fund to support adoption and implementation of agroforestry, silvopastoral and forestry systems to support of landscape resilience through improvements to ecosystem services.

256. Project interventions will improve accessibility to incentives from the National Forestry Development Fund and the Soil Conservation Fund by transforming them into a single Landscape Resilience Fund focused on farmer cooperatives and especially vulnerable small landholders. For example, these Funds offer public incentives as part of a group of actions proposed by the government designed to pay cash to producers for adopting more environmentally sound production methods that use less chemicals. These incentives are both short term and long term. The project will also contribute to small-scale diversified production landscape rehabilitation supporting land usufruct schemes from individual landholders to implement land usufruct Decree No 300/2012. Through this activity, FAO will provide the Government with assistance in legal, regulatory and policy matters, and facilitate inter-institutional dialogue to implement the clear political mandate contained in NDP 2030, *Tarea Vida* and NDCs, and overcome barriers that still hinder their implementation. An in-depth analysis of current coordination mechanisms at provincial and local levels and institutional resources and capacities for project implementation can be found in Appendix 2.7.

257. With project support, MINAG will transform its Forestry Development Fund (FONADEF) and Soil Conservation Fund (SCF), and other established funds to support land use and rural development into a single Landscape Resilience Fund (LRF); no GCF funding will be used to capitalize the LRF. The purpose of Landscape Resilience Fund will be to promote, incentivize and otherwise support resilience-enhancing land use by farmer and producer organizations around the country as well as to support CC adaptation and mitigation policies, starting with the most vulnerable geographic areas.

258. Transformation of FONADEF and SCF will initiate with expert analysis of their current funding scope, organization, financing, management and administration, and identification of strengths and weaknesses, lessons and best practice of these funds as well as others from around the world. At the same time, expert analysis will be carried out on the feasibility of a single Landscape Resilience Fund, identifying necessary modifications, reforms and other steps required to make it a reality. As part of LRF feasibility study, analysis will be undertaken on options for economic instruments to sustain the fund, criteria for grants and loans, governance arrangements, integration with public policy priorities, and other topics. As appropriate, MINAG and other authorities will discuss and debate expert analysis and the LRF study as prelude to decision making regarding establishment and operationalization of a Landscape Resilience Fund. With LRF establishment, MINAG will develop and execute a communications strategy to generate interest in the Fund and its objectives on the part of farmers throughout Cuba.

259. The GCF will cover costs of workshops and expert analyses and assistance; international exchanges to incorporate lessons learned from other governments and institutions; development of proposals for reforms to regulations, policies and planning; analyses of financial mechanisms and economic instruments to incentivize farmers to adopt and maintain resilience-enhancing practices and cropping systems; and development and execution of a communications strategy to engage farmers with the LRF. The Government of Cuba will provide discussion and working spaces for consulting experts, task forces and working groups, as well as logistical and organizational support.

260. GCF investments to support this activity will consist of these sub-activities:

3.2.1 Expert analyses of existing funds (FONADEF, SCF) and other regional and global funds;

3.2.2 Ten workshops to analyze and develop options for a Landscape Resilience Fund to implement landscape resilience policies on the ground;

3.2.3 Design of Landscape Resilience Fund to support resilience-enhancing land use by farmer and producer organizations;

3.2.4 Formal legal establishment of the Landscape Resilience Fund; and

3.2.5 Design / disseminate of a communications strategy and materials.

Activity 3.3: Strengthen planning, governance and coordination at the landscape level in support of landscape resilience through enhancement of ecosystem services.

261. Reinforcement and maintenance of climate resilience in production landscapes requires effective governance as well as efficient planning and management of landscape resources – soil, crops, forest habitat, and water. This project will train key organizations in the seven target municipalities for effective and collaborative participation in planning and decision-making processes that determine management outcomes, outputs and activities in target landscapes to improve climate resilience. Strengthening of governance mechanisms will also include development of norms, agreements and organizational capacities for collaborative management in areas targeted for restoration to augment the stability and sustainability of water flows into, across and / or out of the landscape as a key element in enhancing its climate resilience.

262. Targeted organizations will have access to required modeling and visualization technologies to improve their analytical capacities along with the most effective tools and instruments for coordinated planning and management of landscape resources from farm to landscape level. Women and youth will receive specific attention to ensure that their interests, concerns and perspectives are represented in these processes both individually as members of organizations, as well as collectively in women's and youth organizations. Participating organizations include cooperatives and other producer associations, entrepreneurship groups, youth groups, and women's groups, including the *Asociación Cubana de Técnicos Agricolas y Forestales* (ACTAF), *Asociación Cubana de Producción Animal* (ACPA), *Asociación Nacional de Agricultures Pequeños* (ANAP), *and Federación de Mujeres Cubanas* (FMC).

263. The project will also support multilevel review and analyses of existing landscape planning methodologies through inter-institutional collaborative teams and provincial discussion and debate forums to integrate climate adaptation and mitigation principles / concerns into these instruments, including prioritization of agroforestry / silvopastoral / forestry systems for sustainable production and ecosystem service restoration. Institutional staff will train municipal environmental units, local development associations, and local communities to analyze, discuss and propose agreements and negotiate standards on governance of natural resources at the landscape level, including protection of aquifer recharge areas, micro-watersheds and headwaters, and areas targeted for restoration.

264. GCF will cover the costs of development of strategies and local planning for resilience-enhancing land use management, integration of climate change principles into local plans and programs, and use of modeling and visualization technologies for coordinated planning and management of landscape resources. GoC resources will cover logistical and ongoing support to local organizations and institutional staff for participation in training workshops and forums.

265. GCF investments to support this activity will consist of the following sub-activities:

3.3.1 Train 30 senior management staff from 10 local branches of different organizations *(Asociación Cubana de Técnicos Agricolas y Forestales* - ACTAF, *Asociación Cubana de Producción Animal* - ACPA, *Asociación Nacional de Agricultures Pequeños* - ANAP, and *Federación de Mujeres Cubanas* - FMC) for efffective participation in local planning and decision-making processes;

3.3.2 Multilevel review and analysis of landscape resilience policies and planning instruments as a framework for adaptive landscape management; and

3.3.3 Conduct 15 workshops to strengthen coordination in local landscape governance structures for climate change adaptation: *Comisión de Reforestación, Grupo de Bahía, Comisión de Cuencas Hidrograficas, Comisión de Asuntos Agrarios; Grupos Provinciales* and *Tarea Vida* municipalities.

5.4 Potential risks and mitigation measures

266. This Project has been classified as moderate risk (Category B) due to activities in Outcome 1, which are expected to activate the following FAO Socio-Environmental Safeguards Policies: ESS 1 (1.1), ESS 2 (2.3, 2.4); ESS 3 (3.2.1) and; ESS 5 (5.1) - which were all evaluated as presenting moderate risk. The main reasons for this are risks introduced by limited use of herbicides for *marabu* control, use of heavy machinery for marabou clearing, seed management and risks of controlled use of species that may show

invasive behavior in conditions without management. In order to comply with these policies, the following specific safeguard instruments have been identified:

Safeguard policies	Applicability	Safeguard instruments and mitigation measures
ESS 1**– Natural resources management**	YES	Agricultural conservation principles will be applied, especially for use of appropriate implements and minimum tillage, as well as amendments following specific damages resulting from machinery use.
ESS2 **– Biodiversity, ecosystems and natural habitats**	YES	ESMF / ESMP with proposals for strict species management and greater attention on planting in silvopastoral modules based on experiences validated by research and mitigation measures. Also, with measures to reduce impacts caused by incremented use of water, machinery and chemical products.
ESS3 **– Plant genetic resources for food and agriculture**	YES	ESMF / ESMP, seeds and planting materials free from pests and diseases, locally adapted. Following national Phytosanitary and IPPC norms.
ESS4 **– Animals - genetic livestock and aquatic resources for food and agriculture**	NO	Non-eligible activities (see Appendix 6.1 of Annex 6 of the Funding Proposal).
ESS5 **– Pest and pesticide control**	YES	ESMF / ESMP with integrated pest management (IPM) used in activities, training on safe management and use of pesticides in cases when unavoidable. A tentative Pest Management Plan (PMP) is provided in Annex 2.
ESS6 **– Resettlement and involuntary displacement**	NO	Non-eligible activities (see Appendix 6.1 of Annex 6 of Funding Proposal).
ESS7 **– Decent work**	NO	Non-eligible activities (see Appendix 6.1 of Annex 6 of Funding Proposal).
ESS8 **– Gender equality**	NO	The project incorporates a gender analysis and action plan with specific activities focused on gender incorporated into project design.
ESS9- **Indigenous peoples and cultural heritage**	NO	Non-eligible activities (see Appendix 6.1 of Annex 6 of Funding Proposal).

267. Table 34 below presents main potential risks identified as well as recommended mitigation measures. Risk factors 1-5 (environmental and social) are related to Outcome 1, where the most significant potential negative impacts are expected.

Table 34: Potential risks and mitigation measures

Selected Risk Factor 1		
Category	Probability	Impact

Other	Low	High
Description		
The use of invasive alien species (IAS) could cause damage to biodiversity and agro-ecosystems. Certain tree species that manifest invasive behavior, and already introduced in Cuba, will be managed in a controlled manner to minimize biodiversity and ecological risks. The alien species to be used have been in Cuba for decades with no reported problems; however, native species will be favored where feasible.		
Mitigation measure(s)		
● Make implementation adjustments to SILLEC and SILSOM modules to include strips of trees to act as barriers to expansion of herbaceous IAS. ● Adjust SILLEC and SILSOM modules calendars of activities to guarantee adequate planning for minimizing risks. ● Execute constant monitoring of species behavior in implementation areas and their vicinity. ● Establish a management plan[108] for early detection, control and eradication of IAS. ● Provide training to extension agents and technicians on characteristics and management of IAS, with emphasis on those of the project. ● Develop an Early Warning Protocol linked to IAS expansion in management plans.		
Selected Risk Factor 2		
Category	Probability	Impact
Other	Low	Medium
Description		
The use of pesticides may cause soil and water contamination problems and affect biodiversity and human health. These will be applied to a limited extent, in specific areas and only in initial phase of the project. No highly hazardous pesticides will be used in project areas.		
Mitigation measure(s)		
● Implement integrated pest management (IPM). ● Prepare a Pest Management Plan that will be a part of project's social and environmental commitments. ● Ensure acquisition and use of protection necessary to ensure health of the producers who will be trained to perform these tasks. The means of application will be adequate. ● The entities that store and handle pesticides will follow their established management plans.		
Selected Risk Factor 3		
Category	Probability	Impact
Other	Low	Medium
Description		
Phytosanitary risk due to non-compliance with rules established for seed management.		
Mitigation measure(s)		

[108] Appendix 2.6.2 of Annex 6 of the Funding Proposal. Guide to elaborate the Invasive Alien Species management plans.

- Improve local seed production system (local seed farms).
- Meet bio-security and phytosanitary standards to ensure protection for seed production areas.
- Guarantee that seeds and planting materials are from locally adapted crops and varieties that are accepted by farmers and consumers.

Selected Risk Factor 4

Category	Probability	Impact
Other	Medium	Medium

Description

Possible impact on surrounding environment resulting from use of more machinery, water and chemicals with respect to baseline with potential increases in amounts of dust particles, gas emissions, including GHG (without affecting total emission balance), and possible effects on water quality and aquatic life.

Mitigation Measure(s)

- Apply principles of agricultural conservation, especially on use of appropriate implements and minimum tillage to reduce dust emissions.
- Select machinery using concepts of fuel efficiency (lower GHG emissions) with low gas emissions (with filters).
- Install small irrigation schemes in accordance with low resource availability.
- Monitor state of water resources (availability and quality).
- Directly harvest rainwater and runoff in traps and reservoirs to increase availability in dry periods for irrigation and livestock supply.
- Conduct efficient water management following strict planning and national regulations established in "Water Plan" without creating competition with human supply or pressure on aquifers.[109]
- Promote an integrated water management system as part of preparation for small farmers and extensionists.
- Use climate information for planning and efficient use of water.
- Install hydrometric equipment to monitor and adjust consumption.
- Apply measures established in the National Soil Conservation and Improvement Program and indicators designed to determine impact of measures applied, in addition to taking into account good practices appraised by the Viñales Forest Station (Pinar del Rio).
- Implement integrated pest management.
- Prepare Pest Management Plan as part of the project's social and environmental commitment plan.
- Ensure acquisition and use of necessary protections to ensure health of the farmers who will be trained to perform these tasks. The means of application will be appropriate.
- Management plans developed by entities that store and manage pesticides.
- Install efficient irrigation systems (preferably drip irrigation).

Selected Risk Factor 5

[109] More information on the Cuban Water Plan is available in ANNEX 2 FEASIBILITY STUDY, Appendix 2.6: AGROFORESTRY MODULES FOR LANDSCAPE RESTORATION.

Category	Probability	Impact
Other	Low	Medium
Description		
Possible biological or physical degradation of soil as a result of impact caused by machinery use.		
Mitigation measure(s)		
• Apply principles of agricultural conservation, especially for use of appropriate implements and minimum tillage. • Amend specific impacts of heavy machinery use, mainly those derived from *marabou* pruning. • Apply measures established in the National Soil Conservation and Improvement Program. • Carry out soil monitoring to update its characterization and determine specific measures to apply for improvements and maintenance of its productive capacities. • Develop robust systems of organic matter production from crop residues, pruning and other residuals to incorporate them into soil within agro-ecosystems that generate them.		
Selected Risk Factor 6		
Category	Probability	Impact
Technical and operational	Medium	Medium
Description		
Limited availability of qualified human resources with necessary field experience to mainstream climate resilience and adaptation concepts and approaches into agroforestry, silvopastoral and forestry schemes and marabou eradication.		
Mitigation measure(s)		
The project will use FAO's experience and regional contacts to support identification of highly qualified and motivated candidates with required experience to introduce and promote new landscape restoration and multifunctional, sustainable plantation and agroforestry concepts.		
Selected Risk Factor 7		
Category	Probability	Impact
Other	Medium	Medium
Description		
Farmers, communities and new landholders benefitting from the project have little interest in project activities and implementation of agroforestry and CTNPF modules.		
Mitigation measure(s)		
The project will promote previous experiences that were successfully implemented and provide the basis for proposed modules. The project will engage stakeholders by providing training opportunities, access to new technologies and financial incentives to promote module implementation with a focus on areas classified as most vulnerable to climate change.		
Selected Risk Factor 8		
Category	Probability	Impact

Other	Medium	High
Description		
Hurricanes and tropical storms are striking Cuba with increasing frequency and intensity. The intensity and prospective impact on soils and water are unpredictable, with stronger storms doing greater damage overall.		
Mitigation measure(s)		
Cuba has a strong civil defense system which, when deployed before storms strike, has resulted in reduced numbers of casualties and property damage. Every effort will be made to limit damage to property and loss of life in project areas if these are struck by hurricanes or tropical storms. The project itself is oriented to creating and strengthening agro-ecosystems that are resilient to these extreme events; over time, as the agroforestry, silvopastoral and forestry modules increasingly take root and provide greater ground cover, damages from these storms can be expected to decrease proportionately.		

268. All the environmental and social risks are considered moderate, with limited spatial footprint and temporal duration, and controllable through protocols outlined in the Environmental and Social Management Framework available in Annex 6 of the funding proposal.

5.5 Carbon estimations

269. Appendix 2.3 provides an analysis of carbon balance estimations for proposed interventions in the PIA. The net carbon balance quantifies GHGs emitted or sequestered resulting from the project compared to "without project" (BAU) scenario. In this case, results indicate that the project constitutes carbon sink of -2,675,727 million tCO2-eq in 20 years. Without this, Cuba will be limited to intervene only in 50% of the proposed area based on projections for future operations, thus reducing intervention scalability. This indicates the project can also make an important contribution to mitigation, which complements adaptation and resilience objectives.

Table 35. Summary of results mitigation impact per module

	Area (ha)	C balance (tCO2-eq) year^{-1}	C Balance tCO2-eq. in seven years of implementation	C Balance tCO2-eq. in 20 years
1. CEDPLA Cedrela / plantain agroforestry system	1753.58	-7704	-53928	-154081
2. FRUAGR Fruit trees, agricultural crops and living fences agroforestry system	2529.36	-784	-284248	-15687
3. MARREG Natural regeneration	3094.7	-40607	-284248	-812138

management of native arboreal species				
4. MARFOM Establishment of close-to-nature planted forests	8166.52	-30218	-211526	-604359
5. SILLEC Silvopasture with arbustive leguminous	10498.6	-22947	-160630	-458943
6. SILSOM Silvopasture with shade trees and protein banks	9691.2	-31526	-220682	-630519
Total	**35,733.96**	**-133,786**	**-1,215,262**	**-2,675,727**

5.6 Economic and Financial Analysis

270. Alternative Funding Options: Due to the global geopolitical context, Cuba faces serious barriers to access to international financing, technologies and know-how. Furthermore, other funds like the GEF cannot fund this project as it goes beyond the scope of the GEF Focal Areas. However, lessons learned from the previous GEF-funded initiative on invasive species are being incorporated in the design of the FP, particularly with regards to Marabú, and coordination with current and new GEF initiatives will be pursued. The funding requested from the GCF is therefore crucial to address existing technology gaps and to achieve the necessary paradigm shift to increase resilience of sustainable livelihoods, agricultural and productive landscapes, as well as ecosystem services.

271. An economic and financial cost-benefit analysis was carried out for the four agroforestry production modules and of the two proposed silvopastoral modules of the project IRES, based on the technical information compiled from official sources and on the information gathered by the project formulation team. In order to perform an economic and financial analysis on the incremental benefit that is generated with the implementation of IRES, flows of costs and benefits for the situation with and without the project were forecasted for a twenty-year period, which is the Project lifespan, and for the mid-term 10-year horizon. In order to compare the financial indicators between the modules, the incremental net benefit was estimated per hectare.

272. Market prices of inputs and outputs were considered for the projection of costs and benefits, as well as reference values for ecosystem goods and services obtained from peer-reviewed sources. A 20-year horizon was considered given the type of investments, as it reflects the full income flow and the project lifespan. To evaluate the financial and economic indicators in the medium term, a 10-year horizon was also projected. The analysis was completed with a financial discount rate of 12% and the following percentages of project area incorporation were considered: 10% of the area was incorporated into the project in year 1, 20% in year 2, 30% in year 3, and 30% in year four, which means that the full incorporation is completed in year five with the remaining 10%. This is aligned to the project implementation schedule in Appendix 2.6 of this Document.

Financial analysis

273. As presented in Section 1, climate change currently affects forests and pastures in cattle areas, which is expected to worsen according to climate change projections. Conditions of increased temperatures and variations on precipitation patterns due to climate change effects will benefit the expansion of Marabú that has a high capacity for adaptation, recovery and growth. Considering the high costs of rehabilitation of lands invaded by Marabú, farmers who own land under these conditions do not have the economic capacity to make investments for their recovery; what leads to keeping these lands in abandonment; limiting the development of production systems that allow the conservation of soil and water resources; as well as generating income to improve their living conditions and their adaptation capacity to climate change. Taking into consideration that the agroforestry modules proposed in Output 1 of this project will be implemented in areas that would remain unused without the project, all the investments, costs and income would be incremental.

274. In order to compare the financial indicators between the modules, the net benefit was estimated per hectare. Taking into account a 20-year horizon, the proposed models proved to be financially viable (please see Table 1 in Annex 3 for the financial evaluation indicators of the agroforestry and silvopastoral modules of the IRES project, specifically, the net present value, the internal income rate and the equivalent annual NPV for planning horizons of 10 years and 20 years), except for the MARREG model. The incremental net present value and the internal rate of return ranged between - US$1,998 (IRR of 2.45%) and US$82,430 (IRR of 29.52%). The Annual Incremental Equivalent NPV, which is equivalent to the yearly incremental net present value, ranges from - US$268 to US$11,036. The results show that the models generate benefits for farmer families that are higher than the investment costs. The results for a 10-year horizon show that almost all of the project modules present a positive incremental net present value in a medium-term analysis, except for the agroforestry MARREG, MARFORM and FRUAGR models.

275. It should be remembered that MARREG has very particular characteristics when compared to the rest of the modules, since it is focused on the conversion of marabuzales into forests through assisted natural regeneration, a novel technique with the potential to scale up throughout the country. This module is based on soils of very low agro productivity with severe limiting factors (low effective depth, high rockiness, low organic matter content, etc.); in these areas, it becomes more difficult to implement other agroforestry systems that require greater availability of labor, which is not always possible due to the remoteness of human settlements.

276. The MARFOM module seeks the implementation of multifunctional forest plantations on a large scale and with an optimum level of mechanization in areas infected by Marabú, constituting a safe and stable source of income and employment generation, improving the quality of life for families, which puts them in a less vulnerable situation in the face of extreme weather events that affect their homes. The timber exploitation of forest species included in this module begins with pruning and thinning practices, generating marginal income in year 8, with an 11% share of total income in 20 years. Full timber exploitation is reached until the year 20, due to the characteristics of forest species.

277. FRUAGR seeks to improve families' increased resilience to climate change; as well as to achieve greater stability in the supply of annual agricultural and perennial fruit products. These fruits will be marketed, generating income and jobs. This module has two characteristics that delay profitability; 1) the income of fruit species is only commercially reached in year 5; 2) the module includes annual crop production, which will generate permanent income from the first year; but due to limitations to irrigation availability it is not possible to establish crops in summer, reducing income and profitability in the medium term.

278. A financial benefit was estimated for Output 1 (Increased climate change resilient production landscapes through investment in innovative agroforestry and silvopastoral systems) that considered an investment cost of US$ 34.66 million contributed by the Green Climate Fund and US$ 76.29 million of national matching contribution. The general benefits were estimated by adjusting the net financial flow for each productive module for a 20-year horizon based on the total area included in each module, taking

into account the gradual inclusion of the participants over five years. The total net financial present value of Output 1 is estimated at US$ 115.98 million, with an internal rate of return of 19.8%. This means a financial net present value per hectare benefited of US$ 3,245.97, and a net present financial value for each participating household of US$ 7,263.83. This per household result refers to the average household considering the clustering in associations and the fact that different combinations of modules will be selected for planting in each area. For a 10-year horizon, the total net financial present value is estimated at - US$38.9 million, with an internal rate of return of 5.2%. The lower results, considering a medium-term horizon, can be explained by the gradual benefits of the proposed modules that will have a long-term effect.

279. A Monte Carlo simulation of Output 1 was performed to analyze the uncertainty, as part of the financial analysis using the Crystal Ball software. The results reveal that there is a probability of less than 1% of obtaining a negative net present value in the 20 years' time horizon. This probability is a proxy of the long-term financial risk of the project.

280. To evaluate the robustness of the financial feasibility of IRES, a sensitivity analysis was also performed, to evaluate how the financial indicators of the Output 1 of the project change with variations in key variables:

- Reductions in expected revenues from agriculture models.
- Delay in benefit generation due to lags in project implementation
- Increment in investment costs.

Table 2 in Annex 3 of the Funding Proposal shows that the net present value of the Output 1 of the project is still positive in financial terms even in the case of a reduction of 40% of expected benefits, a delay in benefit generation of 4 years and significant cost overruns. This reveals the robustness of IRES.

281. Outputs 2 and 3 are essential for achieving the results expected with the implementation of Output 1 and the contributions of the GCF are key. Output 2, which will benefit the development of capacities to adapt to climate change, with the objective of establishing a structure that facilitates the transfer of knowledge and the development of capacities to promote adaptation interventions based on ecosystems. Output 3, which includes new mechanisms of financial incentives, to support inter-institutional dialogue and review and the needs in the legal and regulatory framework to incorporate adaptation to climate change. Therefore, the benefits of these outputs were included in the economic analysis presented below.

Economic Analysis for Agricultural Production

282. This economic analysis considers the same assumptions that were specified in the financial analysis of the agroforestry and silvopastoral modules, but with the difference that the economic analysis included economic values. The analyses (presented in detail in Annex 3 of the Funding Proposal) used a high economic discount rate of 12% and different conversion factors, which have been used in similar studies in Cuba, to calculate the economic prices of products, labor, tools and equipment.

283. An evaluation of the economic feasibility of the agricultural activities of IRES was performed considering medium and long term horizon, obtaining as a result incremental net present values and internal rates of return that ranged from - US$33.2757 million to US$21.588 million and 3.78% to 15.2%, respectively.

284. The incremental economic benefits for the project are from the improvement and restoration of ecosystem services in the biomes in which the project activities will be implemented. It is considered that the project will benefit 15,544 hectares of woodlands and 20,190 hectares of grasslands. It is assumed that these ecosystems currently have a capacity to provide ecosystem services of 60% of their potential (baseline) due to their degradation. Therefore, project will seek to restore their full capacity to provide

ecosystem services. The values presented in the Table 3 of Annex 3 are being considered as benefit for biomes restoration.

285. The incremental carbon sequestration and storage benefits were modelled over a period of 20 years, although it is expected that the impact would last longer. A shadow price of US$50/tCO2 is the social value of carbon considered, with an annual incremental rate of 2.25% as proposed by the World Bank[110]. The expected emissions reduction over the assessment period (20 years) is estimated as 2,675,727 tCO2eq.

286. The two indicated sources of benefits (agriculture and climate) were aggregated to obtain the overall estimation of the economic value of IRES, considering the total investment cost of US$119.9 million, taxes excluded (US$38.2 million from Green Climate Fund and US$81.7 from National Matching Contribution). The economic benefit for the entire project is estimated in The economic benefit for the entire project is estimated in US $21.588 million, with an internal rate of return of 15.2%. In other words, with an investment of US$119.9 million, it is expected to create economic benefits in excess to the opportunity cost of capital (12%) and produce a bonus of US$21.588 million. This means an economic net present value per benefited hectare of US$604.15, an economic net present value per household of US$1,351.98 and an economic net present value per beneficiary of $422.49, considering 3.2 family members per household.

287. Of the total economic benefits of US$21.588 million, 20.41% (US$4.405 million) are global in nature, relating to the provision of ecosystem services in the form of carbon sequestration; the remaining 79.59% (US$17.182 million) accrue to Cuba, in the form of the increased resilience of agriculture in the project areas.

Uncertainty and sensitivity analysis

288. An uncertainty analysis was performed on the economic analysis of IRES and results reveal that there is less than 1% of probability of obtaining a negative net present value in the long term for the project.

289. To evaluate the robustness of the economic behavior of IRES, a sensitivity analysis was also performed, to evaluate how the economic indicators of the project as a whole change with variations in key variables:

- Reductions in expected fluxes of benefits from agriculture, ecosystem services and carbon sequestration during its lifetime.
- Delay in benefit generation due to lags in project implementation
- Increment in investment costs.
- Variation in baseline of shadow price of ton of CO2 sequestered.

290. Table 5 in Annex 3 shows that the overall net present value of the project is still positive in economic terms even in the case of a reduction of 20% of expected benefits, a delay in benefit generation of 2 years, significant cost overruns (20%) or a reduction in the social value of the carbon sequestered ($40).

5.7 Implementation arrangements

291. The Cuban government has requested FAO act as Accredited Entity (AE) for project preparation and implementation. The project is aligned with priorities defined in the Country Programming

[110] The World Bank Group. Shadow Price of Carbon in Economic Analysis. Guidance Note. http://pubdocs.worldbank.org/en/911381516303509498/2017-Shadow-Price-of-Carbon-Guidance-Note-FINAL-CLEARED.pdf

Framework (MPP-2013-2018) agreed between the Government of Cuba and FAO, which includes food security, sustainable food production, sustainable use of natural resources, and food quality and safety. The MPP also indicates that FAO will support the country with implementation of a new agro-food management model based on a systemic approach. This includes considerations for adaptation to climate change, such as conservation and sustainable management of natural resources, e.g. water and soil. FAO will ensure donor and UN system coordination to build on previous and existing projects related to climate change adaptation and sustainable food production. FAO will act as Executing Entity (EE) for GCF Proceeds, through FAO-Cuba Country Office, while MINAG will be co-executing agency of co-financed funds according to its own policies.

292. In its role as AE, FAO will be responsible for overall project management. FAO will assume responsibilities in accordance with detailed provisions outlined in the Accreditation Master Agreement (AMA) between FAO and GCF. To perform AE functions (described in Table 1), FAO will establish a dedicated FAO-GCF project task force comprising relevant staff from FAO Country Office in Cuba, FAO Regional Office for Latin America in Chile, and FAO Headquarters in Rome. The project task force will remain independent of Co-Executing Entity functions also performed by FAO. In line with GCF policy on fees adopted through GCF Board Decision B.19/09, the above-mentioned segregation of responsibilities within FAO will ensure that it can independently and effectively perform AE functions as listed in GCF general principles and the indicative list of eligible costs covered under GCF fees and project management costs, also adopted through GCF Board Decision B.19/09.

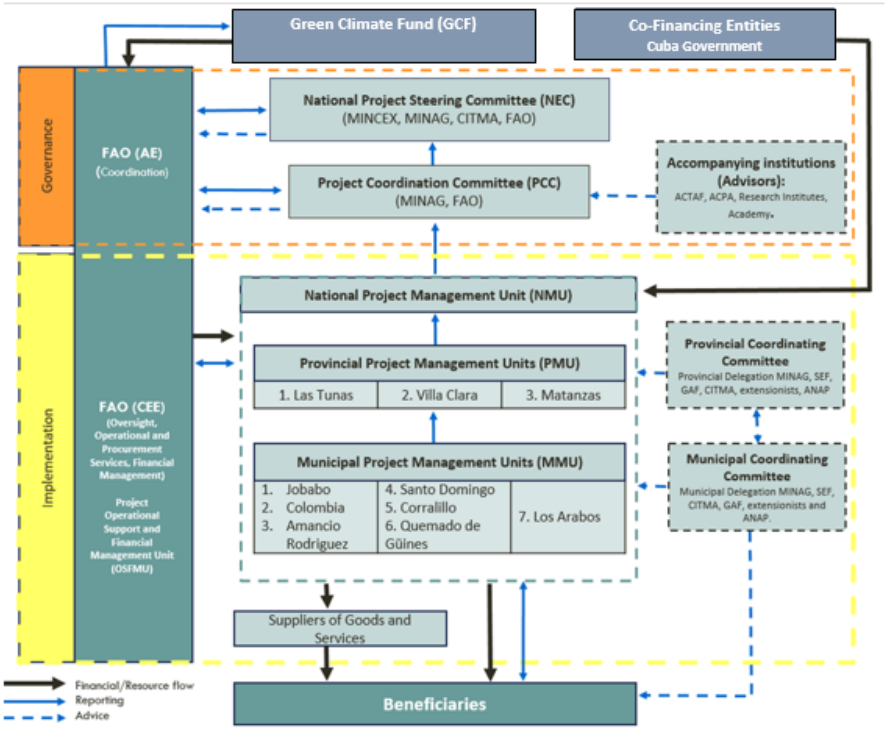
293. In its role as CEE, FAO will establish a project Operational Support and Financial Management Unit (OSFMU), which will be led by the Representation of Cuba, with the main function of supporting National Project Management Unit (NMU), providing procurement services and financial management services for GCF proceeds. The OSFMU will be financed by project PMU funds. Procurement standards, financial management and financial control will follow FAO conventions, rules and regulations and GCF and FAO AMA.

Project governance, execution and implementation

294. Project governance and institutional arrangements reflected below are the result of an ongoing inter-ministerial dialogue facilitated by FAO and led by MINAG, which includes the Ministry of Science, Technology and Environment (CITMA), and is the National Designated Authority (NDA) in Cuba and Provincial Delegations of Agriculture.

295. The main actions for viable project implementation and governance will allow authorities to have greater control over adaptation indicators through interdependent outputs aimed at favoring a paradigm shift through more efficient crosscutting products. In this context, effective coordination and collaboration between research, extension, beneficiaries and other stakeholders will be fundamental for successful implementation, which guarantees teamwork and traceability of actions. See Figure 31.

Figure 31: Governance structure and implementation of IRES Cuba project.



296. Project activities will support and reinforce implementation of several national strategies and programs mentioned above, in order to adopt new models in the short term that integrate agricultural, livestock and forestry production, produce a true paradigm shift, and lead to a sustainable, resilient and low-carbon agroforestry sector.

Roles and responsibilities

297. For project governance and strategic decisions, a National Project Steering Committee (NEC) will be established. It will comprise ministers (or delegates) from MINCEX, CITMA, MINAG and FAO representative in Cuba, and be chaired by MINAG.

298. The main function of NEC is to coordinate, guide and provide political and strategic guidance for project implementation and ensure appropriate inter-institutional coordination. In addition, it will

guarantee that planned co-financing of government entities be delivered in a timely manner; verify and approve annual work plans; and approve financial and technical reports.

299. Project governance also includes a Project Coordination Committee (PCC) composed of National Project Director, technical representatives from MINAG and FAO, and National Project Coordinator (NPC). The PCC will serve as key communication channel between National Project Management Unit (NMU) and key local stakeholders, and will help to implement the stakeholder participation plan. National technical and scientific institutions (extension agents, academia) and three provincial coordinators will support the PCC. NMU will be physically located in MINAG.

300. The MINAG, in consultation with FAO, will be responsible for appointing a National Project Director (NPD), whose main responsibility will be to direct NMU.

301. For project implementation, the NMU financed by the government will be established, with main functions of ensuring project coordination and execution through effective implementation of annual work plans based on NEC and PCC guidelines. The NMU reports to PCC through NPD.

302. The NMU will establish three Provincial Project Management Units (PMU - Las Tunas, Villa Clara and Matanzas / Los Arabos) to ensure proper implementation at the local (provincial) level. Each PMU will have a provincial coordinator, a logistics and training assistant and an administrative assistant. The PMU will be advised by a Provincial Project Coordinating Committee (PCC) to guarantee effectiveness of actions at the provincial level for required planning, coordination, instrumentation and process evaluations.

303. In addition, NMU will establish seven Municipal Project Management Units (MMU) to ensure reliable implementation at municipal levels. Each MMU will have a municipal coordinator, a logistics and training assistant and an administration assistant. The MMU will be advised by a Municipal Coordinating Committee (MPCC), to guarantee the actions effectiveness at the municipal level and promote fluid information exchange for decision-making.

304. The provincial coordinators of Las Tunas, Villa Clara and Matanzas will serve as liaisons with the seven municipal coordinators, as appropriate, and facilitate fluid information exchange and decision-making at two specific levels of management and articulation: territorial / national. This will constitute the essential pillars for producer empowerment in vulnerable communities through value chains and improvement of livelihoods through resilience actions to climate change.

305. The provincial and municipal units will be government financed and report to the NMU. The members and functions of project units responsible for project governance and implementation are described in Table 45 below.

306. The suppliers of goods and services are entities contracted to support agroforestry module implementation in the AIP, among these are UEB of machinery belonging to state enterprises, which will provide technical assistance; maintenance and repair of machinery and implements dedicated to clearing; land preparation to develop crops; subsoiling; drilling for planting plants; support for marketing; transfer of raw materials and productions; and irrigation systems and nurseries. Other entities, such as laboratories, will support soil analysis, plant health, animal health, water quality analysis and seed certification.

307. Table 36 below summarizes functions of each unit participating in project governance and implementation. Table 37 presents functions of management unit members (further detailed information is provided in Appendix 2.7).

Table 36: Functions of governance and project implementation units

Level	Project Unit	Participants	Functions
Governance	**National Steering Committee (NEC)**	MINAG, MINCEX, CITMA, FAO Chair: MINAG	• Provide political and strategic guidance for project implementation. • Ensure proper inter-institutional coordination. • Ensure government co-financing. • Maintain a communication channel with the Government of Cuba, including DNA (CITMA) and receive guidance on relevant policies for project implementation. • Approve PTA and budget.
	National Coordination Committee (NCC)	MINAG and FAO	• Propose annual work plan and budget. • Monitor implementation and safeguard compliance. • Provide information on project progress, results and impacts to NEC. • Request and receive reports from co-financiers (financial and implementation). • Invite, as the case may be, representatives of accompanying institutions. • Mobilize technical expertise of participating institutions in a timely manner, according to agreed annual work plan.
	Accompanying institutions (Advisors)	Formed by: ACTAF, ACPA, Research Institutes (INAF, IAgric, Soils, Plant Health, Tropical Fruit Culture, Pastures and Forages, ICA, INIVIT, and Academia.	• Conduct accompaniment and offer advice to PPC on project governance.
	FAO-GCF Project Task Force (AE)	FAO (Country Office-Cuba, Regional Office for Latin America-Chile, and Headquarters-Rome	• Prepare project inception package for project Board approval. • Ensure project results monitoring and evaluation. • Establish technical standards and exercise control. • Administrative, financial and technical oversight and supervision throughout project implementation (at least one supervision mission per year). • Ensure funds are effectively managed to deliver results and achieve objectives. • Ensure timeliness and quality of reporting to GCF.

Level	Project Unit	Participants	Functions
			• Carry out evaluation of the project, rules, procedures and decision-making mechanisms for NEC and PCC, terms of reference of PCC and NMU, and define communication flow. • Provide technical guidance to ensure technical quality in project activities. • Report project progress and provide financial reports to Secretariat and GCF Evaluation Office.
Implementation	**National Management Unit (NMU)**	Formed by: – National Project Director – National Project Coordinator – In charge of Monitoring and Evaluation – Economic and Financial – Logistics and Training Assistant – Driver FAO will provide support for NMU operational and financial management.	• Prepare work plan and budget for review and approval by PCC (in conjunction with ODFMU). • Report execution (operational and financial) to FAO. • Coordinate project operational arrangements with ODFMU. • Establish and supervise three provincial units and seven municipal units for local level project implementation. • Ensure recommendations of Coordinating Committees at provincial and municipal levels are discussed and addressed, ensuring adaptive project management.
	Operational Support and Project Financial Management Unit (OSFMU)	Conformed by (FAO): – National Operations Officer – Technical coordinator – Head of Training and Extensions – Responsible for Acquisitions, Logistics and Human Resources – Specialist in Finance and Accounting – Monitoring and Evaluation Specialist	• Manage GCF funds. • Prepare operational arrangements. • Prepare budget (in conjunction with NMU). • Manage project budget. • Monitor cash availability. • Coordinate and train extension agents. • Make financial and accounting reports. • Acquire goods and contract services for project activities. • Recruit, select and hire necessary human resources and manage quality of technical assistance. • Make payments for goods, services and products. • Submit semi-annual financial reports on status of project expenditures to NEC. • Prepare budget reviews at least once a year or more frequently if required. • Perform budget revisions to keep the budget up to date. • Ensure project monitoring and evaluation.

Level	Project Unit	Participants	Functions
	Provincial Management Units (PMU)	Each provincial unit will be integrated by: – Provincial Coordinator – Logistics and Training Assistant – Administrative assistant	• The PMU will be established to support project management and implementation at provincial level. • Serve as key communication channel between NMU and key local stakeholders. • Establish and supervise municipal units for project implementation. • Assist with project communication strategy at local level.
	Provincial Coordinating Committee (PCC)	Formed by: – Provincial Delegation MINAG and SEF – Extension workers (ACTAF, ACPA) – Provincial Delegations of CITMA – GAF – ANAP	• Ensure project coordination activities at provincial level. • Provide information to NCC on project progress, results and impacts. • Mobilize technical expertise of participating institutions in a timely manner, according to agreed annual work plan at provincial level.
	Municipal Management Units (MMU)	Each municipal unit consists of: – Municipal Coordinator – Logistics and Training Assistant – Administrative Assistant	• The MMU will be established to provide support for project management and implementation at municipal level. • Serve as a key communication channel between NMU, PMU, and key local stakeholders at municipal level. • Assist with implementation of participation and commitment plan of interested parties. • Supervise machinery administration and maintenance. • Control and ensure efficient use of resources assigned by project. • Assist with project communication strategy at local level.
	Municipal Coordinating Committee (MPCC)	Formed by: – Delegation MINAG, SEF – Extension workers (ACTAF, ACPA) – CITMA – GAF – ANAP	•Ensure coordination of project activities at municipal level. •Provide information on project progress, results and impacts to PCC and PMU. •Mobilize technical expertise of participating institutions in timely manner, according to agreed annual work plan at municipal level. •Assist with implementation of stakeholder participation and engagement plan.

Table 37: Functions of members of the management units

National Management Unit (NMUP)	
Responsible for National Project Director (NPD)	• Supervise Project Management Unit. • Responsible for project general results, both financial and operative. • Coordinate activities with all stakeholders in project outputs. • Manage day-to-day implementation. • Coordinate with other related initiatives. • Ensure a high level of collaboration between participating institutions and organizations at national and local levels. • Guarantee final results established in logical framework.
Technical Sub-Coordinator of Project (TSCP)	• Guarantee management and technical quality in all project stages. • Maintain permanent inter-institutional coordination to support activities of all project outputs. • Track project's technical progress. • Participate, in conjunction with person responsible for monitoring and evaluation, in follow-up on results, demonstrating technical quality. • Together with UOAGF, design a strategy and training plan according to project needs and stages of implementation. • Identify needs and potential of training. • Coordinate training actions with institutions and experts on project-identified topics for execution according to planned stages. • Implement communications program. • Organize annual project and meeting workshops to supervise project progress and prepare, together with National Director, annual work plans, guaranteeing processes from technical perspective. • Guarantee execution of environmental and social safeguard measures in different stages of project. • Incorporate gender perspective to project execution. • Support organization of mid-term review and final evaluation.
Monitoring and Evaluation Assistant	• Advise director and project coordinator on matters related to results at different stages according to project outputs. • Develop and execute project monitoring plan. • Follow up on monitoring plan implementation. • Consolidate results of indicators reported by project technicians / specialists. • Apply and coordinate established methodology to monitor project indicator performance. • Supervise fieldwork through monitoring visits to project activities to measure quality based on quality standards. • Maintain permanent inter-institutional coordination through email and telephone contacts, meetings and visits to ensure monitoring and evaluation of project actions in different stages. • Prepare monitoring and evaluation reports according to established methodologies at each stage of project's development. • Systematize monitoring visit results and accountability, and monitor and evaluate workshops developed within project framework. • Identify bottlenecks in project implementation process.

Economic and Financial Assistant	• Record operational and financial operations related to cash flow. • Responsible for preparation and supervision, control and monitoring. • Develop financial plans and control of disbursements. • Ensure detailed record of accounting operations. • Manage and safeguard financial and accounting management. • Evaluate budget execution in accordance with the plan. • Monitor exchange variations to consider in budget calculations. • Make proposals for budget review requests. • Prepare financial reporting proposals, including final report for approval. • Ensure accurate records of relevant data for operational and financial supervision. • Ensure integrity, punctuality and quality of all data and project documentation, including insertion and maintenance of logical framework, work plan and budget data.
Logistics and Training Assistant	• Plan and coordinate project technical execution and assurance in conjunction with heads of outputs, including preparation of annual work plans for review by Project Director. • Provide experiences and manage technical assistance in key issues associated with reconversion of agro-productive landscapes in context of climate change and new project paradigms. • Maintain permanent inter-institutional coordination through contacts by email and telephone, meetings and visits. • Meet regularly with results and territories coordinators to ensure project training activities are compatible at all levels and avoid duplication of effort.
Driver	• Exercise functions of mobility, transfer of personnel and guarantee work routes to meet project daily activities based on planning. • Guarantee technical maintenance and care of assigned vehicle and support in all tasks associated with transportation in NMU.
Operational Support and Project Financial Management Unit (OSFMU)	
National Operations Officer	• Manage project funds and technical supervision on a daily basis. • Coordinate and supervise execution of project activities. • Manage daily activities of project implementation. • Operational and financial supervision. • Track project progress and ensure timely delivery of relevant inputs and outputs associated with project. • Present project progress reports, work plans and budgets to NEC and FAO. • Prepare project implementation report. • Support organization of mid-term review and final evaluation. • Identify in detail expenses and disbursements to be requested from FAO for timely project execution. • Supervise, provide technical support and evaluate reports and products of national project consultants (funded by GCF funds).
Technical Sub-Coordinator	• Contribute to execution of processes and actions necessary for goal attainment. • Support preparation of technical missions during project execution as planned. • Support development of consultants' work during implementation of their

	activities and products. • Provide follow-up and review of product development. • Support development and storage of databases, data files and images, and all information generated within project framework. • Support project coordination for organization and conduct of all project events of planning, evaluation and rendering of accounts. • Support project coordination in execution of activities foreseen in annual work plan observing all operational and administrative procedures according to rules of executor and FAO instructions. • Support general coordination in management of project knowledge: information systematization, document elaboration, actions review, edition and publication of same, if required. • Update project monitoring system in permanent coordination with national and provincial specialists and technicians. • Support organization of inter-institutional events when the project participates or sponsors: project socialization events, planning events with counterparts, accountability events, among others. • Support project communications processes. • Guarantee execution of environmental and social safeguard measures in different project stages. • Incorporate gender perspective during project execution.
Training and Extension Assistant	• Design strategy and training plan according to project needs and implementation stages. • Identify training needs and potential. • Coordinate training actions with institutions and experts on topics identified by project for execution according to planned stages. • Manage technical assistance from national and international experts linked to topics of project interest. • Identify technology proposals and good agricultural practices for implementation in intervention areas. • With counterpart, jointly manage agrarian extension systems according to project objectives and agroforestry modules planned for each area of intervention. • Socialize experiences through events, field days and use of ICTs. • Prepare technical informative materials, reports, reports and evidences of activities carried out. • Conduct evaluation on follow-up of implementation of training actions and extension results, according to established methodologies.
Monitoring and Evaluation Specialist	• Liaise with M&E assistant of NMUP. • Advise national operations officer on matters related to results in different stages according to project outputs. • Develop and execute project monitoring plan. • Support project progress tracking and ensure timely delivery of relevant inputs and outputs associated with project. • Support preparation of the project progress reports, work plans and budgets for NEC and FAO. • Support preparation of project implementation report. • Support National Operations Officer to organize mid-term review and final

	evaluation. • Follow up on Monitoring Plan implementation. • Consolidate results of indicators reported by project technicians / specialists. • Apply and coordinate methodology established to monitor performance of project indicators. • Maintain permanent inter-institutional coordination as necessary, through email and telephone contacts, meetings and visits to ensure monitoring of project actions in its different stages. • Prepare monitoring and evaluation reports for FAO according to established methodologies at each stage of project development. • Systematize results of monitoring visits, accountability and monitoring and evaluation workshops developed within project framework. • Identify bottlenecks during project implementation.
Procurement, Logistics and Human Resources Assistant	• Review and complete technical specifications of resources to be purchased. • Analyze offers. • Prepare and process documentation to and from importing company (approved offers, shipping documents). • Prepare proposed procurement plan and proposals for procurement plan adjustments, prepare and present documents to purchasing committee. • Develop a schedule of project purchases and acquisitions with detailed description in coordination with government authorities. • Propose internal control system for project procurement plan execution (control and monitoring method) in stage subsequent to PPG, which contains: FAOCU management, MINCEX and MINAG. • Market analysis, identification and search for suppliers. • Ensure timely execution of project activities, including coordination of operational arrangements. • Send requests for orders and purchase orders in GRMS for acquisition. • Manage and monitor purchasing processes in In-Tend and other required services. • Provide specific information on procurement activity for annual and final reports, issuing periodic reports. • Plan and process staff travel / project consultants. • Obtain terms of reference, initiate personnel selection processes (consultants), manage quality of technical assistance, participate in performance evaluations, control attendance and aspects related to personnel management.
Finance and Accounting Assistant	• Daily management of project budget, including monitoring of cash availability, preparation of budget for review by National Coordinator and National Director of Project. • Analyze offers, payment requests. • Evaluate budget execution with POA. • Monitor exchange variations to be taken into account in budget calculations. • Make proposals for budget review requests. • Prepare proposals for financial reports, including final report for CDN approval. • Ensure accurate records of all relevant project-related data for operational and financial supervision of all purchases and payments for services. • Ensure accurate records of all relevant data for operational and financial supervision.

	• Ensure integrity, timeliness and quality of all data and project documentation in FPMIS, including insertion and maintenance of logical framework, work plan and budget data.
Communication and Gender Assistant	• Update, validate and execute project communications strategy. • Support project-generated public communication activities. • Design / develop / disseminate information of general interest oriented to sharing of project results. • Lead and promote communication processes for benefit of agricultural producers and project beneficiaries using a variety of approaches, platforms and products. • Support knowledge management system and information provided for the project. • Manage and update project website. • Disseminate relevant project information through social networks (Twitter / Facebook). • Ensure incorporation of gender perspective in different project stages. • Promote actions that contribute to reduction of gaps in gender equality and provide evidence for follow-up. • Support evaluation and monitoring processes from a gender perspective. • Generate reports and reports according to FAO established methodologies.
Provincial Management Units (PMU)	
Provincial Coordinator	• Coordinate and closely monitor execution of project activities at provincial level and those corresponding to each municipality. • Execute activities relevant to project development. • Manage day-to-day implementation. • Coordinate with other related initiatives. • Ensure high level of collaboration between participating institutions and organizations at provincial and local levels. • Track project progress in your province. • Implement and manage project monitoring plan at your level. • Implement communications program. • Organize project workshops and meetings to monitor project progress and prepare annual project work plans in province according to national planning. • Guarantee execution of environmental and social safeguard measures in different project stages. • Incorporate gender perspective in different project stages. • Support organization of mid-term review and final evaluation.
Logistics and Training Assistant	• Receive equipment and resources assigned by the project. • Distribute and register equipment and resources assigned to final recipients (beneficiaries). • Monitor and control equipment and resources assigned to guarantee use and correct operation thereof. • Ensure timely execution of project activities and other required services, including coordination of operational arrangements. • Provide specific information on procurement activity, control of resources for

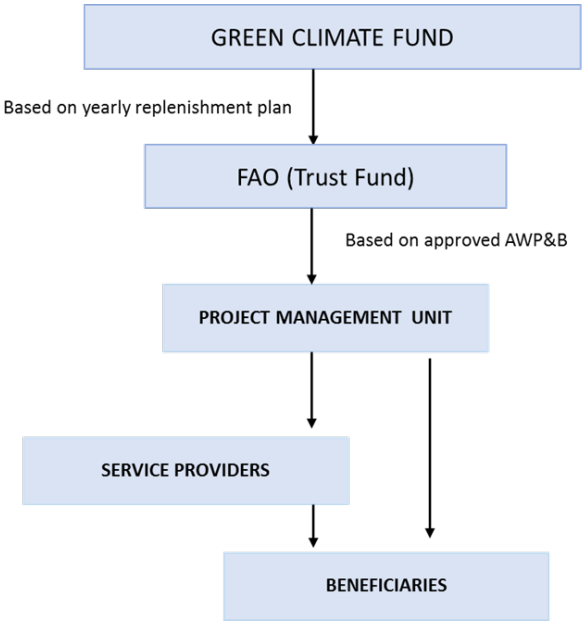
	annual and final reports, and issue periodic reports. • Coordinate training actions with institutions and experts on topics identified for project execution according to planned stages. • Ensure execution of training and implementation of extension system according to established project plans and priorities.
Administrative Assistant	• Execute daily management of project budget, including supervision of availability of funds, budget preparation and review, which will be supervised by Project Coordinator. • Ensure accurate recording of all relevant results-based operational, financial and monitoring data. • Ensure preparation and presentation of reports related to expenditures, forecasts and progress in relation to plans and project closure in accordance with procedures, formats, presentation schedules and communication channels. • Participate in periodic meetings related to project management and render accounts of administrative and financial matters. • Prepare information and correspondence related to financial matters. • Support project coordinator to organize midterm and final evaluations and provide information on project budget issues. • Perform other tasks when necessary.
Municipal Management Units (MMU)	
Municipal Coordinator	• Coordinate and closely monitor execution of project activities in municipality and areas of project intervention, as planned. • Execute activities relevant to project development. • Manage day-to-day implementation. • Coordinate with other related local-level initiatives. • Ensure high level of collaboration between participating institutions and local-level organizations. • Track project progress in your municipality. • Support project monitoring process at your level, managing necessary evidences. • Implement communications program at your level. • Support project workshops and meetings at municipal level, and guarantee fulfillment of planned activities with participation of project beneficiaries. • Support execution of controls, follow-ups, as well as the organization and development of mid-term review and final evaluation. • Guarantee execution of environmental and social safeguard measures in different project stages. • Incorporate gender perspective in different project stages.
Logistics and Training Assistant	• Receive equipment and resources assigned by the project. • Distribute and register equipment and resources assigned to final recipients (beneficiaries). • Monitor and control equipment and resources assigned to guarantee use and correct operation thereof. • Ensure timely execution of project activities and other required services, including coordination of operational arrangements. • Provide specific information on control of resources for annual and final

	reports and issue periodic reports. • Coordinate training actions with institutions and experts on topics identified by the project for its execution according to planned stages. • Evaluate training and development needs of project personnel. • Ensure execution of training and implementation of extension system according to established project plans and priorities.
Administrative Assistant	• Execute daily management of project budget, including supervision of funds availability, budget preparation and review, which will be supervised by Project Coordinator. • Ensure accurate recording of all relevant results-based operational, financial and monitoring data. • Ensure reports related to expenses, forecasts and progress in relation to plans and project closure are prepared and presented in accordance with procedures, formats and schedules of presentation and communication channels. • Participate in periodic meetings related to project management and render an account of administrative and financial matters. • Prepare information and correspondence related to financial matters. • Support project coordinator with organization of midterm and final evaluations and provide information on project budget issues. • Perform other tasks when necessary.

Structure of flow of funds

308. At the request of the GoC, FAO will serve as financial and operational executing agency of GCF resources, including financial management, procurement of goods and contracting of services (through UAOGP). FAO will be responsible for presenting annual work plans and budgets that will include a specific purchasing plan. The PCC, jointly with NEC, will validate and approve annual work plans and budgets. The FAO will be responsible for disbursement of funds according to established conventions, norms and standards. The funds flow is presented in Figure 32 below.

Figure 32: Project budget cash flow



5.8 Addressing gender dimension

309. A preliminary gender assessment was conducted during project preparation stage, and was summarized in a document (See Annex 8 of the FP.) indicating the characterization and gender analysis in areas defined for project implementation based on perception and information handled by people contacted by the project, territories and analysis of various documents and data offered by local actors.

310. The aforementioned document included:

- Characterization of gender context in Cuba;
- Achievements of Cuba in terms of gender equity;
- Gaps and stereotypes that reproduce gender inequalities;
- Characterization of territories from different dimensions; and
- Proposal for a gender action plan.

311. Cuban society has made important progress in terms of the participation and role of women in economic, social and political spheres. Women have been given conditions and opportunities necessary to improve their social status, largely due to the political will of the Government and to unconditional support of the Federation of Cuban Women and female activism. These have had had their expression in the Constitution of the Republic, labor legislation, the Family Code and other legal norms and policy documents that protect and empower women's rights on equal terms with men.

312. Cuban women have spaces to insert themselves and participate in the country's development process as protagonists and at the same time as beneficiaries of policies and programs that have taken place over the past 60 years. In spite of this, they face challenges in order to combine their commitment to fertility and family with their representation in the labor and management process, owing to persistence of obstacles to the full extent of their rights due to sexist patterns. Traditionally, it has been women's role to take care of the family or domestic work. Processes such as population aging and internal and external migration limit the socio-labor participation of women who must dedicate themselves to the care of children, elderly and disabled persons.

313. At the same time, the most common family structure in the country shows a tendency for the majority of work in the home to be developed by women. This phenomenon is accentuated in rural regions.

314. According to 2016 Statistical Yearbook of Cuba, of the total number of people employed in agricultural cooperatives, women represent 15.7 percent. Likewise, they account for 15.9 percent of the total number of people located in agricultural, livestock and forestry activities. It is important to note that agricultural activity occurs in Cuba under difficult environmental conditions such as high temperatures (> 40 degrees), high humidity, weathering and heavy rains, in addition to requirements for heavy physical work. Traditionally women have not been protagonists in this sector, as in other countries with high levels of social development and protection of women. In rural areas, women constitute the majority in the service sector, such as education and public health, which represents more than half of state public employment.

315. From a gender perspective, while there are significant achievements in the Cuban context, there are still many gaps and inequities.

316. The survey conducted for this project showed that in project-targeted areas, rural women account for 47% in Villa Clara / Matanzas and 45% in Las Tunas. Gender gaps and inequities are characteristics of current Cuban reality.

317. In the two project areas together, there is a total of 29 458 female homemakers. Studies carried out in these areas show that this is due to lack of educational preparation, young women who do not complete high school or professional studies, and subordination to their spouse's demands. Another relevant factor is the lack of employment in communities and inadequate transportation to transfer to other areas that offer opportunities.

318. With respect to violence against women, those interviewed in the preliminary evaluations recognize that in these areas (especially in rural areas of the municipality), there are constant expressions of violence from men to women, whether they are husbands or children.

319. There is unanimous perception in these areas that women are more vulnerable than men due to the persistence of sexist practices that perpetuate stereotypes and traditional roles for women and put them at a disadvantage.

320. The low availability of water and its storage capacity is the main problem for rural women in these territories, causing this obvious basic need.

321. Although there is no explicit perception of vulnerability differentiation and risk in the persons interviewed, during meetings they recognize that women are more vulnerable to drought and effects of hurricanes.

322. People do not directly recognize the relationship between gender disadvantages and climate change; that is, there is no crosscutting and integral gender perspective for this type of process, and to a lesser extent, no strategic resilience processes.

323. Climate change can increase migratory processes that involve men more, but confine women to remain in communities and be responsible for the elderly, children, and disabled, in addition to aggravated environmental problems such as drought and water shortages. In the PIA municipalities, a masculinity index of 1043 men per 1000 women is reported, with eight fewer men per 1000 women.

324. Harvest losses and low yields, resulting from the impact of severe weather events and increased prevalence of pests and diseases aggravated by climate change, reduce incomes and the standard of living for families, worsening the situation, increasing the time women work in the home, and reducing their possibilities of accessing employment.

325. There is no perception of differential impact on men and women from effects of climate change. In the communities, it is believed that women are more affected by drought and lack of water because they are responsible for domestic tasks (extremely dependent on water); this generates stress for them, while the responsibility for men ends with hauling water.

326. Equal participation of women and men in the project is sought. Specific tasks will be determined by the disposition, aptitudes and aspiration of each person. The project aims to create jobs that traditionally result from women's preference in management of postures and grafting in nurseries with forest and fruit species; activities in mini-industries; management of collected milk and evaluation of its quality; and in laboratories that will be strengthened to ensure essential services to support agricultural and livestock production, among others.

327. The individual commitments of producer participation in terms of time and activities to be carried out have not yet been determined, but it is expected that a high percentage work full-time, on established working days (eight hours / day) during project execution. It is expected that some producers will make a partial time commitment in proportion to the number of project areas with respect to the total land they manage.

328. The project will conduct restoration transformation of the same agro-ecosystems where the producers work, including idle areas invaded by species such as marabou. Therefore, they are not expected to have to move to other places outside their current work area, and no extra time will be required for transfer.

329. Both work and travel time may not constitute impediments or limitations for women's participation in the project.

330. The GED approach used in the project allows for analysis, design and implementation proposals that generate equitable and sustainable development, involving both women and men in decision-making at all stages of the process.

331. The GED approach assumes construction of gender as key to mediating relations between women and men, and in that sense, assumes that women and men face different problems which reflect interests, needs and priorities; these should not be approved in the design of productive processes of transformation and development. It also identifies differences between women (intragender).

- Validating what has been called the "special condition of women" makes them more vulnerable at the different points in productive processes.

- Reinforcing that women are agents of change, with capacities for resilience, autonomy, contributions and valuable knowledge in the productive sector that allow them to identify vulnerabilities and manage risks.

332. The gender approach in development enables analysis and understanding of different roles and responsibilities, levels and quality of participation in decision-making, and needs and visions of women and men. It promotes gender-sensitive analyzes in different sectors such as agriculture, forestry, economics, health, education and the environment, which have shown that men and women live poverty and development differently.

333. The project promotes social sustainability based on the need to generate tangible results for its participants with a criterion of equity promotion. This means that results are distributed equally among participants and that they mainly favor disadvantaged groups.

334. The project is consistent with national policies, territorial development strategies and interests of local populations, aligned with social development objectives, especially with the Development Strategy of the Ministry of Agriculture to 2030. This includes crosscutting treatment of gender and also supports local implementation of the Gender Strategy of the Ministry of Agriculture.

335. Local authorities, and those in agriculture in particular, have identified the need for improved conditions in the project's impact areas, their productive entities, social services and living conditions, since many communities and rural areas are in a situation of social disadvantage.

336. An important way to promote the project is to stimulate actions of productive improvement and optimal land use. This can lead to an improvement in conditions of community life, associated with generation of jobs and income in a sustainable manner, greater access to food produced locally, and reinforcement of community activities around care and sustainable management of natural resources and biodiversity.

337. The project will assume an Equity Approach, positioning disadvantaged groups in better conditions to generate their development, enable their access to work, knowledge and information, decision-making, and better living / working conditions. As climate resilience is improved, the solutions to social problems are facilitated with a focus on equity since inclusion in the same selected areas of communities with a certain level of social and economic vulnerability is intended. Among beneficiaries, priority is given to women for access to training and productive, income-generating resources. In all areas, direct actions in production processing and marketing of food and forest resources directly benefits small-scale family agriculture producers.

338. The reduction of existing gender equity gaps is focused on fair and equitable treatment in access to information and training, and preferential access to productive resources and jobs generated by the project. This includes recognition of the disadvantageous position of women. Work is directed to:

- Promotion of women's access to productive resources that facilitate their incorporation to paid work in accordance with each territory's problems and potential;
- Development of training processes for local actors for more effective management of equal rights and opportunities for women and men based on recognition women's disadvantages;
- Collection of information disaggregated by sex;
- Inclusion of specific goals, indicators and budgets in the project to encourage participation of women and visibility of their contributions through communicative actions.

339. Proposal for gender indicators:

- Hectares of land benefited by sustainable practices that increase climate resilience served by women (percent);
- New jobs generated by the project occupied by women (percent), in nurseries, mini-industries, production, marketing and along the chains;
- Women benefitting with productive resources for climate resilience (percent);
- Women participating in training actions (percent);
- Evidence disseminated on contributions of women to increased climate resilience (reports, brochures, communications);
- Number of households and entities with access to biogas where cooking is facilitated, the process is humanized, and allows women to save time to devote to other activities of their interest.

5.9 Sustainability of proposed interventions / exit strategy

Government commitment and institutional capacities

340. This project has strong governmental commitment. It is a direct outgrowth of government policies for CC adaptation and mitigation and the Ministry of Agriculture's support for agricultural development and smallholder farmer and producer organizations through extension and technical assistance, infrastructure development, and provision of equipment, inputs and other goods and services. The project will train the Ministry's agricultural extensionists to support farmers in establishment and operation of agroforestry, silvopastoral and forestry systems, application of water efficient technologies, climate-resilient agricultural practices and cropping systems, and farm business planning. The project will build the capacities of producer organizations to support extension activities related to agroforestry and silvopastoral systems and ecosystem services, particularly Farmer-to-Farmer extension of climate-resilient agricultural and agroforestry practices.

341. The government is committed to establishing a Landscape Resilience Fund (LRF)[111] to provide farmers with financial resources as part of implementation of their business plans. The project will train LRF staff in analysis and support for development of farm enterprise business plans. Funding will be provided for specific initiatives originating in and supporting these plans and it is projected now that farmers may also receive incentives of up to an additional 30 percent of project funding. This project will analyze economic instruments to determine which ones can be adapted for use in generating financial resources required to motivate farmers to adopt resilience-enhancing agroforestry, silvopastoral and forestry systems and production practices.

342. After project termination, GoC will be responsible for Operations and Maintenance of equipment and machinery required for land preparation and crop and livestock protection. The GoC's Base Enterprise Units for Integrated Technical Services will be responsible for O&M. While farmers and producers will pay for services, O&M will be subsidized by fiscal resources supplied through standard budgeting processes. Technical, planning, management and other capacities of key institutions like the Ministry of Agriculture are highly regarded and are the result of decades of government prioritization of the agricultural sector. This has resulted in highly competent and skilled extensionists and other support staff.

Capacity building of farmers to sustain climate resilient cropping systems

343. Farmers will receive training within the Ministry's formal capacity building structure of Farmer Field Schools, demonstration plots, research stations, comprehensive training-and-visit extension system, and links to academic and other experts. The capacity-building program of this project will ensure that farmers receive in-depth training and support on- and off-site, including Farmer-to-Farmer exchanges and training-and-visit approaches. Farmers will be motivated to participate in training by the prospect of acquiring new skills that will permit them to increase yields, secure and implement institutional contracts for agricultural products, and successfully market surpluses in the growing variety of supply-and-demand markets, particularly the tourism market.

Access to financing and markets

344. Effective value chains provide a fundamental incentive to drive and support adoption of climate-resilient agroforestry and silvopastoral systems, crops and practices. Producer participation in these value chains requires access to funding as well as markets. With co-financing from GoC, this project will assist producers to access state markets through production contracts as well as the increasing number of other markets. In particular, GoC will establish a Landscape Resilience Fund by combining the National Forestry Development Fund and Soil Conservation Fund, as well as other relevant funds, to finance strengthening the value chain, production improvements, value addition and commercialization to specific markets (e.g. tourism enterprises).

345. GCF will finance sub-activities and inputs focused on development of climate-resilient agroforestry systems. GCF will also support institutional coordination and planning processes that bring together different value chain actors – producers, input providers, buyers, et al. – to more efficiently coordinate their activities in support of climate-resilient value chain development.

[111] Note that no GCF funds will be used to capitalize the Landscape Resilience Funds.

346. The project will increase farmers' capacities by providing them with knowledge, information, capacities and access to critical equipment and technologies to reduce their climate risk and enable them to generate revenues for continual re-investment in resilience-enhancing production practices and systems. The project will train farmers to plan and manage their production assets with a value chain approach to climate-resilient crop production in agroforestry systems.

Operations and maintenance and post-project O&M

347. O&M of project-established infrastructure and technologies will be carried out through a hub-centered system managed by the GoC involving the UEB (*Unidades Empresariales de Base*). O&M of equipment and technologies will be managed in these hubs for a specific set of farm enterprises to achieve economies of scale and their most efficient use.

348. O&M will be focused on Outcome 1 of the Logical Framework: increased CC-resilient production landscapes through investment in innovative agroforestry systems, reforestation with close-to-nature planted forests (CTNPFs), assisted natural forest regeneration, and specifically activities 1.1– 1.2 involving establishment of agroforestry systems and planted forests. O&M for each of these activities is focused on specific technologies and equipment and comprises maintenance protocols, operational procedures and scheduled monitoring of use and repairs (see Annex 20 of FP for a detailed description of O&M). O&M costs will be covered by GCF for the life of the project, with the following years' costs covered by the Government of Cuba.

349. Farmer and producer organizations will be fully responsible for maintaining farm tools and equipment provided by the project, with technical assistance and training from MINAG staff. Future farmer investments in O&M will be enabled through enhanced income generation from sales of surplus yields to institutions and supply-and-demand markets.

Appendices

Appendix 2.1. Climate change rationale for PIA selection

Appendix 2.2. Impacts of climate change on PIA

Appendix 2.3. Carbon estimations

Appendix 2.4. IRES adaptation baseline and vulnerability analysis

Appendix 2.5:. IRES socioeconomic profile of PIA

Appendix 2.6. IRES agroforestry modules for landscape restoration

Appendix 2.7. Institutional analysis and implementation arrangements

Appendix 2.8. Minutes of workshops for participatory design

Appendix 2.9. Marabou invasion in Cuba and climate change