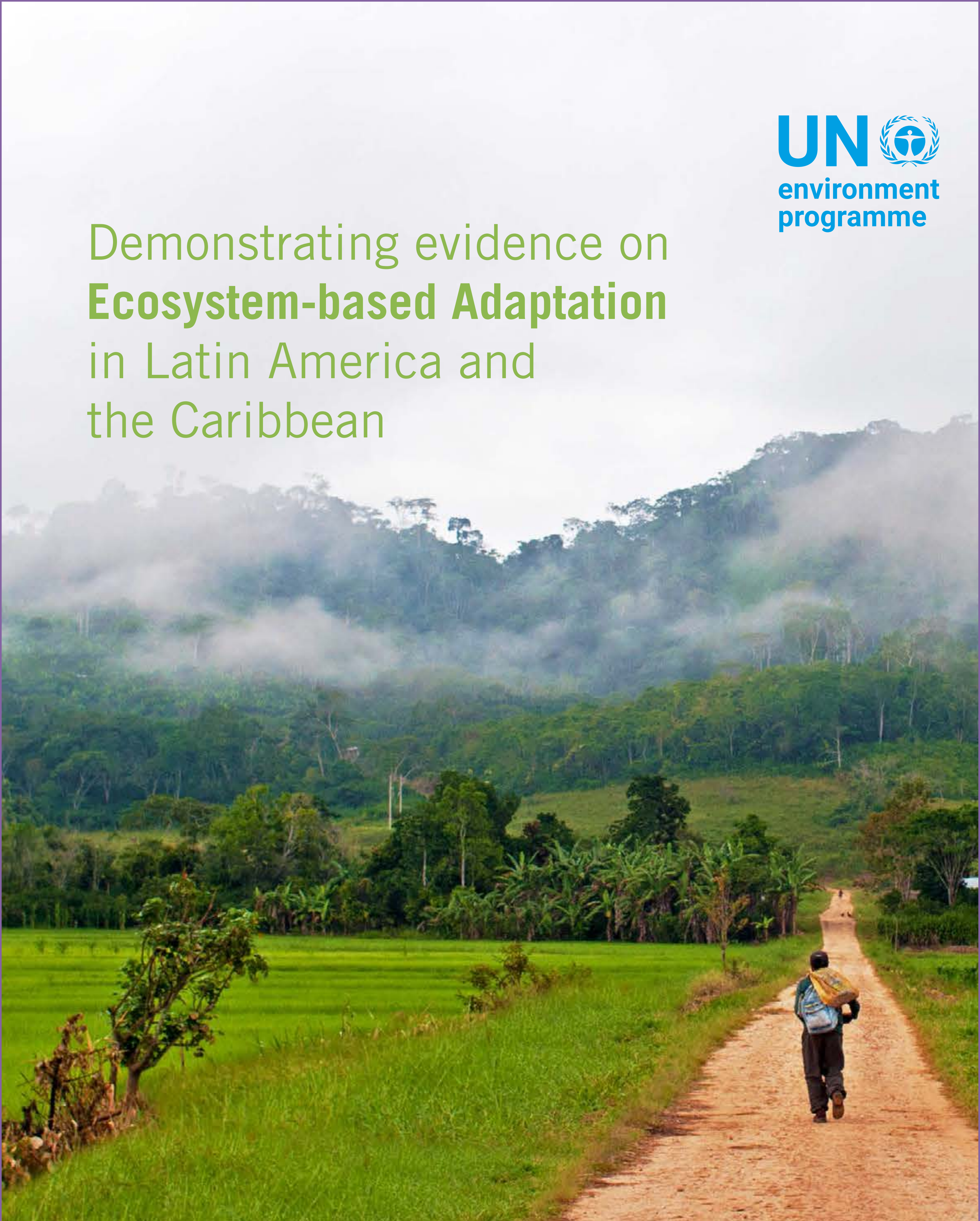

UN environment programme

Demonstrating evidence on **Ecosystem-based Adaptation** in Latin America and the Caribbean

REGATTA
Portal Regional para la Transferencia de Tecnología y la Acción frente al Cambio Climático en América Latina y el Caribe

cooperación española

Practical ACTION

A publication of the EbA Community

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Acknowledgements:
This publication was possible due to the initiative of UN Environment Programme for the creating of the EbA Community of Practice and would like to especially give our thank you to Elena Pita, Silvia Giada and Jacinto Buenfil. We would like to thank also all the members of the EbA Community for their active participation and for sharing their experiences.

August 2019

Demonstrating evidence on Ecosystem-based Adaptation in Latin America and the Caribbean:

Ten case studies

Authors of each case studies

Brazil

A Strategy for Capacity Building in Ecosystem-based Adaptation in the Atlantic Forest

- Jennifer Viezzer (Ministry of Environment, Brazil).
- Patrícia Betti (GIZ, Brazil).

Mesoamerica

Silvopastoral systems: A technology for the development of sustainable livestock adapted to climate change

- Claudia J. Sepúlveda L. (Livestock and Environmental Management Programe - GAMMA in Spanish). The Tropical Agricultural Research and Higher Education Center (CATIE).

Cuba

The promotion of adaptation to climate change in the Ciénaga de Majaguillar wetland and the coastal area of the Martí Municipality in the Matanzas Province.

- Froilán Dueñas Pérez. Representative of Mapa Verde Filial Matanzas.
- Dr. C. Ángel Alberto Alfonso Martínez. Director of the Department of Environment of the Ministry of Science, Innovation and Environment (Citma) in the Province of Matanzas, Cuba.
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Uruguay

Adaptation to climate change via the restoration and conservation of coastal ecosystems in the South Atlantic

- Inti Carro (Division of Climate Change, Ministry of Housing, Territorial Planning and the Environment).
- Leonardo Seijo (Subnational Development and Management Program, Office of Planning and Budget [OPP]).
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Peru

Robust measures of Ecosystem-based Adaptation in Canchayllo and Miraflores in the Nor Yauyos Cochas Landscape Reserve

- Florencia Zapata (Mountain Institute / Andean Program of The Mountain Institute).
- Karen Podvin (Regional Office for South America of the International Union for the Conservation of Nature - IUCN)

Biochar for Sustainable Soils (B4SS)

- Dr. Ruy K. Anaya de la Rosa (Starfish Initiatives)
- Dr. Brenton Ladd (Starfish Initiatives)

Mexico

Adaptation in coastal wetlands of the Gulf of Mexico to the impacts of climate change

- Dr. Margarita Caso (General Coordinator of Adaptation to Climate Change National Institute of Ecology and Climate Change [INECC]).
- Karina Santos del Prado Gasca (Deputy Director of Vulnerability and Adaptation of Species, General Coordination of Adaptation to Climate Change, National Institute of Ecology and Climate Change).

Diversification as an adaptation strategy in ranches in northwestern Mexico. Case study: El Mogor, Valle de Guadalupe

- Pedro Daniel Alcázar Ortega (Autonomous University of Baja California. Master in Management of Ecosystems in Arid Zones)
- Dr. Martha Ileana Espejel Carbajal

Costa Rica

Ecosystem-based Adaptation for the Indigenous Territory Bribri

- José Alfonso Domínguez Núñez (Polytechnic University of Madrid, Spain in collaboration with the National Institute of Rural Development of Costa Rica and the Spanish Agency for International Cooperation for Development)

Grenada

Building the Case for Ecosystem Based Adaptation in Small Island Developing States

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Photo: Practical Action

Abbreviations

EbA	Ecosystem-based Adaptation
PA	Protected Areas
CBD	Convention for Biological Diversity
UNFCCC	United Nations Framework Convention for Climate Change
IPCC	Intergovernmental Panel on Climate Change
MEA	Millenium Ecosystem Assessment
SDG	Sustainable Development Goals
NAP	National Adaptation Plans
SSP	Silvopastoral Systems

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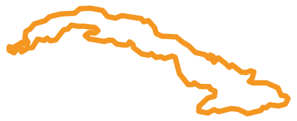

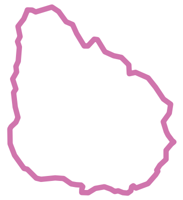

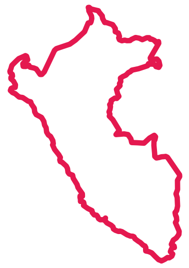

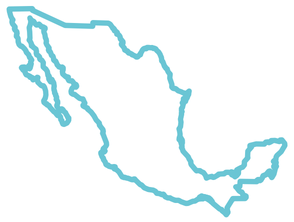

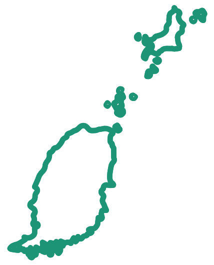

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Introduction

The Community of Practice on Ecosystem-based Adaptation for Latin America and the Caribbean

South-South cooperation has a catalytic potential to address climate change by improving collaboration, knowledge generation and exchange. It further enables the transfer of technology to support effective adaptation practices. Developing countries depend to a large extent on the ecosystems and the services they provide. Ecosystem-based Adaptation (EbA) is emerging as a potential response to climate change and a key pillar for sustainable development. UN Environment Programme under the Regional Portal for the Transfer of Technology and Action on Climate Change in Latin America and the Caribbean (REGATTA) recognises the need for collective learning on EbA. Together with the support of the Government of Spain, and in collaboration with Practical Action Latin America, was established the bilingual knowledge platform and the EbA Community of Practice for Latin America and the Caribbean (www.ebacommunity.com).

The EbA Community of Practice launched in critical years for the climate negotiations (2014 -2015), so it took advantage of a crucial moment to develop a South-South collaboration network in promoting the inclusion and visibility of the EbA approach. This interaction at a regional scale improve learning opportunities for the development, transfer and diffusion of knowledge and technology. Moreover, it is a crucial factor in resilience building and strengthening of adaptation capacities in Latin America and the Caribbean.

Since its initiation, **the goal of the EbA Community of Practice is to establish a regional network of professionals to share success stories and lessons learned from the implementation of EbA measures**. The Community of Practice is designed with two main objectives: (1) to support a learning process and sharing of knowledge about EbA in Latin America and the Caribbean, and (2) to provide a framework for the creation of networks among professionals and organizations in the region.

In 2017, the EbA Community of Practice launched the regional contest entitled "Demonstration of evidence on Ecosystem-based Adaptation: Case studies in Latin America and the Caribbean", based on defined evaluation criteria and eligibility requirements. Its purpose was to identify cases of EbA, which contribute to the resilience and adaptation of communities and ecosystems to climate change. Ten case studies from across the region were selected to share the evidence of the effectiveness of EbA measures in improving the climate resilience of human livelihoods. The case studies further highlight the challenges and lessons learned from these experiences.

Purpose and scope

The objective of this publication is to document and present case studies on EbA measures implemented in countries from Latin American and the Caribbean region. The selected ten case studies highlight:

Additionally, this publication is a complementary document to the study "Ecosystem-based Adaptation in Latin America and the Caribbean: Lessons from the field", which analyses the case studies and identifies the opportunities and barriers for strengthening EbA in the region.

Methodology

The selection of case studies presented in the regional contest "Demonstration of evidence on Ecosystem-based Adaptation: Case studies from Latin America and the Caribbean" used pre-defined evaluation criteria and eligibility requirements.

- **Eligibility.** The contest was open to organizations working in Latin America and the Caribbean, including any organization or group (public, private or civil society) that works on environmental and development issues.

- **Evaluation process and criteria.** Numerous case studies were received from countries in Latin America and the Caribbean, highlighting all the essential steps that local, national and international organizations are taking to address the challenge of climate change by adopting an ecosystem approach. An Evaluation Panel evaluated the case studies with three members composed of a representative of Practical Action, a representative of UN Environment Programme - REGATTA and an independent international expert.

EbA: Definition and principles

What is Ecosystem-based Adaptation?

Climate change has already led to multiple impacts for both vulnerable populations and fragile ecosystems. Climate change will increasingly contribute to changes in wind, temperature and precipitation patterns; frequency of extreme weather events; seasonal patterns; and more significant climate variability (IPCC, 2014). These changes, in turn, will result in substantial impacts on ecosystems and human activities, for example, the increased shortage of fresh water, the expected reduction in crop yields, decreased livestock and forest productivity in many regions of the world.

Climate change and environmental degradation have had an irreversible impact on socio-ecological systems (IPCC, 2014). The socio-ecological system describes the close relationship between people and nature. This system often reveals the high dependence of the communities on the ecosystems and their services to sustain livelihoods (Adger et al., 2005). Ecosystems provide a range of services and ecosystem goods, which serve as the basis for livelihoods and human well-being. Ecosystem functions and processes (e.g., soil formation) support the provision of ecosystem services (e.g., crop production), which in turn provide goods that people value (e.g., food). However, the environmental and human-induced disruption of ecosystem functions (e.g., the functioning of the hydrological cycle that contributes to the control of floods and the supply of drinking water) exacerbates the vulnerability of socio-ecological systems (MEA, 2005).

Photo: Practical Action

Healthy ecosystems and their services are essential to reduce vulnerability and improve the resilience of communities (MEA, 2005). The potential impacts of climate change on ecosystems would compromise ecosystem services and, hence, directly affect human populations. Therefore, ecosystem conservation must be an integral part of adaptation strategies to climate change. Examples of ecosystem services with adaptation value include regulation of climate and water, protection against natural hazards such as floods and avalanches, water and air purification, and regulation of diseases and pests. These services determine the central role of ecosystem management in adapting to climate change and reducing disaster risk. Thus, conservation, sustainable management and restoration of ecosystems can help people adapt to climate change.

The term "Ecosystem-based Adaptation" as defined in the Convention on Biological Diversity (CBD 2009) is now widely accepted:

> "ECOSYSTEM-BASED ADAPTATION IS DESCRIBED BY THE **USE OF BIODIVERSITY** AND ECOSYSTEM SERVICES **AS PART OF AN OVERALL ADAPTATION STRATEGY** TO HELP PEOPLE ADAPT **TO THE ADVERSE EFFECTS OF CLIMATE CHANGE".**

Photo: Practical Action

The concept of EbA is based on a range of existing practices employed by the conservation and development sectors, such as sustainable management of natural resources, community-based natural resource management and community-based adaptation. These practices include existing approaches at the ecosystem or landscape level and may involve, for example, integrated watershed management, sustainable land management or coastal zone management to ensure the functions and services of ecosystems.

The EbA measures receive more and more attention because they have shown great potential to reduce the vulnerability of people and ecosystems to the impacts of climate change. Besides, EbA provides multiple social and economic benefits, such as clean water, food security, risk reduction and other essential services for livelihoods and human well-being. The approach considers that equity, gender and the importance of local and traditional knowledge are fundamental components in effective adaptation efforts.

EbA measures include activities related to coastal habitat restoration, agroforestry, integrated water resources management, diversification of livelihoods, and sustainable forest management interventions that use nature to reduce vulnerability to climate change.

Some examples of EbA measures include (UNFCCC, 2013):

- Conservation, sustainable management and restoration of mangrove forests to reduce the impact of coastal flooding and erosion caused by storm surges related to the changing frequency and intensity of storms;
- Sustainable management of highland wetlands, forests and floodplains for the regulation of water flow and water quality control;
- Conservation and restoration of forests to stabilise the slopes of the land and regulate water flows;
- Creation of agroforestry systems to address multiple climate risks;
- Management of ecosystems to complement, protect and extend the longevity of investments in hard infrastructure;
- Conservation of agro-biodiversity to provide essential genetic reserves and facilitate the adaptation of crops and livestock to climate change;
- Creation and efficient management of systems to ensure the continued provision of ecosystem services to support resilience to climate change, for example through protected areas, land use and agricultural systems.

EbA promotes sustainability in multiple sectors, such as agriculture, forestry, energy, water, health, education and the diversification of livelihoods. Therefore EbA measures help achieve the Sustainable Development Goals (SDGs).

2.2 What are the principles of Ecosystem-based Adaptation (EbA)?

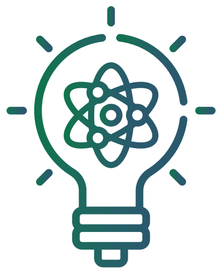
For an activity, initiative, project or strategy to qualify as EbA measure, it should follow different principles. These principles try to guide professionals to avoid maladaptation. The general EbA principles include:

Promote biodiversity and resilient ecosystems and the maintenance of ecosystem services;

Promote multi-sectoral approaches;

Consider the functional scale of ecosystems, recognising that ecosystems have limits and are interconnected;

Use participatory approaches and decentralised and flexible management structures to allow adaptive management;



Use the best available science and local knowledge, and encourage the generation and dissemination of knowledge.

Present EbA measures as an integral part of a global adaptation strategy.

The growing experience with EbA initiatives worldwide has provided evidence of the effectiveness of this approach. **Five criteria can be highlighted to ensure that EbA measures are effective (FEBA, 2017). EbA should:**

1. Reduce social and environmental vulnerability to climate change.
2. Generate social benefits and support the most vulnerable.
3. Restore, maintain or improve ecosystems and biodiversity.
4. Integrate into policies at multiple levels.
5. Support equitable governance and improve capabilities.

A critical aspect of the ecosystem-based approach is that it can be applied to diverse ecosystems and geographic scales: local, national, regional and global (Devisscher, T., 2010). Due to its multi-sectoral and multiple-scale characteristics, EbA can integrate a variety of disciplines, different actors and institutions, so that they can work at various levels of governance and can influence decision-making (Vignola et al., 2009).

Photo: Practical Action

3. EbA case studies

This section presents the ten selected EbA case studies that in the regional contest **"Demonstration of evidence on Ecosystem-based Adaptation: Case studies from Latin America and the Caribbean"**.

They present EbA experiences implemented in diverse ecosystems in Brazil, Costa Rica, Cuba, countries of Mesoamerica, Mexico, Peru, Grenada and Uruguay.

The case studies presented and selected in the contest are presented in this chapter.

Brazil

A strategy for capacity building in Ecosystem-based Adaptation in the Atlantic Forest

Location of the case study

The project's regional focus is on three regions of protected area (PA) mosaics of the Atlantic Forest: Extreme South of Bahia (state of Bahia), with 640,000 ha, 12 PA and 3 municipalities; Central Fluminense (state of Rio de Janeiro), with 300,000 ha, 25 PA and 14 municipalities; and Lagamar (coast of the states of São Paulo and Paraná), with 650,000 ha, 52 PA and 18 municipalities. Besides, the Northeast Region of Brazil is a focus area for training in the area of EbA and restoration.

Ecosystem

Composed of tropical and subtropical rainforests, the Atlantic Forest is a complex of 15 ecoregions, which originally covered 1,345,300 km². The Atlantic Forest is located along the northeast, central east, southeast, and south of Brazil and spreads throughout 17 states, reaching eastern Paraguay and north-eastern Argentina. It covers the largest cities and metropolitan regions of the country, with 120 million inhabitants and a share of 80% of the nation's GDP. The Atlantic Forest is composed of different forest formations (Dense, Open and Mixed Tropical Rainforest, Seasonal Semi-deciduous and Deciduous Forest) and associated ecosystems (such as sandbanks, mangroves and altitude fields).

Climate risks and impacts

The combination of different existing biotic and abiotic characteristics implies diverse climatic risks for each region, and even municipality, of the Atlantic Forest. However, some general risks can be indicated according to the table below. A summary of the climate impacts is presented in table 1.

Tab. 1. Climate risks and impacts in the Atlantic Forest, Brasil.

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	Changes in precipitation patterns were observed, which were resulting in increases in the occurrence of intense rainfall and irregularity of dry and rain seasons.
Increased temperatures	There has been a trend of rising temperatures, consistent with a global warming scenario. The region shows a tendency to become 1 to 4 degrees warmer by the end of the century. Species sensitive to temperature changes will be endangered of extinction, forest fragments will become more isolated due to the dieback of temperature-sensitive vegetation.
Changes in water availability or precipitation	Annual rainfall increased by +120 mm in the south and southeast in the last decade and, in the future, is expected to increase further in the south but decrease in the northeast region, which is already suffering from prolonged rains. In both regions, there will be irregularities in the dry and rain seasons which will have serious impacts on agriculture and water supply.
Sea level rise / soil salinisation	Over the past 50 years, the relative sea level has risen by 4 mm / year. Higher tides, caused by intensified wind activity, can cause a rise of the water at the coast by up to 20 cm.
Increase in flood events	The river flow ratios increased by 2-30%, causing a considerable number of floods. This risk tends to increase, which will simultaneously increase the risk of death, destruction as well as the occurrence of waterborne diseases.
Soil erosion	The lack of vegetation cover on slopes and riverbanks of the Atlantic Forest leaves the soil more exposed to extreme weather events and makes it vulnerable to water and wind erosion.

Objective

Strengthen technical and institutional capacities in the project's regions and at federal level, in the context of the National Adaptation Plan (NAP), to foster the consideration of EbA measures in public policies and territorial planning instruments and identifying, planning and mainstreaming, as well communicating and promoting the EbA approach.

Description of EbA measures

Aiming to meet the growing demand for technical training to identify and implement measures to adapt to climate change with an ecosystem approach, the project's EbA capacity building strategy has four objectives (Fig. 1). The strategy aims at the formation of EbA trainers in the different regions, so that they can internalize the approach in their institutions, as well as sensitize other actors related to their area of action, and thus finally insert EbA in public policies and land use territorial planning instruments (TPI).

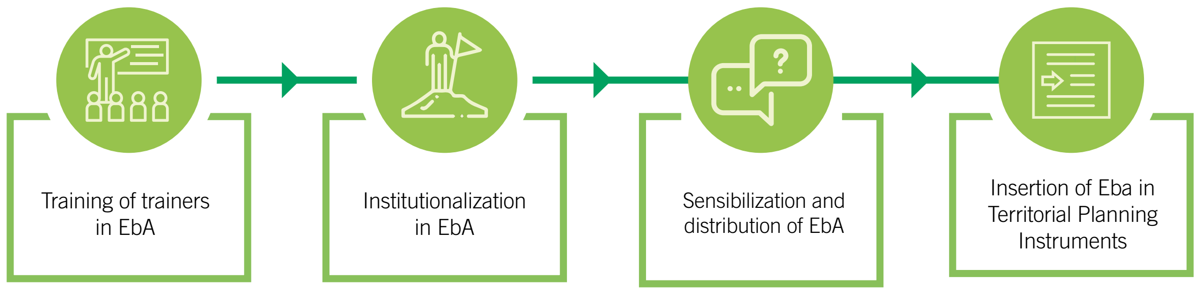


Fig. 1 – EbA capacity building objectives of the Atlantic Forest project.

Photo: Project archive

From the beginning of the project in 2013 until today, courses were designed and offered, didactic materials were provided and coaching was offered to the participants to develop their activities. The approach is based on the Climate Proofing for Development (CP4D) methodology and the manual "Integrating Adaptation to Climate Change into Development Planning", developed by GIZ in coordination with the Organization for Economic Cooperation and Development (OECD). The manual was supported by the German Federal Ministry for Economic Cooperation and Development (BMZ), involving a range of experts from different development agencies, NGOs and research institutions from around the world.

Courses were developed and offered in two main formats:

- **Methodological Course (3 days):** Introduction to the concept, training in adaptation to climate change and EbA, presentation of the methodology for planning EbA measures based on a case study.
- **Training of Trainers Course (ToT, FoFo in Portuguese) (5 days):** Empowerment of the participants to plan and implement EbA measures and to be EbA trainers. Using the example of a case study, the participants acquire profound technical knowledge. They also learn how to reproduce the didactic of the course, using the trainer's manual and other materials.

Following the logic of the EbA cycle (figure 3), the training course follows four basic modules that are structured in a systematic way:

- **Module 1.** Apply the Climate Lens: Identify the relevance of climate change to policies, programs, plans or projects.
- **Module 2.** Assess Vulnerability: Identify factors that contribute to the vulnerability to climate change of a given system.
- **Module 3.** Identify Adaptation Options: Identify options for adapting to climate change to adjust or improve planning and management.
- **Module 4.** Select Adaptation Options: Evaluate and prioritize options using selection criteria.

From the first groups of graduates from the ToT-Course, several FoFos became coaches of following groups. Others started to integrate EbA into public policies, with coaching of the Project.

The following support materials were elaborated: Handouts to deepen the contents, with examples of application of the methodology; Instructor's manual, guiding the organization and preparation of course activities; Awareness video about AbE. Furthermore, an EbA distance course and a set of posters are currently in preparation, which will have a step by step explanation of the EbA cycle, making use of visual resources such as infographics and schemes, to facilitate the application of concepts and methodology.

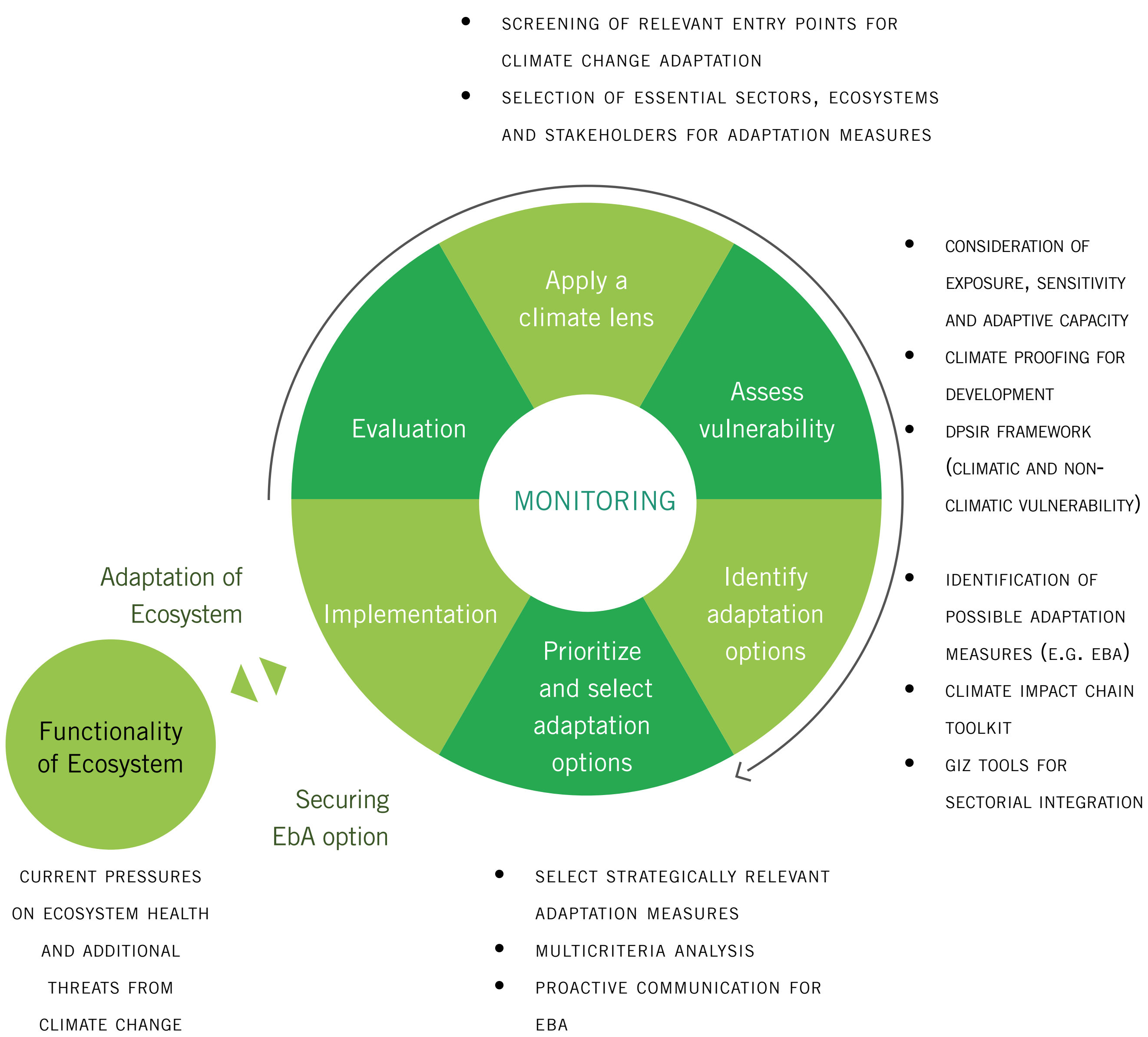


Fig. 2 – Cycle of EbA

How does the EbA initiative contribute to the resilience of ecosystems and communities?

During the courses the participants highlighted the usefulness and importance of the EbA methodology for Brazil, especially for local actions, and contributed to the adjustment of the contents to the Brazilian reality. In addition, they stressed the importance of having a team of national EbA facilitators and trainers, while there initially were international trainers. For that reason it became necessary to build a team of trainers for the multiplication of EbA with general knowledge on climate change, vulnerability, risk and adaptation, ecosystem services and their assessment, ecosystem-based adaptation measures, as well as on capacity building through teaching methods for active learning and participatory methods.

During the trainings, several professionals gained the ability to explain the concepts of climate change and adaptation to climate change, including EbA. They learned about the methodology of the course, how to apply it to their work context, and how to pass on their knowledge.

An important element of the capacity building strategy is the dissemination of training material in Portuguese and of the approach in Brazil in general. As capacities increase, more and more professionals are able to insert EbA in public policies and land-use planning.

Therefore, the project's capacity building strategy has highlighted evidence of the effectiveness of EbA measures, especially demonstrating their effectiveness for the human population by:

- Increasing their resilience and adaptive capacity by providing more knowledge about vulnerability and the importance of maintaining ecosystem services,
- Providing collective learning and the capacity to disseminate knowledge, and
- Enhancing and contributing to the increase of local knowledge.

Results

The main result of the capacity building strategy is the increase of the adaptation capacity through the training of technical personnel, being aware of the vulnerabilities, the impacts of climate change already observed and projected in the Atlantic Forest; as well as the importance of maintaining environmental services and the effectiveness of EBA measures. They are also able to disseminate their knowledge and integrate the focus into their own areas of activity.

The key outcomes achieved by the EbA initiative include:

- Mainstreaming of EbA approach in the National Adaptation Plan (NAP) of Brazil;
- Mainstreaming of EbA approach in instruments for land use planning, such as Municipal Plans for Conservation and Restoration of the Atlantic Forest;
- Mainstreaming of climate change and EbA approach in the elaboration of nine Municipal Plans in Bahia;
- Integration of climate change and EbA in a distance training course for the elaboration and implementation of the Municipal Plans with more than 600 participants;
- Support to the planning of policies on mitigation and adaptation based on ecosystems in an area of 114,556,74 ha located in the Atlantic Forest region, contributing to the conservation and maintenance of environmental services while reducing the vulnerability of communities to the different climate risks;

- Incorporation of climate change and EbA in the management plan of the Environmental Protection Area of Cananéia – Iguape – Peruíbe (NPA CIP) Management Plan, published by the Federal Government in 2016.

Initially the team of the Natural Protected Areas (NPAs) received a training on concepts and methodologies for the planning and implementation of EbA measures, using as a case study the potential for integrating the EbA planning cycle in the NPA CIP Management Plan. Based on this experience, it was encouraged the collaboration between the Trainers and managers of the NPA. Key results of this experience include: awareness raising for the role of EbA approach in NPA CIP management; participative planning workshops addressing themes such as climate change and EbA; the creation of the Environmental Protection and Fighting Climate Change Programs, including EbA measures. The Atlantic Forest Project will promote another eleven NPAs management plans, where EbA measures and climate change will be taken into consideration.

The main result of the EbA capacity building strategy is the increase of the adaptive capacity through the formation of technical personnel in the methods of EbA: aware of the vulnerabilities, the impacts of climate change already observed and projected to the Atlantic Forest, as well as the importance of the environmental services maintenance and the effectivity of the EbA measures; they are also able to disseminate their knowledge and insert the approach in their own activity areas.

Photo: Project archive

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

The strategy influenced the preparation of the Brazilian Federal Government's National Adaptation Plan to Climate Change (NAP), published in 2015. All the focal points of the institutions involved in the formulation process were participating in an EbA training which allowed the inclusion of the approach in the respective strategies of the plan.

One of the principles of the NAP is to promote and integrate the methodology of Ecosystem-based Adaptation across all sectors, with a view on making use of ecosystem services as an alternative or complementary adaptation strategy. In this sense, nine out of eleven sectoral and thematic strategies in the NAP are guided by EbA in the process of reviewing and strengthening its policies: Agriculture; Biodiversity and Ecosystems; Cities and Urban Development; Natural Disaster Risk Management; Industry and Mining; Vulnerable People and Populations; Water Resources, Health, Food and Nutrition Security and Coastal Zone.

Lessons learned

Lessons learned about the processes and implementation of the EbA

The activities of capacity building from the Mata Atlântica Project indicate the factors contributing to the success of the process:

1. **Sequential activities logic:** Starting with courses of sensitization and qualification in different levels along different actors, adjusting of the materials according to the local context and needs, identifying gaps and entry points for the development of a wide capacity building strategy.
2. **Participative development of the capacity building strategy:** Insuring the integration of the lessons learned from the first activities and the adjustment to the local context into the final strategy, as well as the construction of a network of stakeholders and institutions that were involved from the beginning.
3. **Focus on the training of trainers and the institutionalizing of the capacity building topic EbA:** promoting the dissemination of knowledge related to the topic in Brazil, as well as the appropriation and adaptation of the materials to Brazilian context.
4. **Integration of the capacity building strategy into local processes and other related activities occurring in the same time:** Assuring synergies with the capacity building activities and local projects, and promoting of the immediate application of the acquired knowledge in the capacity building courses context.
5. **Elaboration of Portuguese material:** Experiences in or near Brazil.

6. **Methodology for adaptation:** Adaptation of the course to the cultural realities in the respective areas.
7. **Addressing of complementary knowledge gaps**, as vulnerability, climate change, environmental services as well the capacity strategy.
8. **Technical language adaptation of workshops methodology and contents**, in order to provide the participation of a variety of people from the local communities in the project actions.

Lessons learned about policy processes for EbA

1. Initially the Project wasn't expecting the strengthening of capacities in EbA. When the Project faced some barriers to the implementation in public policies and territorial planning instruments, this strategy was needed.
2. It was necessary to involve and qualify not only technicians, but also decision makers, for them to support the initiative of EbA implementation on policies.

Photo: Project archive

For more information

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Organization

The Capacity Development Strategy Ecosystem-based Adaptation (EbA) was developed by the Biodiversity and Climate Change Project in the Atlantic Forest (hereinafter Atlantic Forest Project). The project is coordinated by the Ministry of the Environment (MMA for its acronym in Portuguese) within the framework of the Brazilian-German Cooperation for Sustainable Development, under the International Climate Initiative (IKI) of the Federal Ministry of the Environment, Nature Protection, Construction and Nuclear Safety. For technical and financial cooperation, the project has the support of Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), GmbH and KfW Development Bank.

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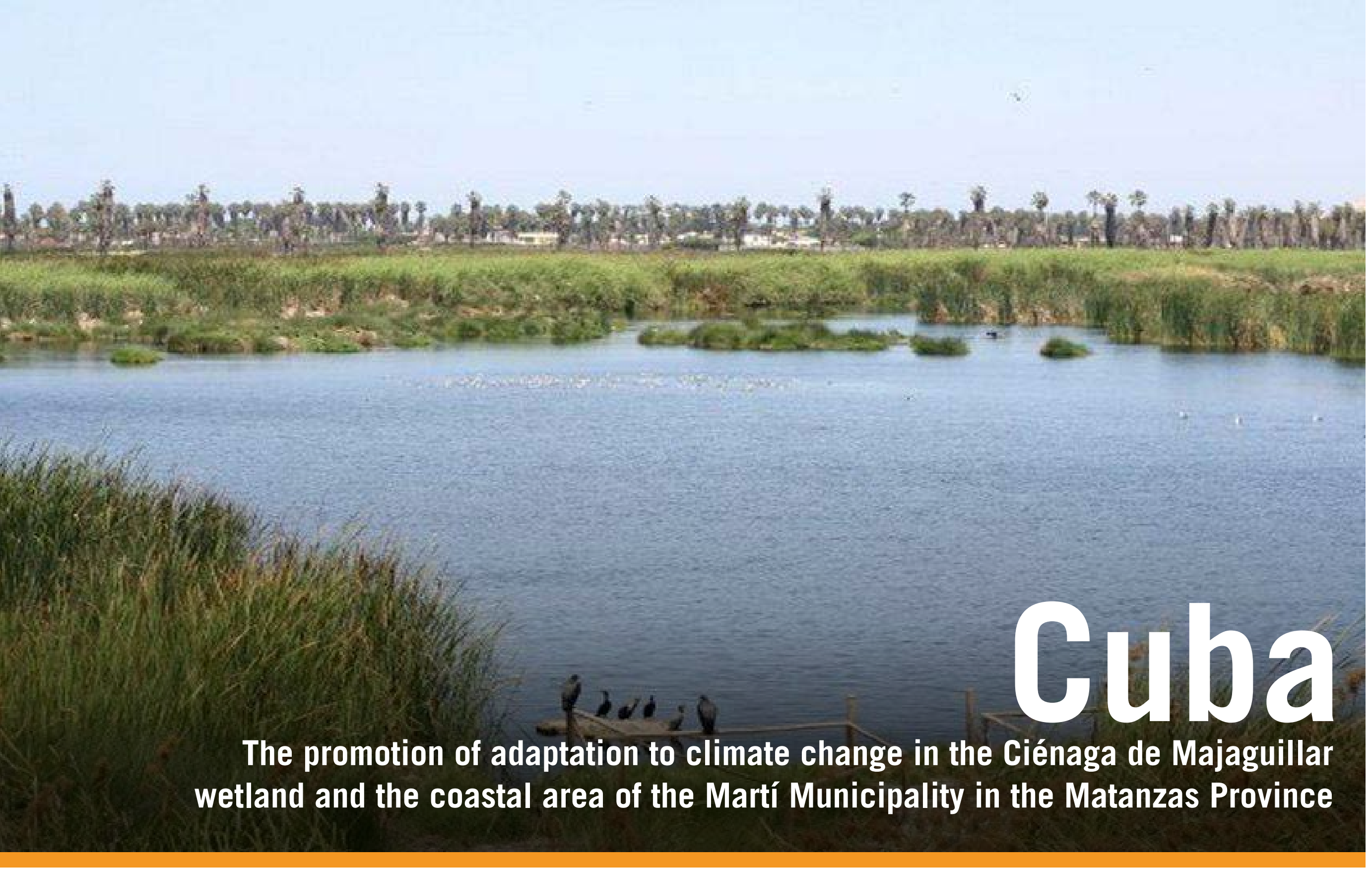

Cuba

The promotion of adaptation to climate change in the Ciénaga de Majaguillar wetland and the coastal area of the Martí Municipality in the Matanzas Province

Location of the case study

The case study takes place in Matanzas Province, Martí municipality. The municipality is located on the north coast of the country and the province. The agriculture is one of the main economic activities in the region, the main crops are cane, rice and various crops.

Ecosystem

Wetland and Coastal Ecosystem

Ciénaga de Majaguillar stands out for its unique biodiversity in the Cuban Archipelago. It provides useful environmental services in the face of climate change effects such as: regular flooding, carbon sink, protecting underground karstic aquifers from salinity, supporting populations of aquatic species in critical periods of their development through coastal mangroves. It further contributes volumes of biomass important for fishing on the north coast, among others. Significant impacts of the ecosystem are predicted under the 2050-2100 scenarios. This makes the design and implementation of adaptation measures for agriculture and forestry practices adopting a sustainable land management approach pivotal.

Climate risks and vulnerability

The summary of the climate risks and impacts in the Matanzas Province is described in table 2.

Tab 2. Climate risks and impacts in the Matanzas Province, Cuba.

Climate related risk	How has this risk increased in the area during the last decades? What are the past and future impacts?
Increase in climate variability	It is observed reduction of water availability, abundant rainfall in short periods of time, frequent prolonged droughts and increase in temperature. This leads to reduced crop yields, low availability of water in reservoirs, increase of forest fires and alterations of the agricultural calendar.
Increased temperatures	Analysis of official data demonstrate the increase of the average temperature by 0.2ºC. This results in decrease of soil moisture, the quality of pastures and fodder. It leads additionally to increase in evapotranspiration. Pests and diseases appear at different times than historical ones.
Changes in water availability or precipitation	It is observed greater frequency, duration and intensity of drought occurrence and changes in the temporary precipitation regime. Occurrence of salinisation of underground aquifers, which results in reduction of food production.
Sea level rise / soil salinisation	There is evidence of the penetration of the saline water in underground aquifers. This decreases the availability of drinking water and affects agricultural and livestock production.
Increase in floods	There is observed accumulation of high precipitation in 24 hours, which leads to increased flood risk and economic losses due to production loss and water logging.

Objective of the initiative

The main objective of the project is to contribute to the resilience of ecosystems and landscapes in the prioritised area and thus mitigate climate impacts, which threaten the lives of vulnerable populations, their assets and local socio-economic development.

Description of EbA measures

The project has developed a package with various EbA measures to comprehensively address climate risks and the needs of the local population. The package of EbA measures includes:

- **Agricultural conservation practices:** production and application of organic fertilisers; compost production; levelling the soil to improve the efficiency of the irrigation; production of seeds of resistant grass and forage cultivars;
- **Water resource management:** restoration and construction of reservoirs; rainwater harvesting;
- **Reforestation and establishment of silvopastoral systems**;
- **Management and control of invasive alien species;**
- **Training of the actors** involved in issues related to adaptation to climate change.

How does the EbA initiative contribute to the resilience of ecosystems and communities?

Through the EbA measures, the capacities of the main actors are strengthened and thus their resilience to the potential impacts of climate change. The vulnerability of the agricultural sector is reduced due to the adoption of climate resilient crops, sustainable pasture management, introduction of cultivars resilient to climatic variability and the identified effects.

Likewise, **by strengthening their capacities, the application of strategies and programs is favored based on the proposed objective with the application of ecosystem-based management**. Vulnerabilities in the agricultural sector are reduced, with the establishment of protected crops, actions with cattle, swine, introduction of cultivars resistant to climatic variations, pests and diseases. Rainwater reservoirs are built, adopting technologies for reducing water consumption. Ecological practices are used for the integrated management of pests, and biodigesters are built for the treatment of waste and energy generation. Trees are planted as natural barriers that facilitate the management of pests and reduce the effect of strong winds.

How does the initiative contribute to the integration of EbA in national and sub-national policy frameworks?

The EbA initiative is aligned with the national program: Climate Change in Cuba: impact, mitigation and adaptation. The EbA initiative contributes to a better design and articulate the implementation of the sustainable management of water and soil. Also, the initiative identifies environmental solutions for adaptation to climate change at the territorial scale, considering the coastal zone, wetland and conservation area, which corresponds to the objectives of the national program. Moreover, the EbA initiative responds to the nationally established priority “development of the scientific and technological base in particular with regard to climate change and the conservation of Cuban biodiversity”.

These issues are recognised in the national environmental strategies. The experiences of this project are disseminated in a number of Municipalities of the Province to encourage their involvement in the adaptation solutions.

Achieved results

A National Program has been implemented to promote adaptation solutions with ecosystem approach, raise awareness for target groups and others regarding the use of adaptive agricultural practices.These activities resulted in:

- **Improvement of the forest cover of the wetland:** Actions with the Alameda Silvicultural Company and the peasantry of the municipality allowed to reach the figure of 28,357.7 ha of covered area in the period of application of the project, with emphasis on native species and local biodiversity in general.
- **Four economic sectors have climate impact assessments and programs for adaptation:** agricultural, pig industry, silviculture and forestry.
- **Increased perception of the population on climate risk and adaptation:** Initial study of risk perception demonstrate increased awareness of potential climate impacts and adaptation solutions.
- **Increase in agricultural production:** The vulnerability of the bovine species is reduced, therefore there is observed an increase of milk production. The pig production has increased ensuring food supply to the population.

Lessons learned

1. **The project has demonstrated the importance of improving and updating the climatic scenarios (A2 and B2) for the years 2050 and 2100**. The current climate variability has been updated up to the year 2100. Calculations of the probability of occurrence of climatic hazards such as hurricanes, strong winds, fires and rainfall of 100 mm in 24 hours has informed have informed decision-making. The decision makers and part of the population have been trained in climate change and variability issues.
2. **In terms of monitoring, the behavior of meteorological variables that influence the behavior of different diseases is analyzed**. The climatic characterizations of the municipality and the surroundings of the project are updated. The behavior of the precipitation patterns and the values of the total water potential of the province for future scenarios are also monitored, as well as the behavior of the climate in the project area. The occurrence of electrical storms and meteorological variables that influence the reproduction and development of invasive alien species in the municipality is monitored daily.
3. **The environmental land-use management is important to design the EbA measures aligned with economic development priorities in the regions.** In the land-use planning it is crucial to consider climate change aspects and the state of the environment.
4. **Engagement with local and national stakeholders is key and workshops can served as a tool to strengthen the risk perception, vulnerability analysis, co-design of EbA measures.**
5. **Making the case for the effectiveness of EbA is important to inform public policies**. The project demonstrates how evidence of adaptation benefits can bring changes in decision-makers at the local and municipal levels

Organization

Mapa Verde Filial Matanzas (Civil Society Organization), Department of Environment (UMA - Unidad de Medio Ambiente in Spanish) y Meteorological Center (CMP – Centro Meteorológico in Spanish), both part of the Ministry of Science, Technology, Innovation and Environment (Citma - Ministerio de Ciencia, Tecnología, Innovación y Medio Ambiente in Spanish) and the Province of Matanzas.

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Location of the case study

In the Mesoamerican region a large area is destined for extensive livestock farming and it is also one of the regions with the greatest climate vulnerability. Therefore, the Livestock and Environmental Management Program (GAMMA for its acronym in Spanish) and the Tropical Agricultural Research and Higher Education Center (CATIE for its acronym in Spanish) have identified together with its strategic partners (producers, researchers, policy makers), various Silvopastoral practices, mainly in Mexico, Honduras, Nicaragua, Costa Rica and Panama, and has proven its economic, environmental and social benefits, with the purpose of improving the productive indices of the herd, improving the quality of life of families, reducing the impact on the environment and improving the adaptation and mitigation of livestock to climate change.

Ecosystem

Silvopastoral Systems have different characteristics. They perform flexibility in temporal and spatial arrangements, therefore the incorporation of tree and shrub species in each region and / or country has been developed in different altitudinal levels . These practices have been successfully adapted and adopted in ecosystems ranging from coastal savannahs (100 masl) to coniferous forests (3000 masl). However, it is essential to consider the

context to potentiate the adoption and establishment of Silvopastoral Systems, for example, when identifying the species of trees and/or shrubs present in the ecosystem.

Climate risks and impacts

Tab. 3. Climate risks and impacts in Mesoamerican region

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	The loss of forest, due to the change of land use to livestock, has caused the increase of greenhouse gas (GHG) emissions, generating greater climate variability, and making ecosystems more vulnerable.
Increased temperatures	The high temperatures are a factor that causes the loss of moisture in soils and pastures, directly affecting the production of water and food for people and animals.
Changes in water availability or precipitation	Water availability and precipitation have undergone modifications. The entire region of Mesoamerica has reduced its history of precipitation and water availability. This has caused a reduction in milk production, and resulted in the death of some animals
Increase in flood events	Due to the decrease in the coverage of forests in the upper reaches of the basins, sucédanse have produced landslides and floods in the lower parts, which has been increasing due to the expansion of the cattle border to the upper reaches of the basin.
Soil erosion	The lack of coverage of pastures and poor grazing practices of animals have increased erosion, and the loss of productivity of soils, which causes farmers to expand their livestock areas to produce more fodder for their animals.
Loss of biodiversity	The loss of trees in livestock landscapes has decreased the migration of wildlife, which has caused some of the migratory species to decrease their population. Likewise, the floristic composition of the species present in the livestock landscapes has been substantially reduced.

Objective of the initiative

The main objective of the project is to create more sustainable animal production systems through the Silvopastoral Systems. In addition to improving the productive indices and the livelihoods of families, the project seeks to conserve biodiversity and generate multiple ecosystem services, restoring ecosystems to generate greater capacity for adaptation and mitigation to climate change.

Description of EbA measures

Implementation of Silvopastoral Systems in its different designs, spatial arrangements and tree species according to the region:

Tab4. Description of EbA measures

Practice	Description	Timeframe for implementation
Simple living fence (one trees specie)	Multipurpose trees and shrubs forming part of the fences or divisions of paddocks (in place or in addition to the “dead poles”). They can come from stakes and / or nursery plants.	According to the experience developed by GAMMA, the implementation of the Silvopastoral Systems has been carried out in the region for more than 17 years...
Multi-level living fence (four tree species)	Multipurpose trees and shrubs forming part of the fences or divisions of paddocks (in place or in addition to the "dead poles"). They can come from stakes and / or nursery plants.	
Scattered trees in pastures	Scattered trees within the paddocks. In general, natural regeneration trees already exist, however, when there are not or there are very few, it is possible to establish trees of desired species.	
Fodder banks for protein	Fodder shrubs (usually legumes) established in a high density plot (1x1 m) to have a source of high quality forage (high protein content) to supplement the feeding of livestock, either by cutting and carrying, or controlled grazing.	... during this time we have been working continuously with local producers and / or technicians to rescue and respect traditional knowledge about the use, adaptation and adoption of Silvopastoral Systems.
Fodder banks for energy	Plots of cutting grass (grass) with high forage production potential, used mainly for cutting and hauling. You can provide fresh livestock, or ensiling it. Usually zacates of the genus Pennisetum are used.	
Intensive Silvo-pastoralists (with improved pasture).	Woody bush fodder (usually Leucaena sp.) Established in high density in association with grass to be periodically grazed together. The density of the forage shrub should allow a consumption close to 30% of this in the diet.	
Timber trees in lines	Timber trees in the available spaces within the farm. For example, fences, boundaries and banks	

How does the EbA initiative contribute to the resilience of ecosystems and communities?

Tab.5. Contribution to the AbE practices

Practice	Contribution of the practice to the adaptation and resilience
Simple living fence (one tree specie) and multi-level living fence	• Multiple benefits for the farm (fodder, fruit, firewood, wood) • Carbon capture • Light for livestock • Biological activity
Simple living fence (a kind of trees)	• Multiple benefits for the farm • Carbon Capture • Shade for cattle Improved pasture resilience in dry season • Biological connectivity
Fodder banks for protein	• Improvement of diet and reduce GHG emissions • Increase in yields • More availability of forage in smaller area
Godder banks for energy (cutting grass)	• Improvement of the diet and reduces GHG emissions • Increase of yields • Increases the efficiency of the area (+ pasture / area) • Facilitates livestock management
Intensive Silvopastoralists (with improved pasture)	• Improvement of the diet and reduces GHG emissions • Increase system efficiency • Carbon Capture • Improves soil fertility
Timber trees in lines	• Increase in income of the farm in the medium and long term (investment) • Carbon capture • Shade for livestock • Biological connectivity
Improved pastures	• It can triple production of forage compared to naturalized pastures.10 - 14% PC vs 4 - 9% natural grass • They support shade Higher resilience to drought • Soil cover (protection against erosion). • Increase Carbon in the soil
Timber plantations with grazing (improved pasture, Taungya type)	• Increase in income of the farm in the medium and long term (investment). • Greater resilience to drought Carbon Capture • Shade for livestock Biological connectivity
Forage silage	• Improvement of the diet and reduces GHG emissions. • Increase the efficiency of the system • Avoid weight loss and / or death of animals in the dry season.

Achieved results

- **Restoration of degraded livestock agro-ecosystems**, through the recovery of cover / vegetation and biodiversity.
- **Generation of ecosystem services** (carbon, water, scenic beauty) necessary to communities to sustain their livelihoods.
- **Biological connectivity in productive landscapes.** The greater arboreal coverage allows a more favorable environment for the transit, and even dwelling, of numerous species of wild fauna, bringing local, regional and global benefits.
- **Improvement of the livelihoods of rural communities**, by providing food security and surplus production. This is due to the diversification in production and the increase of productivity, as a result of the increase in the resilience of the ecosystem to extreme climate events.
- The increase of the tree coverage in the farms has boosted the amount of carbon fixed and stored, improving in this way the **balance of greenhouse gases in the farms**.
- Land-sue change to ensure the **restoration and conservation of forest in unsuitable areas for livestock.**
- **The water quality has been improved and water availability increased**, ensuring that consumers have access to water resources for drinking and irrigation.
- **Manuals have been designed for the development of Silvopastoral Systems and good practices for sustainable livestock management.**

How does the initiative contribute to the integration of EbA in national and sub-national policy frameworks?

A regional strategy is under development and aims to include Silvopastoral Systems within public policy mechanisms, with particularities depending on each country. The strategy include:

- Silvopastoral Systems are being included in the design of livestock NAMAs in the countries of the region. The NAMA seeks to increase carbon fixation and the sustainability of livestock, taking a training and technical collaboration program to different scales.
- Likewise, national coordination mechanisms are being established with key actors in order to have a management structure at a national level, and where Silvopastoral Systems are an important activity.
- Partnerships are being created with the public and private sectors to establish a piloting of “financial mechanisms” and / or “Payments for Environmental Services” that involve the implementation of Silvopastoral Systems and the conservation of forests as environmental safeguards.

Lessons learned

Lessons learned about the processes and implementation of the EbA measures

1. **The process of capacity building.** The development of the Field Schools for Cattle Ranchers methodology has been fundamental for these silvopastoral practices and / or technologies to be adapted and adopted by livestock producers throughout the Mesoamerican region. Likewise, this methodology has facilitated that producers can exchange their experiences generated in this process, facilitating that other producers can adopt these recommendations.
2. Similarly, t**he development of participatory studies, and the exchange of experiences from producer to producer** has been crucial to observe the benefits of the practices and potentiate their adoption.
3. **The experience and knowledge of producers in the development of livestock has served to strengthen the capacities not only of other producers, but also of the institutions** that design and develop new strategies and / or sustainable livestock practices.

Lessons learned about policy processes for EbA

1. Thematic tables and discussion groups for sustainable livestock management at the local and national level have been a good mechanism to influence policies that support silvopastoral practices. However, it has been a challenge to link and articulate all sectors that work in livestock. **It is crucial to find a common goal and establish a joint action plan.**
2. The creation of a sustainable livestock network among academia, producers and decision makers has been a space where successful and unsuccessful experiences of sustainable livestock have been exchanged. However, **it is important that decision makers include in its language the importance of the Silvopastoral Systems as a strategy for adaptation and mitigation to climate change.**
3. There is a **lack of articulation** between public institutions that promote livestock and institutions that promote and encourage the conservation of natural resources. This has caused that mechanisms of safeguards that ensure the conservation of natural resources are not generated.
4. Likewise, **it is necessary to encourage the private sector to participate in a payment scheme for environmental services as a safeguard** mechanism to ensure the conservation of natural resources.

For more information

Livestock and Environmental Management Program (GAMMA for its acronym in Spanish): http://gamma.catie.ac.cr

Tropical Agricultural Research and Higher Education Center (CATIE for its acronym in Spanish): www.catie.ac.cr

Organization

Livestock and Environmental Management Program (GAMMA for its acronym in Spanish) and the Tropical Agricultural Research and Higher Education Center (CATIE for its acronym in Spanish)

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Uruguay

Adaptation to climate change via the restoration and conservation of coastal ecosystems in the South Atlantic

Location of the case study

The case study is located in the coastal zone of the River Plate of the Eastern Republic of Uruguay. In a tourist town called Kiyú (34°42'S: 56°43'O), located in the Municipality of Libertad (local government) of the Department of San José (subnational government).

Kiyú is a small coastal rural town of less than 400 inhabitants that is historically dedicated to the cultivation of potatoes, grains and livestock activities. In recent years has begun to develop activities linked to tourism receiving a population of approximately 2,000 people per season.

Ecosystem

The project was developed in a coastal ecosystem characterised by alternating landscapes of vast prairie areas, river deltas and streams, bathing areas (some of global importance are part of the RAMSAR sites in Uruguay) dune fields and coastal cliffs. This coastal area is a geological formation of greater vulnerability to erosion processes, which represent areas especially sensitive to extreme events and the increase in mean sea level associated with climate change.

Climate risks and vulnerability

The Uruguayan coastal zone generates 75% of the national GDP and houses 70% of the population. Characterised by a deep urban, demographic, logistic and tourist development that meant important changes in its configuration, both environmental, social and economic (Ecoplata, 2010). Where 30% of the same (more than 200 km of 680km total) presents situations of medium and very high vulnerability to erosion (DCC, 2013).

At the national level the longest continuous erosive line (36 km) is located in Kiyú. Approximately 40% of the departmental coast has a vulnerability between medium and high, developing acute erosion processes, of the order of 1 to 1.5 lineal meters of retreat per year in the coastal zone of high brittleness, according to observations in the field. This threatens the imminent loss of housing, road infrastructure and tourism services in that locality.

Tab. 6. Climate risks and impacts on the Department of San José. Uruguay.

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	The increase in rainfall regimes and extreme wind events strongly increases erosion processes in highly vulnerable coastal areas.
Sea level rise / soil salinisation	The rise in sea level causes extreme weather events to impact incrementally on the coastal zone.
Soil erosion	The urban development, demographic, and tourism constitute a source of pressure on the coastal area meaning important changes in its configuration, increasing the erosive processes of beaches.

Objective of the initiative

The main objective of the project is to develop an alternative for coastal management based on an ecosystem and community approach. Adopting this approach the project seeks to increase the resilience to climate change where citizen participation and economic viability are contemplated for its sustainability over time.

Description of EbA measures

- **Installation of dune regeneration catchment fences:** 1,500 linear meters of fences were built for the recovery of the dune with the functionality of trapping the sand mobilised by the winds, generating an artificial dune of variable height and extension. This generates also a positive impact on the slope of the beach. The fences are composed of plant remains from pruning of public green spaces and private gardens whereby they are completely degraded when buried by sand, becoming an organic fertiliser for plant communities that spread on the recovering dune system.
- **Revegetation of the coastal forest:** approximately 35 trees of exotic species were cut per year (mostly eucalyptus) in order to reduce the effect of their shade on the dune system and avoid the process of disaggregation of the canyon that occurs punctually with the fall of trees in extreme wind events due to the large size. The branches of these cut trees were used in the construction of the catchment walls for dune regeneration. Later, more than 400 specimens of native forest were planted from different species of the coastal systems, of rapid growth and low bearing that have a better performance against the occurrence of extreme wind events. This measure seeks to protect the front of the ravine from erosive effects.
- **Prevention of impacts from car parking:** more than 300 m of wooden fences were placed. This action prevents cars from parking on the edge of the ravine, avoiding danger to users and erosion. In addition, it stimulates the growth of the reforested species of native coastal forest.
- **Sustainable drainage systems:** more than 600 meters of rainwater conduits were made to the beach area with dissipation structures with different stone sizes. This measure seeks to strengthen rainwater runoff routes to reduce the impacts of the evacuation of water to the coast in the area of project implementation.
- **Awareness signs for sustainable coastal use:** posters were placed for education of the tourist and visitors to promote the sustainable use of the coast.

Photo: Start of actions. Beach without sand. High vulnerability. Project archive

How does the EbA initiative contribute to the resilience of ecosystems and communities?

The EbA measures allowed the improvement of the environmental quality of the beaches of Kiyú and its ability to absorb wave energy and wind during extreme events. This demonstrated quantitative changes in the profiles of monitored beaches, significantly increasing the volumes of sand captured and the vegetation present in the dunes. This reflects an improvement in the ecosystem services provided by the coastal zone, making more beach area suitable for tourism and activities that refer to the cultural use of the beach (leisure and recreation). Moreover, it contributed to the intrinsic improvement of the landscape.

At the same time, it enabled the local community to identify concrete actions to increase the resilience of the ecosystem and participate in their implementation and monitoring. Another relevant element is that the community improved its perception of the associated risks and provided an area in which to reflect and agree on actions in an inclusive manner.

This experience resulted in the articulation of actors at the local, departmental and national levels, adopting a strong participatory approach. It was demonstrated the importance of the synergy between different actors to enhance local processes and lay the foundations of EbA

How does the initiative contribute to the integration of EbA in national and sub-national policy frameworks?

The implementation of EbA measures in the town of Kiyú as well as other similar experiences in the coastal area (altogether approx. 680 km) has contributed to promote EbA in the National Plan of Coastal Adaptation of Uruguay and the National Policy for Climatic Change. Likewise, each EbA experience at the level of the departmental governments served to improve the articulation of the actions in the subnational level and its integration into the local regulations and land management plans.

Photo: Intermediate results of sand accumulation in capturing fences. Project archive

Achieved results

After 4 years of implementation of the EbA measures under the project and despite the occurrence of new extraordinary weather events, the restoration process has proved successful in maintaining the quality of the coastal ecosystem and adjusted infrastructure. The actions of dune recovery, management of the coastal forest, and management of coastal storm drains have resulted in a substantial improvement in the quality of the beaches in Kiyú, both for tourist use and the increased potential of ecosystem service to buffer against the impacts of climatic hazards. An accumulation of 10,000 m^3 of sand per year was achieved, equivalent to USD 120,000 per year of sand material (according to local market costs).

The project outcomes contributed to specific inputs to introduce aspects of adaptation to climate change in Territorial Planning plans for coastal areas.

Strengthened the community's understanding and commitment to adaptation practices by understanding the way in which they were involved with the use of ecosystems and the concrete possibilities for improved management.
Demonstrated a concrete and low-cost practice strategy that contemplates a set of actions that can be potentially replicable in the 680 km of coastline of Uruguay on the Río de la Plata and the Atlantic Ocean. Facilitated the articulation with the three levels of government and identifying specific actions, responsibilities and synergies among priorities.

A Departmental Climate Change Cabinet was created, which meant a space for positive socio-institutional innovation that allowed for the viability and transversality of adaptive coastal management.

The implementation of coastal adaptation measures to climate change has proven to be an effective tool for quality management of beaches and coastal ecosystems of San José. The possibility of deepening the actions in the sites already intervened and the expansion to new sites in San Jose will mean an increase in the resilience capacity of the departmental coast. In addition to this, the development of infrastructures for sustainable use, such as access ramps, improvements in services located on the coast, will enhance the positive effect of the measure.

Lessons learned

Lessons learned about planning processes, implementation and monitoring of EbA measures

1. **It is necessary to have community participation at an early stage**. This means overcoming the initial resistance, understanding the process and having support from the community. In addition, having a community that is active and participative stimulated the sense of ownership and therefore the continuation of the process and sustaining it over time.
2. **Obtaining and showing results in the short term (months)** is very important to maintain the motivation of the community and the support the rationale for the implementation of the EbA approach.

Photo: Works of reprofiling canyons. Rain damping. Project archive

3. **The analysis of the perception of the community regarding the project becomes a success factor** for anticipating possible resistance on behalf of the community. They can be based on pre-concepts, ignorance, among many other options, so knowing them, understanding them and being able to dialogue about them is necessary to maintain the support of the communities.
4. **The importance of monitoring for the management of the process**, as it provides concrete information on the evolution of the measures and keeps interested parties informed.
5. **The adaptation measures implemented, with their components of analysis, training and social participation, were valued by the team, municipalities and local actors**, for their results in the short time (less than 6 months).
6. **The importance of the conception of all measures as a whole that must be implemented simultaneously to achieve greater positive effects in less time.**
7. The importance of the conception of all measures as a set that must be implemented simultaneously to achieve greater positive effects and in less time.

Lessons learned about policy processes for EbA

1. **The analysis of the cost and effectiveness of EbA measures and as well scenarios presenting "with adaptation" and "without adaptation" are useful for the decision makers.** This will facilitate the understanding that the failure of innovative measures does not involve political costs, but rather demonstrates political willingness to make changes.
2. The implementation of adaptation pilots with the EbA approach throughout the 6 coastal departments of the country, allowed the accumulation of learning and feedback in the work at local scale that allows to be used for future national adaptation planning. The actions carried out in San José determine a set of measures, which can easily be implemented and demonstrate high response capacity.
3. **The implementation of adaptation pilots with the AbE approach throughout the 6 coastal departments of the country has allowed the learning and feedback collection in the local scale work that can be capitalized for a future national adaptation plan.** The actions developed in San Jose determine a set of measures of easy implementation and high response capacity suitable both on the beaches of Rio de la Plata and on more oceanic beaches located at the other end of the coastal zone of Uruguay.

For more information

http://mvotma.gub.uy/sala-de-prensa/noticias/item/10008982-otra-experiencia-exitosa-de-gestion-y-participacion.html

Videos:
https://www.youtube.com/watch?v=EoY4_Gopu7Y
https://www.youtube.com/watch?v=2RMUs4r9rf0&list=PLFoXmxs2Oc2QtCuxone4-Siq17vKaq01r

Organization

The work has been led by the Climate Change Division and the Department of Coastal and Marine Management of the Ministry of Housing, Territorial Planning and Environment of the Republic of Uruguay (MVOTMA for its acronym in Spanish).

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Peru

Robust measures of Ecosystem -based Adaptation in Canchayllo and Miraflores in the Nor Yauyos Cochas Landscape Reserve

Location of the case study

The case was developed in the Nor Yauyos-Cochas Landscape Reserve (RPNYC for its acronym in Spanish), located in the central Andean region of Peru; specifically, in the communities of Canchayllo and Miraflores. The main objective of the Reserve is the conservation of important watersheds for water regulation and hydroelectric energy production. The Campesino Community of Canchayllo is part of the district of the same name, province of Jauja, Junín region. It has an area of 7650 hectares between 3600 and 5700 meters above sea level. The Campesino Community of Miraflores belongs to the district of the same name, province of Yauyos, Lima region. It has an area of 13,031 hectares between 3000 and 5400 meters above sea level (Zapata, F. et al., 2016).

Ecosystem

The EbA measures were implemented in mountain ecosystems; specifically, in humid puna ecosystems dominated by high Andean grasslands, which include ecosystems specific for the Andean region such as “pajonal”, “puna grass” and “bofedales”. The integrity of these ecosystems is key for water regulation and production, an important aspect considering that the main objective of the Reserve is the conservation of the upper basin of the Cañete river and the Pachacayo river basin, important for water regulation, production of hydroelectric power and other ecosystem services. The mountainous landscape of the RPNYC houses a complex hydrological system of glaciers, waterfalls and 485 lagoons.

Climate risks and vulnerability

According to the Vulnerability and Impact Study, there is a high level of uncertainty regarding future trends and climate scenarios in the Reserve. The study reports that during the 1950-2010 historical period the temperature increased between 0.21 ° C and 0.32 ° C per decade and estimated that it could increase between 0.61 ° C and 1.12 ° C between the years 2011 and 2030. In Regarding precipitation, it is estimated that there will be no changes in annual volumes, but in their patterns of distribution, as well as a decrease in surface runoff (water supply).

On the other hand, climate trends and scenarios developed by the IGP (2005) estimate that by 2050 there will be a decrease in precipitation, an increase in temperature and more intense frosts. For that study, the climatic scenarios were raised for conditions A1 (Rapid growth) and B2 (slower growth); in both it is appreciated that the temperature would increase on average by 1.3 ° C and the precipitation would decrease by an average of 10.4%. Another study prepared by SENAMHI (2009) estimates, for the year 2100, an average increase in minimum and maximum temperatures of 2.7 ° C and 2.3 ° C, respectively, as well as a decrease in rainfall in the upper and middle parts of the country. the basin, and an increase in frost in some regions.

In the studies mentioned, the future scenarios proposed for the Reserve suggest changes that could affect pastures and water, vital resources for peasant communities that depend on agricultural activities. Coincidentally, local people express their concern about the changes in climate that they are perceiving in recent years that affect their production and health: variations in seasonal patterns of rainfall, decreased rainfall, frost, more intense and greater radiation . Likewise, by decreasing the vegetation cover, water retention decreases and lesser supply of pastures; increased fire risks; increase of diseases in animals, less carbon sequestration; Wildlife is displaced by competition for forage (vicuñas, deer), and diseases in susceptible animals and plants are increased. Table 5 presents summary of the climate risks and impacts in the area.

Tab 7. Climate risks and impacts in Nor Yauyos Cochas Landscape Reserve, Peru

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	Variations in seasonal patterns of rainfall, decrease in rainfall, frost, more intense and greater radiation.
Increase in climate variability	The temperature increased between 0.21 ° C and 0.32 ° C per decade and it was estimated that it could increase between 0.61 ° C and 1.12 ° C between 2011 and 2030 (FDA, 2013).
Changes in water availability or precipitation	In both communities, the intervention areas of the project were areas that during the last decades were having less availability of water in the dry season (due to deterioration or lack of water infrastructure, changes in rainfall patterns, glacial retreat, etc.).) and, therefore, with grassland areas that were not suitable for grazing due to lack of water for cattle, while other areas were overgrazed. In addition, in both communities, although with greater incidence in Canchayllo, the agreements for grazing (zoning, rotation of livestock, etc.) were not fulfilled, which was generating greater pressure on the pastures.
Soil erosion	The above-mentioned overgrazing, causes greater erosion, less infiltration and the loss of palatable species, among other negative effects.

Photo: Community work in Miraflores. Project archive

Objectives of the initiative

The main objective of the project is to reduce the vulnerability of the population and ecosystems by means of: (i) better distribution of water through the rehabilitation of ancestral and contemporary technologies and (ii) better management of pastures through land management. livestock activity and (iii) the strengthening of local organizational knowledge and skills[1].

Description of EbA measures

The work started from an analysis based on the perceptions, knowledge and needs of the communities; in addition to this, and with the integration of scientific knowledge, a joint design of robust measures[2] was carried out in Canchayllo and Miraflores focused on the expansion and conservation of wetlands and the communal management of native grasslands and contemplate the restoration of ancestral and contemporary technologies for the water management in the puna. A key aspect of the design is that the EbA measures include three components for adaptation to climate change:

Fig. 3. Components of robust Ecosystem-based Adaptation measures

Source: Mountain Institute and IUCN

1 Aligned to the objective of the collaborative initiative to strengthen national capacity to identify and implement EbA measures, which reduce the vulnerability to climate change of local communities in high mountain ecosystems.

2 "Measures that do not worsen vulnerability to climate change or that increase adaptive capacity, and that will always have a positive impact on livelihoods and ecosystems, regardless of how the climate changes" (Rizivi et al., 2014; see also Eales et al., 2006 and Hjerp et al., 2012).

It should be noted that the structure of the three components of the robust measures is consistent with our understanding of the technologies as fundamentally social practices, whose restoration goes beyond the rehabilitation of an infrastructure and rather implies an intense work in the organizational and social aspects. capacity development.

The EbA measures in Canchayllo, included:

- **In the organizational component, a Management Plan for Pastures and Water was obtained from Diagnostics (in Canchayllo and Miraflores)**, which reflects the vision, mission, priorities and proposals of the residents for the management of pastures, water and won in your community. The plan contains projects and actions that as implemented will generate organizational and ecosystem changes. The Chacara - Yanaotuto water user committee was also created to manage water in the area of influence of the infrastructure and a document was prepared with technical recommendations for the management of the grasslands in the communal farm. In this way, it is expected to contribute to the making of communal decisions for the management of the installed infrastructure, the distribution of water and the management of livestock in the area of influence of said infrastructure.
- **As part of the capacity building and local knowledge component, courses, workshops, a discussion session, training in evaluation and application of pasture recovery techniques were carried out.** These actions have made it possible to raise awareness among livestock owners, who now have new project ideas for fencing and pasture recovery, water drainage and livestock management. Likewise, the applied monitoring system shows that there is an increase in technical knowledge at the community and family level in pasture evaluation, fencing and pasture recovery (IM and IUCN, 2015a, IM and IUCN 2015b). Among the communication actions, an informative showcase was installed and two participatory videos, a play and publications were made; this made it possible to disseminate the project at the level of the community and the RPNYC, as well as to raise awareness of the group of livestock owners for the management of pastures, water and livestock (IM and IUCN, 2015).
- **In the infrastructure component, an old canal was rehabilitated and areas of the Chacra lagoon was improved**, allowing the recovery of a network of traditional ditches in a part of the communal farm and in high areas of Yanaotuto and Pumapanca, where it supplies 560 ha of pastures (Hidroandes, 2015). In addition, the water is recharging temporary lagoons and underground aquifers that fulfill the role of supplying water to springs in the lower part of the Jaramayo micro-basin and the Cochas-Pachacayo sub-basin (Idem, 2015). Fences of three ha were also installed in which the grasslands are recovering and are monitored by the RPNYC with support from the community. In the process of implementing this component, the unskilled labor was contributed by the community through community work.

Photo: Infrastructure improvement in Canchayllo. Project archive

The EbA measures in Miraflores included:

- **In the component of strengthening the communal organization, a Pastures and Water Management Plan was carried out** with the purpose of promoting an integrated management of pasture, water and cattle resources of the communal territory, optimising the grazing system to improve the condition of the pastures and strengthen the communal organization for better distribution of water and rotation of grazing areas. To build the pasture and water management plan, a methodology was followed (López, 2014) that included six workshops that were carried out throughout the entire process.
- **The component for strengthening local capacities and knowledge was aimed at community members and park rangers with the aim of providing technical knowledge for the management and conservation of natural pastures, animals and water, mainly.** To this end, workshops on evaluation and training on pasture fencing and water management and distribution were held. Likewise, a model of the Miraflores community was developed in a participatory manner to facilitate the planning of the management of pastures and water in the communal territory.
- In the **green-grey infrastructure component**[3], the following actions were carried out: expansion of the Yanacancha bofedal enclosure, repair of the Yanacancha - Curiuna - Huaquis water pipeline, sectorization (by enclosure) from Curiuna to Tuntinia, repair and construction of five drinking troughs (Curiuna, Wayacaña, Pampalpa, Colulume and Tuntinia) and construction of a water grotto at the entrance of Huaquis. In the process of implementing this component, the unskilled labor was contributed by the community through community work. The community also assumed the transfer of the materials to the area where the works were carried out.

3 That combines natural infrastructure with local elements such as PVC pipes or cement.

How does the EbA initiative contribute to the resilience of ecosystems and communities?

The implementation of robust EbA measures contribute to strengthening the resilience of both communities and the ecosystem in a scenario of uncertainty and climate change (IM, 2015a). In this sense, **conserving and improving pasture management —as a result of the regulation of the hydrological system and the strengthening of community organization and capacities— will better prepare people to face uncertain climatic scenarios** (Podvin, K., Cordero , D. and Gómez, A. 2014).

As for the communities, they have laid the foundations for a better resilience, by having better capacities on the management of their natural resources and by having ecosystems with higher humidity and better pastures for their livelihoods. In terms of adaptive capacities, there has been a growing awareness of the importance of sustainable management of pastures, water and livestock, and concrete actions have been implemented to address climate change, as well as improving community organization. A relevant factor to contribute in the medium and long term in reducing vulnerability to climate change of populations and ecosystems is that both communities are within a protected natural area, and that they have the Pastures and Water Management Plans.

In terms of the main factors affecting ecosystems (climate change, overexploitation, overgrazing, poor water distribution, invasive species, weak governance) added to pressures affecting the ecosystem services (less plant cover which reduces water retention and less provision of pastures), the role of the green - grey infrastructure was key to distributing and storing water for longer, and thus withstand droughts and reduce fire risks.

How do you measure and monitor the impacts of the EbA initiative?

During the project, an impact monitoring system was developed in order to guide and allow the construction of the baseline as well as the monitoring and periodic evaluation of the project, contributing to measure the indicators in an orderly and systematic manner, and helping to determine the adequate compliance with the goals of the project. For this, a set of indicators was constructed to measure the impact of robust EBA measures, both in the social dimensions - ex. level of knowledge, practices, compliance with agreements - as in the ecosystem, biodiversity and ecosystem services dimension (IM and IUCN, 2015a). The baseline was assembled with data from the Integrated Rural Participatory Assessment of 2013 and a monitoring was carried out between July and September 2015 to measure the impact of the measures in both communities (IM and IUCN, 2015b and 2015c).

In addition, the cost-benefit analysis (CBA) of the robust measures was carried out in both communities. Given the interest of knowing both the cost-benefit ratio in monetary terms

Photo: Participatory diagnosis. Project archive

and the local perceptions of environmental, social and economic benefits, a conventional CBA and a qualitative CBA were carried out in each community (Alvarado, 2015a and 2015b). It should be noted that for the latter a methodological guide (Alvarado, Gómez and Podvin Eds., 2015c) was developed as a type of innovative research. The results of the CBA, both conventional and qualitative, indicate that the benefits of implementing robust measures outweigh the costs. Additionally, the qualitative analysis showed its capacity to make visible the communal assessment of the environmental and social aspects of the project.

Also, throughout the project 4 cycles of Learning in Action or Action Learning (Barrow, 2012, adapted from Fisher and Jackson, 1999), which is a monitoring and evaluation tool that was applied periodically in order to document and evaluate progress, collect lessons and adjust the planning of activities for the next period.

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

The EbA Mountain Collaborative Project aimed to contribute to national and subnational frameworks to integrate the EbA approach (UNDP, UNEP, IUCN and IM, 2016). In this sense, the project is mentioned in the INDCs as part of the Adaptation to Climate Change efforts in Peru. The project also supported the process of integrating the EbA approach into the regional climate change strategies of Junín and Lima (UNDP, UNEP, IUCN and IM, 2016). Likewise, the integral design of the EbA measures is considered as a model for future initiatives of this nature.

The robust EbA measures constituted a pilot at the level of two communities, which provided evidence of cost-efficiency and the mechanisms to implement EbA measures to be used as an example both at the level of the communities, their municipalities and the RPNYC , but also as an example that can serve as a basis for other natural areas protected by the State and even inform national policies on the effectiveness of this approach. At the local level, some examples that point to sustainability and scaling include the financing of some projects of the Pastures and Water Management Plans of both Canchayllo and Miraflores as part of the participatory budgets of the municipalities (Zapata et al., 2016), as well as as the construction of more watering places, extension of fences in the case of Miraflores, based on the experience of the Project[4].

Achieved results

Agreements were established and the organization for water management was strengthened; the recovery of communal and family practices in the management of pastures and water was promoted. Also, the territorial analysis and planning capacity of the community was strengthened, and the ecosystem services of water provision and regulation improved. Among some of the main results and impacts:

1. **Design and implementation of robust EbA measures resulting from a process of dialogue** between local interests and knowledge and scientific knowledge, which included empowerment and participation of local researchers and members of the communities.

2. **Strengthening institutional capacity and community organization** through the participatory construction of pasture and water management plans that reflect the vision, mission, priorities and proposals of the residents for the management of pastures, water and livestock in their community. The plans contain projects and actions (Canchayllo with 36, and Miraflores with 34 projects) that, as implemented, will generate organizational and ecosystem changes.

3. **Capacity building** through various courses, workshops, talks, training in evaluation and application of pasture recovery techniques to improve local and traditional knowledge for community members and park rangers, strengthening technical knowledge for the management and conservation of natural pastures , livestock and water. These actions have made it possible to raise awareness of livestock owners, who now have new ideas for projects for fencing and pasture recovery, channeling water and managing their livestock. Also, the applied monitoring system shows that there is an increase in technical knowledge at the community and family level in the evaluation of pastures, fencing and pasture recovery. Likewise, models were developed in a participative way in both communities to facilitate the planning of the management of the pastures and water of the communal territory.

4. **Implementation of green-grey infrastructure** that included the rehabilitation of reservoirs, water channels, pipes and fences, as well as the recovery of green infrastructure such as humid lands, pastures, natural water courses, infiltration capacity and water regulation. The achievements and changes generated from the implementation of the green-grey infrastructure are the most evident in comparison with the other components since:
   - They generated short-term impacts: grassland recovery is beginning to be seen and water is available in a larger area.
   - Organizational strengthening for the management of resources: community members revised their status to improve the rotation and limitation of livestock and formed committees for the maintenance of infrastructure.

4 Based on the application of the tool to assess the effectiveness of EbA as part of the EbA Approaches Project (general project information).

Photo: Project team and local partners in Miraflores. Project archive

- It has served as a practical and demonstrative example of fencing and pasture recovery.
- It has generated motivation in the community to carry out similar actions in other sectors.

5. **The communication activities also had a role and an important impact in raising awareness and informing the progress of the project.** These communicational products revalued and made visible local knowledge, culture and identity, being key success factors to achieve community participation and acceptance. Thanks to these activities, the levels of participation and community commitment increased in all project activities (IM, 2015a).

Among the co-benefits it can be listed:

- Contributions to food security and livelihoods through the provision of water and fodder;
- Sustainable water supply;
- Social cohesion through better organization and work among comuneros;
- Better governance with better compliance with community agreements and tasks;
- Better knowledge and skills.

Photo: Inauguration of the infrastructure in Canchayllo. Project archive

Lessons learned

The process of implementing robust EbA measures generated numerous lessons and recommendations, which are detailed in the analysis of robust measures, and which are expected to be useful for replication and scaling up (see Zapata et al. 2016 pp. 87-101). Among some of these:

Lessons learned about planning processes, implementation and monitoring of EbA

1. **Site selection:** The proper selection of sites is a determining factor when implementing robust EBA measures. In this case a set of relevant selection criteria was identified - ecological, socio-economic, cultural and operational - however, other criteria can also be considered, such as the percentage of the local population that depends on ecosystem services.

2. **Analysis:** The Integrated Participatory Rural Appraisal methodology was adequate and useful to integrate the diagnosis with the selection and design of the robust AbE measure. In the field, the dialogue of knowledge through cooperative work between external and local researchers was very productive and highly appreciated by both groups. It was also key to form a team of researchers with a transdisciplinary approach and who had a scientific coordinator who helped integrate the knowledge of the different disciplines and local knowledge. Local researchers who collaborate in the diagnostic phase can play a key role in the following stages of the project and in the sustainability of the measure.

3. **Implementation:**
   - From the planning stage, it is crucial to allocate sufficient time for critical activities such as infrastructure works, impact monitoring, communication and systematisation. Also to have reflective spaces during the implementation in order to take actions that enhance the positive impacts. The processes of strengthening the local organization and local capacities for the EbA require longer time horizons.
   - Implement the measures from an adaptive management approach; As the knowledge of the scope of the measures progresses, make adaptations along the way.
   - The form of implementation, based on permanent consultation with the population and its formal levels of organization, has printed a sense of ownership and co-authorship of the project.
   - Diversify the working tools with local partners, combining the workshops with other methods and more practical tools and in the field (of the type “learning by doing”).
   - The design of green-grey or ‘hybrid’ infrastructure options are the most comprehensive in contrast to only grey. In contrast to grey options, green-grey points to greater sustainability in terms of ecosystem benefits.

- It is important that during the project the capacities, both technical and organizational, are consolidated so that they incorporate best practices at the local level, both as a community and at a family or individual level (for example, that communities integrate day to day best practices of pasture and water management).

4. **Communication:** these activities were key to sensitise and involve the local population, improve levels of participation and develop the collective sense.

5. **Monitoring and follow-up:**

- Design a simple monitoring system and (where possible) easy to apply from the start, with few but key indicators, including measuring the additionality of the EbA approach. Identify, with local partners, indicators that are relevant to the local population and that they themselves can measure.
- In addition to periodic monitoring to measure the progress of planned activities, incorporate a tool that allows (i) capture the learning of the different actors throughout the implementation process and (ii) make the necessary adjustments in the planning of activities. An example of this type of tool is Learning in Action (or "action learning") (Barrow, 2012).
- Carefully analyse the possible environmental and social impacts of robust EbA measures and develop a mitigation and risk management strategy.

Lessons learned about incidencia política sobre AbE

1. It is important to work in a coordinated manner from the beginning with the various actors and partners of the initiatives, establishing good governance for implementation.
2. Finding the commitment and support of local authorities / leaders and involving them in the key decision processes and also fostering alliances with local governments will help to make the measure sustainable.
3. Learning should not be limited only to the time of implementation of the project (such as 3 years in this case), but it is important to use the learning to generate specific products[5] that aim at replication and scaling up at other levels (local, regional governments, system of protected areas).

5 For example, see the toolkit developed in a participatory manner with the project partners: UNDP, UNEP, IUCN and IM (2016). *Toolbox to facilitate Adaptation to Climate Change: the case of the AbE Montaña project in Peru. Lima.* Available at: https://bit.ly/2M42PO7

For more information:

Webpage of IUCN (in Spanish): https://www.iucn.org/es/regiones/am%C3%A9rica-del-sur/nuestros-proyectos/proyectos-conclu%C3%ADdos/adaptaci%C3%B3n-al-cambio-clim%C3%A1tico-en-ecosistemas-de-monta%C3%B1a
Information on the project (in Spanish): http://www.pe.undp.org/content/peru/es/home/library/environment_energy/el-futuro-ancestral--la-adaptacion-basada-en-ecosistemas/

Organization

Mountain Institute (IM) and International Union for the Conservation of Nature (IUCN).

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Peru
Biochar for Sustainable Soils (B4SS)

Location of the case study

The Biochar for Sustainable Soils (B4SS) project is implemented globally with two locations in Peru. We have a research site in Lurin on the southern fringe of Lima, where we experiment with biochar production technologies and work with university students. We also work in San Ramon, Junin, on the eastern flank of the Andes in the upper reaches of the water catchment for the Amazon with small scale coffee farmers. We work on soil fertility management and recycling of agricultural waste, such as tree prunings and the acidic pulp left over after processing the coffee beans.

Ecosystem

Lima and Lurin are located in a hyper-arid desert. Agriculture here is mainly conducted in alluvial valleys that receive run off (water and sediment) from the Andes. Because Lurin is located on the fringe of a megacity we have access to abundant raw material (municipal green waste and agricultural residues from intensive feedlots) for our production process. The proximity to Lima also ensures ease of access for students working on our project. The second site, in San Ramon, is in a zone that is naturally montane tropical rainforest. Small scale farmers practice agroforestry with coffee as the main cash crop.

Climate risks and vulnerability

The summary of the risks related to climate change in Lurin is described in table 8.

Tab. 8. Climate risks and impacts in Lurin, Peru.

Risk related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Risk related to climate change	More greenhouse gases = more radiative forcing = more intense storms in the tropics = more soil erosion = the loss of soil fertility = poverty.
Soil erosion	Caused by increased storm intensity and by deforestation.
Others (please indicate): water quality	Caused by unsustainable management of agricultural land.

There is scientific evidence that biochar can improve water retention in coarse textured soils which may help with water availability. There is also evidence that biochar can improve aeration in soils that contain a large clay content which may help maintain healthy crop growth during floods. **Biochar may therefore help maintain agricultural production when extreme weather events driven by climate change occur.** The development of a strategy to maintain and even increase soil fertility in a cost effective and sustainable way can reduce pressure to deforest and thus help reduce the rate of deforestation and erosion.

Objective of the initiative

The objective of the project is to develop, via experimentation and demonstration, formulations of biochar-based soil amendments that are effective in improving soil functions in Lurin and San Ramon, and to communicate and share as widely as possible this knowledge to increase sustainable land management in Peru.

Description of the EbA measures

Our B4SS project is diffusing knowledge of a strategy for own fertiliser / biochar production which is a modern version of the strategy that the pre-Columbian indigenous peoples of the Amazon used to manage soil fertility. We are reviving the traditional and indigenous method of fertiliser production that led to the creation of the soils known as "Amazonian Dark Earths". In the first (completed) stage of the B4SS project our attention focused on testing various biochar production technologies for economic viability in both the coastal desert and tropical coffee growing regions. After the successful completion of this project's goal, we worked on experimentally testing various biochar formulations for agronomic efficacy in the same two regions.

The project is ongoing for the last six years; the first phase of the project was financed by the Australian Government (through Ausaid) and the current phase is being financed by the Global Environment Facility.

For biochar to be effective as a carbon sequestration method and achieve its potential to reduce the necessity for slash and burn agriculture and thereby reduce deforestation, it is essential that biochar production and application has clear benefits for farmers in their specific context. We have identified biochar production approaches that can work in the Peruvian context, both in the coastal desert and in the coffee growing regions. We have also finished the second phase of the project in which we experimentally tested the efficacy of various biochar formulations (recipes) across a range of different ecozones in Peru.

Photo: The B4SS research station can run three Kon Tikis simultaneously. Project archive

As a result, we are currently in the third phase of our project in which the aim is to 1) publish the experimental results in collaboration with Peruvian thesis students and 2) diffuse as widely as possible the knowledge we have generated on biochar production technologies and formulations so that we see widespread farmer uptake of biochar production and use in Peruvian agriculture.

How does the EbA initiative contribute to the resilience of ecosystems and communities?

The production and use of biochar, by smallholder farmers, reduces the need for external inputs (fertilizers) that often is too expensive for them. In addition, with the biochar it is possible to change the chemistry of the soil (especially the pH of the soil), which allows the cultivation of a greater diversity of crops. A greater diversity of crops means a higher probability that at least some of the cultivated crops will be resistant to the changing conditions that are expected to occur as climate change intensifies.

The fact that biochar improves soil nutrient retention capacity means that already cultivated land, to which biochar is applied, can retain soil fertility for longer, reducing the pressure to deforest and allowing access to a new soil fertility.

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

In coastal cities, such as Lima, municipal green waste, the material obtained when street trees and vegetation in urban parks are pruned and maintained, is often sent to landfill where it releases potent greenhouse gases (GHGs) such as methane and nitrous oxides. There is scope to utilise this waste stream as a resource because plant biomass has calorific value and could be used as a feedstock for bioenergy production. The diversion of green waste from landfill would also reduce emissions of GHGs from landfill[6].

The B4SS strategy in Lima has developed and tested biochar formulations from municipal green waste that 1) diffuse some of the cost associated with management of municipal green waste, and 2) increase the use efficiency of regular fertilizers. As a result, biochar production is specifically evaluated and promoted as a possible and allowed waste management strategy in the new Peruvian law for solid waste management, passed in December 2016 (Decreto Legislativo 1278).

6 See http://biochar.international/news/ , specifically: Improving the production of biochar from green waste in Lima (January 2017) and y http://www.ithaka-institut.org/en/ct/101.

Achieved results

In the B4SS project in Peru we have trialed a range of technologies for biochar production. **A key result is that simpler technologies generally work better in the Peruvian context**. We have also found that Kontiki reactors made by simply digging a hole in the earth are attractive to small scale farmers in Peru's coffee growing region as they require no capital investment and can reduce reliance on unaffordable external inputs such as fertilizer needed to maintain soil fertility. We have also found that the Kontiki reactors work well for municipal green waste because no processing of the waste is required before feeding the waste into the reactor. The finding that a single technology can work in these two very different contexts simplifies massively the job of communicating the knowledge we have generated regarding production techniques.

In addition, our results show that **a single formulation of biochar works well across a broad range of soil types**: i.e. on highly acidic and weathered clay soils in the tropical coffee growing region and on the soils of the coastal desert which are highly alkaline and contain a large amount of sand and silt. This likewise simplifies massively the message we need to promote biochar production and use.

Photo: Farmer Dennis Castro promoted the useof biochar for sustainable soils in Peru. Project archive

Photo: On the left, plant with biochar. On the right, plant without biochar. Project archive

Our focus has been on biochar production and use in agriculture to promote more sustainable land management practices. However, there are numerous co-benefits that biochar production and use generates:

1. Improves waste management.
2. Reduces greenhouse gas emissions and sequesters carbon over the long term.
3. Improves the micro hydrology of both water logged (clay) and freely draining (sand) soils.Reduces reliance on external inputs in agriculture benefiting poor farmers.
4. Can reduce the bioavailability of contaminants in soil such as cadmium which now threaten two of Peru's most important export crops (cacao and asparagus).

Lessons learned

1. **A biochar system has to be designed according to the context in which it will operate.** The system variables range from the collection of sustainable feedstock through the type of biochar production and post-production technologies to the type of climate, soil, and crop grown – among others. In addition to the technical parameters, social, environmental and cultural aspects should be considered.
2. The B4SS project was designed to bring together various world experts in biochar research to address promptly any scientific questions arising during the evaluation of the biochar formulations. **Having a solid scientific understanding of the effects of biochar is likely to lead to a relatively high confidence of policy makers in promoting biochar for sustainable land management.**

For more information

http://biochar.international/
http://starfish-initiatives.org/

Organization

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Mexico

Adaptation in coastal wetlands of the Gulf of Mexico to the impacts of climate change

Location of the case study

The case study is located in three pilot sites of the Gulf of Mexico.

- **Site 1.** Papaloapan River - Alvarado Lagoon: Municipalities of Alvarado and Tlacotalpan, State of Veracruz. In two sites: Private Conservation Area "El Pájaro" and Ejido El Tarachi.
- **Site 2.** Carmen-Pajonal Machona Lagoon System: municipality of Cárdenas, State of Tabasco. In four communities: El Golpe 1st Section, El Golpe 2nd Section, Las Coloradas and El Mingo.
- **Site 3.** Punta Allen Wetland: Sian Ka'an Biosphere Reserve, State of Quintana Roo. In two areas: El Playón and the coral reef.

Ecosystem

The EbA measures were implemented in communities located in three coastal wetlands of the Gulf of Mexico, including mangrove areas at the Veracruz, Tabasco and Quintana Roo sites, and coral reef in Quintana Roo. The project included women and men from the communities, promoting the gender perspective, who participated in each of the stages of the project, including the diagnosis of the problems associated with climate change, the identification of adaptation measures, the work associated with the installation of the adaptation measures and the evaluation of each one of the components of the project.

Climate risks and vulnerability

Tab. 9. Climate risks and vulnerability in the pilot sites of the Gulf of Mexico

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	During the last decades an intensification of climatic events is perceived, with variation in the months of more rain (more concentrated rain in less time), and wider periods of drought with variation in the months in which it occurs. This causes floods in the communities of Tabasco and Veracruz due to torrential rains concentrated in a short time, as well as lack of drinking water in the months of drought.
High temperatures	During the last decades an increase in temperature is perceived in the communities of Tabasco, Veracruz and Quintana Roo. The rise in temperature causes heat waves that affect the health of the inhabitants especially in the months of drought.
Coastal erosion	Illegal mangrove logging for the expansion of the agricultural frontier in Veracruz and Tabasco has caused extreme weather events such as hurricanes to directly impact the shores of coastal lagoons, causing erosion. In the case of Tabasco, communities are settled on these coasts, and their infrastructure, like schools, is at risk.
Changes in water availability or precipitation	In recent decades changes in rainfall patterns have been observed, concentrating on a smaller number of months, and with variation in the months in which it occurs. This has caused a reduction in the amount of surface water that feeds the lagoons of Tabasco and Veracruz, causing the levels of the lagoons to drop, little availability for agricultural activities and for human consumption in the months of drought, and flooding during the time of precipitation. Changes in precipitation patterns in Quintana Roo have meant that, during extreme rainfall events, the salinity of the sea decreases causing damage to the coral reef.

Sea level rise / soil salinization	In the last decades the sea level has increased in Veracruz, Tabasco and Quintana Roo. This has caused salinisation of the coastal lagoons of Veracruz and Tabasco and the salinisation of the soil and water wells in Tabasco. As a result, there has been a decrease in the species of fishing importance in the lagoons and the introduction of invasive species, as well as affecting agriculture. In Quintana Roo, in the area known as El Playón, a mangrove area that was split in half by the path of a dirt road that interrupted the water flow impacting 450 hectares of mangrove, the rise in sea level has increased salinity in the affected area.

Objective of the initiative

The main objective of the project is to design and implement adaptation measures based on ecosystems, focused on reducing the vulnerability of the communities to climate change that live and depend on coastal wetlands.

Description of EbA measures

- **Mangrove reforestation:** Reforestation of 25 hectares of mangrove swamp, 5 hectares of riparian vegetation and manual de-watering of 3 km of canals to restore water flow in the Private Conservation Area "El Pájaro". In the reforestation of mangrove, 22,712 black mangrove plants (Avicennia germinans), white mangrove (Laguncularia racemosa) and red mangrove (Rhizophora mangle) were used. The mangrove survival rate was 80%.
- **Riparian reforestation: I**n the riparian reforestation 3,343 plants of 35 native species were used (fruit trees, woody, timber). The survival rate for this reforestation was 80%.
- **Conservation and sustainable use of mangroves:** Specification of restoration, recovery and zones for use. In this way the production is diversified, giving economic value to the mangrove and promoting its conservation. Mangrove conservation protects coasts and communities from climatic variability, extreme events, sea level rise, floods and coastal erosion. In addition, it regulates the local climate by decreasing high temperatures and provides nesting and feeding sites for species of fishing importance, while improving the economy of the ejido through the sustainable use of wood.
- **Territorial Ecological Planning with a focus on climate change:** The Ecological Territorial Ordering is a public policy instrument through which the best uses of the territory are specified according to their vocation. It establishes zones, guidelines and actions for protection, conservation, restoration and exploitation.

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

The Project contributed to the fulfilment of several national and global goals and objectives, acquired by Mexico in terms of climate change, biodiversity and sustainable development. With regard to international commitments, the Mitigation and Adaptation Commitments to Climate Change for the period 2020-2030 form part of the Nationally Determined Contribution of Mexico (NDC).

The Adaptation component includes Adaptation based on Ecosystems, an approach used to implement the Adaptation Project in Coastal Wetlands of the Gulf of Mexico before the impacts of Climate Change. Among the actions committed in terms of Adaptation based on Ecosystems to be carried out in the period 2020-2030, are:

1. Reforestation of the upper, middle and lower basins considering native vegetation species.
2. Increase of ecological connectivity and carbon capture through conservation and restoration practices.
3. Increase of carbon capture and coastal protection through the conservation of coastal ecosystems.

Photo: Project archive

Lessons learned

Lessons learned about planning processes, implementation and monitoring of EbA

1. The **secured land tenure** (widespread problem in the Mexican countryside) is fundamental to implement EbA measures.
2. Involving and **achieving ownership of the project in communities with a weak social fabric and limited experiences in terms of organization is essential** for the success of the EbA measures.
3. The **EbA measures require the execution of multidisciplinary teams,** with specialists in social participation and focus on human rights and gender, who are constantly working in the field beyond the duration of the project.
4. In a community, **there must be a balance between EbA measures** whose benefits (environmental, economic, health, local development) are tangible in the short term (for example, the collection of rainwater), and measures whose benefits are long term (which communities live as very uncertain) (for example the restoration of mangrove or coral reef).
5. Promote **comprehensive adaptation measures** (for example, rainwater harvesting, more school garden, more mural on the water cycle, more wood-saving kitchen for the school dining room) enhances adaptation measures and permeate the meaning and objectives of the same when encouraging that several institutions converge. The integrality guarantees the continuity of the measures and the monitoring of the actions by various institutions.

Photo: Project archive

Photo: Project archive

Lessons learned about policy processes for EbA

1. **Involve local decision makers from the beginning of a project is essential** to have a broad picture of the social, political, environmental, economic and security situation. It is also very effective to reach communities; choose work places; contact local consultants; disseminate the project in the States and follow up on the measures once the project is completed.
2. **The success of the engagement with local government institutions depends on the establishment of effective channels of communication and coordination among the participating agencies**; to keep them informed and report the progress of the project; to invite them to participate in the workshops and meetings and to make them feel part of the project.

Organization

National Institute of Ecology and Climate Change (INECC in Spanish). Public dependence of the Federal Public Administration of Mexico, Ministry of Environment and Natural Resources (SEMARNAT in Spanish).

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Mexico

Diversification as an adaptation strategy in ranches in northwestern Mexico. Case study: El Mogor, Valle de Guadalupe

Location of the case study

The Valle de Guadalupe is in Baja California, Mexico. The historical use is of cowboys who raised cattle, sheep and goats and cultivated vine, olive, citrus and vegetables of European origin. Recently, the wine boom has favored gastro-tourism tourism. The case reported is a property of a woman, is a small ranch (farm, farm, farm) diversified located at km 85.5 of the federal highway No. 3 Tecate-Ensenada, in the town of San Antonio de las Minas.

Ecosystem

It is a region different from the rest of the country due to its semi-arid Mediterranean climate (long dry summers and rainy winters). The chaparrales dominate with coastal influence and since the Spanish Conquest the European crops that characterize it have been introduced. There are two indigenous groups (Kumiai and Kiliwa) whose population is greatly diminished, they speak their ancestral languages and know the native species. Currently, traditional and neorural ranchers dominate (academics and businessmen who leave the city) who have enriched the region with viticulture and eno-gastronomic tourism and have turned the region into an exemplary rural development pole (Leyva-Aguilera & Espejel, 2017) .

Background

The farm land was selected based on the existence of historical data and the possibility of in-depth interviews that allowed to demonstrate a process of building sustainability in 60 years of ecosystem-based management. The story begins in 1954 by a couple of European farmers who implemented a model of wheat production, fattening of animals and conservation of natural vegetation. In 1960, they introduced the carob tree, but recurrent droughts and family issues led to a collapse. Looking for alternatives, in the 1980s they planted vineyards and sold livestock. In 1994, they successfully produce unconventional vegetables from the Mediterranean areas of the world. Currently the ranch diversification reaches its maximum with holistic livestock, soil and fruit recovery, sustainable restaurant with traceable ingredients, management of the natural landscape, weather station and carbon, water harvest and responsible wine. The management of ecosystems has been intuitive and this research documents it as a successful case.

Climate risks and vulnerability

This case study is an example of a constructivist process ("learning by doing") based on the recognition of ecological limitations as climatic risks. Also, the semiarid region has drought cycles of seven to ten years. In the history of the ranch, the lessons learned from the recurrent droughts are incorporated and are assumed as natural constraints of the projects. Among many examples, fruit trees and seasonal vegetables adapted to the climate are planted. In the beginning, the soil was not leveled, nowadays the soil is managed (keyline) to make the rainwater more efficient. The temporary stream was not managed, now there are gabions and an infiltration dam for the water table. Rainwater was not harvested, now it is harvested. The soil now compacted with holistic livestock infiltrates more water. Irrigation is now an ingenious drip system. It is transformed into a meteorological and carbon station to monitor climate changes and changes in land use. The restaurant is an example of responsible consumption. Organic pesticides and fertilizers are used. The vegetation is conserved as a landscape, but also as a barrier for pests. The productive diversification based on the management of ecological constraints is exemplary and in the future it is possible that they suffer less disasters of climatic origin than the conventional non-diversified ranches.

Tab 10. Climate risks and vulnerabilities in el Mogor, Valle de Guadalupe, Mexico

Risks related to climate change	How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	The periods of droughts are variable, in the past they occurred every 7-8 years and the projections indicate that the probability will now be up to 10 years (Molina-Navarro et al., 2016). In addition, the poor management of water throughout the valley has accentuated the risks in crops. There are sites in the valley that cultivate highly demanding species of water, such as alfalfa, and there was a golf course project, which did not prosper due to water scarcity. There are producers analysing new crop varietals better adapted to longer periods of drought.
High temperatures	In nearby areas there was a day of extreme temperatures and losses were heavy. Scenarios of higher evapotranspiration and the probability of "heat shock" are projected. The temperature is expected to rise by approximately 1.5 ° C and annual precipitation will decrease during the present century, directly affecting the recharge of aquifers in winter and spring (Cavazos et al., 2012).
Changes in water availability or precipitation	Water availability has decreased in the region. The precipitation has become less and less frequent and uncertain. The sand of the main stream has been looted and there is no infiltration of water into the water table, the ecological flow has been reduced.
Increase in flood events	When it rained the streams overflowed, now the sacking of sand from the stream causes the water to flow to the sea and does not accumulate, but neither does it infiltrate the water table.
Soil erosion	The uncontrolled livestock in the past has caused soil erosion on the slopes and abandoned land. In the case study ranch is recovering with soil management through holistic livestock and composting.

Objective of the initiative

The main objective of the project is to demonstrate the ability of an agro-ecological system to adapt to climate and socioeconomic changes through a process of productive diversification based on ecosystem management. Also, to contribute to a rural example of greater resilience to climate changes that are expected in semi-arid areas.

Description of EbA measures

In 60 years, the farm was diversified and strategies to adapt to both climate change and social, economic and political changes have been implemented. This has allowed for the farm to be a functional alternative model in the Valley of Guadalupe.

The practices that are carried out are the following:

- Strategies for adapting to ecological constraints
  1. Production of seasonal fruits adapted to the Mediterranean climate (since 1954).
  2. Production of wine for local consumption at a scale appropriate to ecological constraints (since 1985).
  3. Production of organic vegetables adapted to the environment (since 1994)

- Sale of products with added value (jams, preserves, among others) (since 1994).

- Strategies for soil improvement
  1. Holistic grazing of cattle and cattle for soil improvement. Systematic movement of animals to avoid compaction of the soil and leave rest for soil recovery (since 2014).
  2. Constant experimentation with different types of compost generated from restaurant waste, family consumption, decomposing firewood and livestock manure (since 1994).

- Strategies for water management
  1. Water harvest in buildings (since 2015)
  2. Water treatment system for the use of gray water in domestic use (since 1954).
  3. Wetland for the wastewater treatment of the restaurant (under construction)
  4. Infrastructures for infiltration to the aquifer such as gabions (since 2007) and a dam (2017).
  5. Padding between the rows of crops for moisture conservation and erosion reduction. Before, it was frequently pruned in order to be leafy and "professional"; At the moment the weed is allowed to grow and pacas are left between the furrows (2014

6. Land management with “keyline” for rainwater efficiency (2015).
7. Vineyard with drip irrigation with underground hose technique (since 1985).

- Strategies to support research and culture
  1. Association with high-level Chef that promotes a gastronomic culture, for example restaurants for local consumption, with traceable (without intermediaries) and sustainable ingredients (since 2014).
  2. Meteorological station (since 1954) and carbon associated with a local research center (since 2008).
  3. Opening to train human resources through professional practices (since 1980).

- Strategies for the protection of nature
  1. Beekeeping (since 2001)
  2. To treat pests and diseases in vegetables, two organic pesticides are used (since 2012).

All projects are interconnected, integrated and have a compatibility in the care and improvement of natural resources, as well as the conservation of the natural landscape of Valle de Guadalupe.

Photo: Project archive

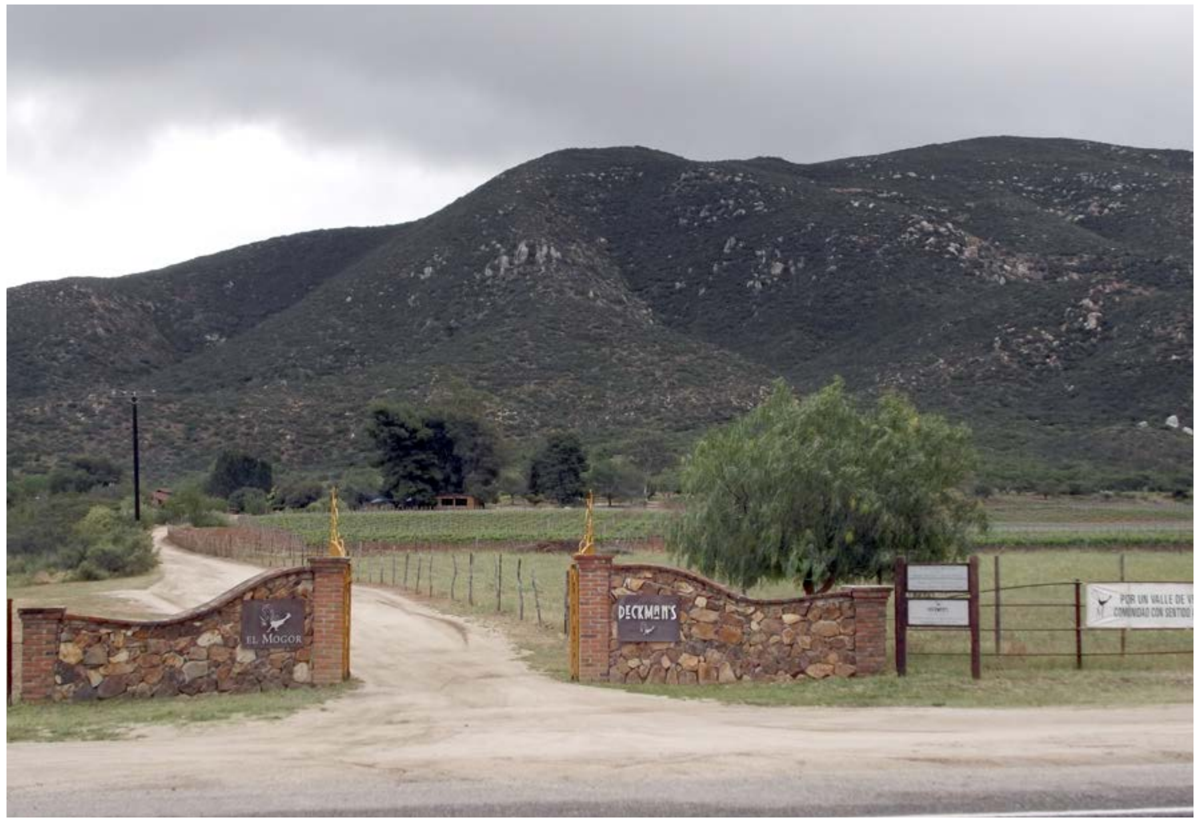


Photo: Project archive

How does the EbA practice contribute to the resilience of ecosystems and communities?

The conservation of the chaparral and the riparian zones has allowed the diversity of flora and fauna to be conserved. As a result of the conservation of the vegetation, the rainwater has been added to the ecological flow, as shown by the Toro-Guerrero et al., (2014) who estimated in 2011 that the water balance of the El Mogor sub-basin, resulting in the recharge at 466 000 m^3 and a contribution of 7% of the precipitation that has been infiltrated. Agroecosystems have improved by the techniques and practices related to soil and water management. The diversification of the ranch has led to increased labor opportunities that have been trained in applying more sustainable techniques. This has resulted in greater empowerment of workers and awareness of climate change risks and suitable approaches to mitigate them.

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

The ranch is expected to be an example to be incorporated as part of an observatory of sustainable rural development. The valley has a history of basin planning since 1993

(Badan et al., 2005, Espejel et al., 1999, Municipal Institute of Research and Planning of Ensenada, 2009) and is in the process of finalizing the management plan for the basin and the aquifer in agreement with foundations, government and academia. This will inform local, regional and national initiatives of best practices in agro-ecology for adaptation to climate change.

Results

To illustrate the sustainable structure of the farm, a retrospective analysis was made with qualitative indicators. Sixteen sustainability indicators were evaluated in six aspects: social, economic, ecological, business, technological / scientific and cultural. Each indicator was estimated from 1 (least sustainable) to 5 (most sustainable). The results of this analysis is shown in table 11 and the complexity of the system is presented in Figure 4.

Indicator	Description	Suggested questions	Score
Diversification of products / services	The company generates various products / services	Does the company generate more than one product / service? Does the company carry out different economic activities for the generation of said products? Do the products to be marketed go through more than two intermediaries?	1: The company depends entirely on only one product. 3: The company generates more than one product; produced by a single economic activity 5: The company generates more than one product through different economic activities.

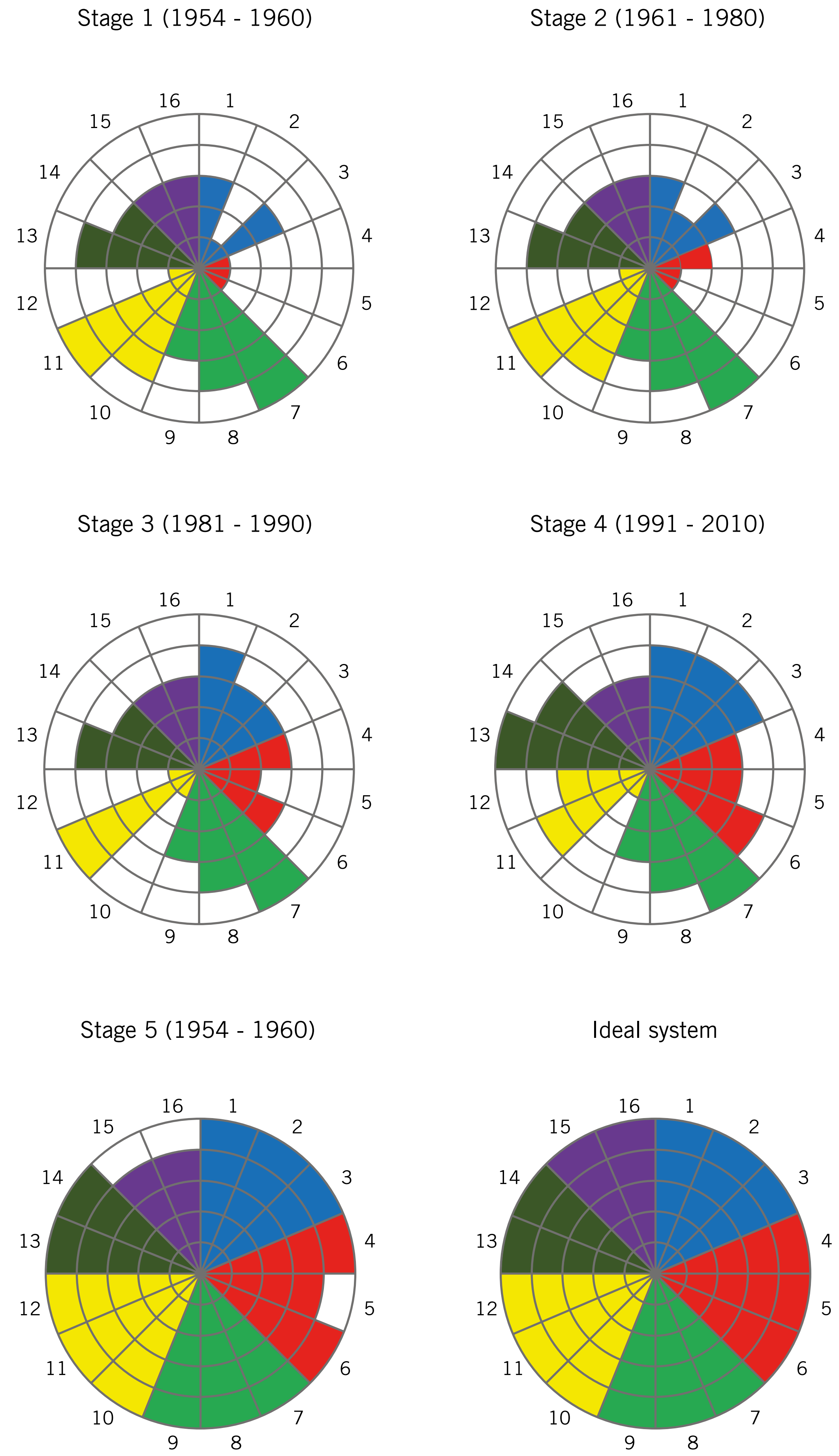
Tab. 11. Estimation of sustainability over time in the farm

Aspect	#	Indicator	Stages: 1 (1954-1960)	2 (1961-1980)	3 (1981 - 1990)	4 (1991 - 2010)	5 (2011 - Act)
Social	1	Satisfaction of family needs	3	3	4	4	5
	2	Permanence of employees	1	2	3	4	5
	3	Working conditions	3	3	3	4	5
Economic	4	Economic feasibility	1	2	3	3	5
	5	Economic risk	1	1	2	3	4
	6	Diversification of products / services	1	1	3	4	5
Ecologic	7	Pollution and energy consumption	5	5	5	5	5
	8	Rational use of natural resources	4	4	4	4	5
	9	Adoption of agro-ecological techniques	3	3	3	3	5
Private	10	Internal accounting	4	4	2	2	5
	11	Legal	5	5	5	4	5
	12	Empowerment of employees	1	1	1	3	5
Technológical / Scientific	13	Research / education	4	4	4	5	5
	14	Ability to change or innovation	3	3	3	4	5
Cultural	15	Perception of intangible benefits of employees	3	3	3	3	4
	16	Training and generation of knowledge to employees	3	3	3	3	4
		Total by stage	45	47	51	58	77
		Maximum score per stage	80	80	80	80	80
		% of sustainability	56.25	58.75	63.75	72.50	96.25

FIG. 4. CONSTRUCTION OF SUSTAINABILITY THROUGH ECOSYSTEM MANAGEMENT IN THE FARM EL MOGOR

Indicators:

1. Family satisfaction
2. Permanence of employees
3. Working conditions
4. Economic feasibility
5. Economic risk
6. Diversification of products
7. Pollution and energy consumption
8. Rational use of natural resources
9. Adoption of agro-ecological techniques
10. Internal accounting
11. Legal
12. Empowerment of employees
13. Research / education
14. Ability to change or innovate
15. Perception of intangible benefits
16. Training and knowledge generation



Social
Economic
Ecologic
Admin
Tech/Science
Cultural

Photo: Project archive

What at first could have been an intensified farm in the production of carob tree —an innovative product for the region and with current demand —is now a farm model that allows for the family needs to be met,but at the same time has products of high quality and at the same time conserve natural resources and ecosystems. The diversification in the farm takes a vital importance from 1995 with the inclusion of the sale of vegetables, wine and cattle. This strategy has worked not only for family support, but also for generating jobs and competing in the local market of Valle de Guadalupe.

As of 2014, the farm's objectives are the conservation of natural resources, an example of which is the adoption of organic practices with least damage to the ecosystem and managing livestock for soil recovery.

Lessons learned

The farm has presented a complexity and diversification over time. What has allowed for its functioning as a subsistence system and demonstrate an alternative functional model in the Valley of Guadalupe.

1. The greater the diversification of the ranch, the greater the commitment to soil and water conservation, protection of native plants, and the improvement of wildlife habitat.
2. This case study demonstrates that diversification is an EbA strategy widely used by family farmers which strengthens their adaptive capacity and build resilience to external drivers such as climate change.
3. This social organization, which is also being transformed into a cooperative scheme, demonstrates that such forms of farm management allow for effective decision-making and adoption of EbA measures.
4. It is necessary to establish monitoring programs for the operation of permaculture practices, holistic livestock and agro-ecological techniques that are being implemented to show the benefits in a systematic way.

Organization

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Costa Rica

Ecosystem-based Adaptation for the Indigenous Territory Bribri

Location of the case study

Territory Talamanca-Valley of the Star of Costa Rica. The Talamanca Mountain Range and the Bribri indigenous territory belong to the La Amistad Caribe Conservation Area and the La Amistad International Park.

Ecosystem

There are six zones where Bribri indigenous territory are identified (one of them is transition). The zones are located in tropical forests at different altitudes and precipitation levels varying from 1800 mm/year to > 4000 mm/year (TEC, 2014; Holdridge, 1982)

Tab 12. Life zones and precipitation

Life zone	Precipitation (mm/year)
Tropical humid forest	1800 - 4000
Very humid premontane forest	2000 - 4000
Very humid tropical forest	4000 - 6000
Premontane rain forest	> 4000
Low montane rain forest	4000 - 8000

Climate risks and vulnerability

During the last years, the occurrence of the phenomenon "El Niño - Southern Oscillation" and combined with climate change, temperatures are observed to have increased and also changes in the frequency and intensity of rainfall. These changes have adversely affected ecosystems which provide ecosystem services to indigenous communities. Moreover, the increased cultivation of banana monoculture and other unsustainable practices for natural resource management, have additionally contributed to fragility of the ecosystems. As a result, Bribri indigenous communities are highly vulnerable to climate impacts and especially their food security.

Objectives of the initiative

The main objective of the case study is to describe the Bribri indigenous production systems and identify the general effects of climate change on a representative sample of the territory. As part of that, adaptation measures to Climate Change are proposed through the Ecosystem-based Adaptation (EbA) and Communities-based Adaptation (AbC) approach.

Description of EbA measures

Five representative farms were selected from several communities within the Bribri territory, where indigenous productive spaces were recognised and the general effects of climate change were identified. The diagnostic work consisted of a tour of the production spaces, the evaluation of plant and animal species, soil analysis and interviews with the small producers, trying to know how the farms were managed, what problems they faced, and what was the future vision of them.

The proposed adaptation actions were identified in a participatory manner and were related to inputs delivered by the parent project to families (forest seedling, fruit tree, seeds, small and large animals, tools), in addition to being linked to a manual of good practices. The aim was to combine ancestral knowledge (Adaptation Based on Communities) with actions from academia and scientific knowledge, seeking, among others, to increase the diversity and productivity of crops, the protection of soil and water sources, and the maintenance of forest cover on farms. Taking into account the importance of forest elements in indigenous ecosystems, several of the proposals were based on the implementation of agroforestry systems or the increase of forest cover.

Photo: Community of Bajo Coen. Project archive

Photo: Nursery workshop. Project archive

Before the preparation of the workshops and construction of forest nurseries, an analysis was made of the situation of the use of forest species and the management of seeds in the territory; the places for their establishment were selected, as well as the species to be cultivated, method of cultivation, quantity, infrastructure, materials and equipment. The trainings were based on basic concepts about forest nurseries and the justification of these as adaptation actions.

Results

All the indigenous farms have three productive spaces: witö or home garden, teitô, dedicated to the sowing of basic grains and chamugrö, permanent production space for cocoa and varieties of Musaceae, which have a commercial use. **The effects of climate change perceived by the population are related to the decrease in productivity in crops and fruit trees, heavy flooding, water stress and problems in the planning of their activities due to the variations in the sowing and harvesting seasons.**

The agroecosystems identified were: polyculture of cocoa, musaceas, cocoa-musaceas and banana.

Some adaptation proposals are related to:

- Diversification of products and spaces within the farm
- Protection of mature forests
- Increase of the arboreal component: fruit and timber
- Organic agriculture
- Use and exchange of endemic seeds
- Recovery of traditional indigenous knowledge and cultural characteristics of all plant species
- Planning and certification of production
- Support for agro-ecological tourism
- Greater area destined to PSA (Payment for Environmental Services)

Lessons learned

From the analysis and visits made, it was concluded that:

1. The analysis of the indigenous productive systems must be participatory as a way to ensure the adoption of the proposed measures.
2. All the farms studied had the three indigenous productive spaces, “witö”, “teitö” and “chamugrö”, or they were going to be implemented, the “chamugrö” being the one with the most surface since the species cultivated there were destined for commercialisation.

Photo: Substrate preparation. Project archive

Photo: Plantain polyculture. Project archive

Photo: Home garden. Project archive.

3. All the analysed soils shared the characteristic of being very acidic and of presenting little organic matter, because **the conditions of the tropical climate facilitate a rapid mineralization**.
4. **All the producers had as main objective to promote food security in their families** with the products of their farms and, secondly, to promote the commercialisation of these, mainly cocoa, banana and plantain, to obtain income.
5. **The indigenous community priorities the conservation of mature forest and the conversion of abandoned areas into secondary forests throughout the territory**, to provide tree and shrub species with different traditional uses.
6. **The population perceives that the main effect of climate change is the non-seasonality of the climate** that causes difficulties in the planning of the planting and harvesting seasons of the products. Producers have experienced the increase in droughts and floods in recent years, coinciding with climate records.

From the adaptation proposals, it was concluded that:

- **The identification of adaptation measures has been based on the rescue of ancestral knowledge** (Adaptation based on Communities), which in turn implies understanding the indigenous farm as an integral farm, that is, an agroecosystem.
- The diversification of endemic species of the territory and its uses, mainly of tree species, both timber and fruit trees, and the protection and regeneration of native forest species is a priority; along with the selection of crop varieties that present good responses to drought and / or floods.
- **Agroecological proposals have been identified as priorities for the population**, and producers have been trained about them in the context of the Matrix Project
- At the territorial level, c**ooperation between the different actors and institutions is needed**, as well as monitoring the implementation of the measures in order to increase the resilience of the territory.

Organization

Universidad Politécnica de Madrid, Spain in collaboration with the National Institute for Rural Development of Costa Rica and the Spanish Agency for International Cooperation for Development (AECID in Spanish)

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Location of case study

Grenada is a tri-island state located in the Eastern Caribbean that is comprised of Grenada (main), Carriacou and Petite Martinique, and is recognised as a Small Island Developing States (SIDS) by the United Nations.

The ecosystem-based adaptation (EbA) technology presented in this submission is being implemented at two pilot sites in the country:

1. Grand Anse, Grenada, the country's tourism hub and location of one of the world's best beaches according to a CNN report in 2016; and
2. Windward, Carriacou, a traditional boat building and fishing village tucked away at the North Eastern end of the island.

Ecosystem

The EbA practice being implemented is in the marine-coastal areas focusing on the restoration and sustainable management of Coral Reef ecosystems where the loss of coral cover has impacted areas. Grenada has a total of 78.1 square kilometers of coral reef of which only 4% is managed.

According to the Vulnerability Impact Assessment conducted for the Project to identify potential EbA interventions, Grenada's coral reefs have suffered from the loss of the Acropora coral species, which has led to a reduction in the height, roughness and three-dimensional structure of the reef, and thus their ability to provide coastal protection.

Climate risks

Tab 13. Climate risks and impacts in Grenada

Risk related to climate change	Description. How did the risk in this area increased in the last decades? What impacts did this risk have?
Increase in climate variability	Grenada has experienced fluctuations in rainfall level and patterns. Temperatures have shown a warming trend and hurricane landings have increased. The impacts of this has been increased coral bleaching events, coastal flooding and damage from hurricanes and storms.
Increased temperature	Mean annual temperature has increased by around 0.6 °C since 1960. Projections for the next 50 years indicate that temperatures are likely to increase by 0.7°C to 2.6°C by 2050 and by 1.1°C to 4.3°C by the 2090s. (McSweeny et al. 2010)
Change in the availability of water and precipitation	Between November 2009 and June 2011, Grenada experienced one of the driest periods in its recorded in history, and this was attributed to Climate Change (UNDESA, 2012). The main water production centres experienced reductions of up to 65% during the 2009/2010 drought.
Increase in sea level and salinization of coastal land	Vulnerability scenarios conducted for Grenada revealed that 1m SLR places 73% of Grenada's major tourism resorts at risk. This increases to 86% at risk with 2m SLR. 90% of major hotels on the island in the coastal zone are vulnerable to sea level rise (CCCCC, 2002).

Beach erosion	Overall, between 1951-2013, 19 m of beach has been lost at Grand Anse. The period 2010-2013 showed a loss of 4m of beach.
Increase in sea surface temperature	Between 1960 and 2006, increases in Sea Surface Temperature ranged from 0.05°C to 0.08 °C per decade (CARIBSAVE, 2012).

Objectives

The principle objective of the project is to reduce the vulnerability of the coastal communities and assets in the pilot sites by reducing their exposure to damaging wave energy, while supporting the provision of co-benefits to tourism and fisheries. It is also expected to strengthen community and institutional capacity to adapt to climate change.

Description of EbA measures

The project has selected active coral restoration and management as the EbA strategy for implementation. Given the complexity of coral reef restoration, other components identified as critical for the successful management of coral reefs were integrated to support the approach. These included: capacity building; conducting research and monitoring; raising public awareness of and education on coastal ecosystem services; spatial planning and management; developing sustainable financing mechanisms; and integrating EbA into relevant policies and plans:

- **Coral Restoration and Research:** In June 2015, the first coral nurseries were established in Grenada to be used for the active restoration of key coral reef ecosystems within the pilot areas, and to start a long-term Coral Reef Restoration Programme. They also serve as demonstration sites to illustration EbA in action. Genetic analyses were done in 2016 on the stock in the nursery to provide information that will help understand coral resilience. The coral nurseries provide first-hand understanding of local threats to the coral reefs and their responses to these threats, while supplying the source of live corals fragments needed to restore degraded sites. This information is used to raise public awareness on the importance of reefs; the threats that they face; the importance of reducing climate change risk; and the need for strategies and plans like EbA options. Between May 2016 and present, over 2000 coral fragments have been outplanted at 4 sites in Grand Anse and Carriacou.
- **Building Capacity:** Working with the local coastal communities to build their capacity for coral reef restoration was identified as critical for the long term success of the programme. Since July 2015, 14 community members were trained via a series of workshops on necessary skills and employed as “Coral Gardeners” under the programme. A community-based coral reef restoration manual is currently being prepared to document the training curriculum so that it could be shared and replicated. Taskforce committees were also formed at both pilot sites that incorporate community members, government officials, technical personnel and other stakeholders. This governance structure was designed to incorporate stakeholder feedback, as well as involvement in and ownership of the process, especially of the communities.
- **Integrating EbA:** Including EbA within relevant policies and plans was identified as crucial to the support of adaptation measures at the demonstration sites. Key elements of EbA are now highlighted as part of the strategic objectives of Grenada’s National Adaptation Plan, Nationally Determined Contritions (NDC) and revised Climate Change Policy for instance. Work is ongoing to ensure other policies, plans and legislation are also updated or designed to give consideration to EbA. In addition, draft strategic plans are being specifically developed for both sites focusing on mitigating land based impacts to the marine environment towards the development of management plans for the areas.

How does the EbA initiative contribute to the resilience of ecosystems and communities?

The EbA technology has, and is expected to continue to build community resilience particularly because of the support provided to livelihoods:

- Along the strip of 2 mile beach in Grand Anse for instance, there are four dive shops providing daily dive and snorkel trips. In addition, a number of persons from the local and adjacent communities fish in the reef system. Active coral reef restoration therefore will help ensure that the value of the reefs for tourism and fisheries is improved and maintained.
- Windward is a traditional fishing and boat building community in Carriacou. The erosion affecting the Bay has been attributed to loss of coral cover on the barrier reef, among other factors like overfishing of herbivorous fish. A number of community members, mainly fishermen, have been trained in coral restoration and are now provided with an alternative source of income and a new category of profession in Grenada called “Coral Gardener”. Moreover, activities in the area has raised awareness on the threats facing the reefs and the community is now more equipped to take action to address issues with support from Government.

The Coral Reef Restoration Programme is therefore expected not only have benefits in reducing coastal erosion but to contribute to improving the livelihoods of residents in both areas by ensuring that they have a sustained and alternative source of income. It is also anticipated to continue to provide evidence to strengthen support for considering EbA strategies more in climate change adaptation planning.

It is anticipated that the genetic analysis conducted on the corals will be used to start a coral genetic database for Grenada. Building on coral scientific research will help inform the best management approaches, and increase reef building corals chances of adapting to climate change through maintenance of genetic variability.

How does the initiative contribute to the integration of EbA in national and sub-national frameworks?

The EbA approach being implemented is in line with many of Grenada's policy instruments. The Coastal Zone Policy for example outlines the vision for the coast Grenada wants and clearly articulates coastal ecosystem restoration as a key priority area.

Grenada is also well advanced with the preparation of its National Adaptation Plan. This key guiding document for outlining the steps Grenada will take in adapting to Climate Change places heavy emphasis on EbA approaches for ecosystems resilience, recognising that ecosystems goods and services underpin our economy and will be adversely affected by climate change. In 2014 for instance, Grenada received 531.9 million XCD in revenues as total contribution from tourism alone, that is, 24.2 % of Grenada's GDP. It is important to note that two objectives in the document speak to strengthening ecosystem resilience and on raising awareness for EbA, as well as advocating the successes of existing EbA projects in Grenada.

Results

- **The formation of a new skilled profession in Grenada called "Coral Gardener" where community members have been trained and hired to work in the coral nurseries to maintain and manage key reef restoration activities.** Being a "Coral Gardener" involves weekly maintenance of coral nursery structures on which corals are grown in the nursery, and the planting and monitoring of these pieces along the reefs earmarked for restoration. A total of approximately ten (10) Coral Gardeners are currently employed with the Programme; this number is anticipated to be expanded in the near future.
- **Successful design and packaging of a systematic process for training persons in the construction and installation of coral nurseries and on coral nursery and reef management and maintenance**, which are the key skills necessary for becoming a Coral Gardener, one key output of which is the production of a training manual. No such document exists globally and thus this will be a significant national, as well as regional and international contribution. This can be used to replicate and upscale coral reef restoration as an EbA action in other areas.
- **Initiation of a community-based data collection programme on growth and health of corals.** This includes the first genetic analysis on coral in Grenada to be used as the basis of monitoring coral resilience in the face of climate change.
- **Planting of almost 2000 coral fragments** grown in the nurseries on to degraded sections of 3 planting sites in Grenada and 2 planting sites in Carriacou;
- **Increased community awareness on coral reef ecosystems and ecosystem based adaptation** through planned community day activities, the production of fact sheets, school presentations, community consultations and focus group sessions, radio and television interviews, glass bottom boat trips to the nursery and an active social media presence;
- **Increased support and buy in from government and the private sector** through active information dissemination and nursery visits;
- **Working with local communities to strengthen community structures including facilitating the establishment of community** Taskforce committees to strengthen community structures and to ensure that they have an input into the decision making process;
- **Hosting of two regional workshops in 2016**: "Integrating Ecosystem Based Adaptation into National Planning" (Grenada) and "First Meeting of the Caribbean SIDS Regional Network of Permanent Secretaries" (Cuba). Recommendations included the formation of a "Caribbean SIDS Permanent Secretary Network" to enhance regional cooperation and improve knowledge exchange and transfer and to adopt a regional approach to facilitate the integration of EbA into planning and policy in Caribbean SIDS. As a follow up to this, Permanent Secretaries of the Environment met in November 2016 in Cuba to develop an action plan towards the operationalisation of a Regional Permanent Secretary of the Environment Network and to begin the process of designing a regional EbA project that will assist Caribbean SIDS with pursuing appropriate national coastal EbA interventions.

Lessons learned

A number of lessons were learned through the design and implementation of the Coral Reef Restoration Programme:

1. **The lack of a centralised data management system and access to relevant information presented a major challenge for the design and implementation of the EbA option.** In many cases data protocols did not exist and information had to be retrieved from multiple sources. The need to put in place appropriate structures to facilitate easy access, storage and packaging of data for decision making was identified as necessary. Additionally there was an apparent need to review institutional arrangements to eliminate redundancies and streamline intervention actions.
2. **Strengthening of coral research is needed** considering the ecosystems themselves are at risk to Climate Change. More information can help to inform which species of corals are more resilient and can help to increase the robustness of the reefs.
3. **The long term success of the EbA strategy is dependent on instituting sustainable financing**

mechanisms at different scales including through public investment projects/programs, private sector partnerships and crowd source funding.

4. Based on the project scope, we were unable to address the impacts of land-based sources of pollution on the ecosystem itself. However, **in making any intervention at the coast, especially in an island setting, one must consider the interconnectivity of land and sea.**

For more information

https://www.facebook.com/GrenadaEBAProject/

Organization

Government of Grenada

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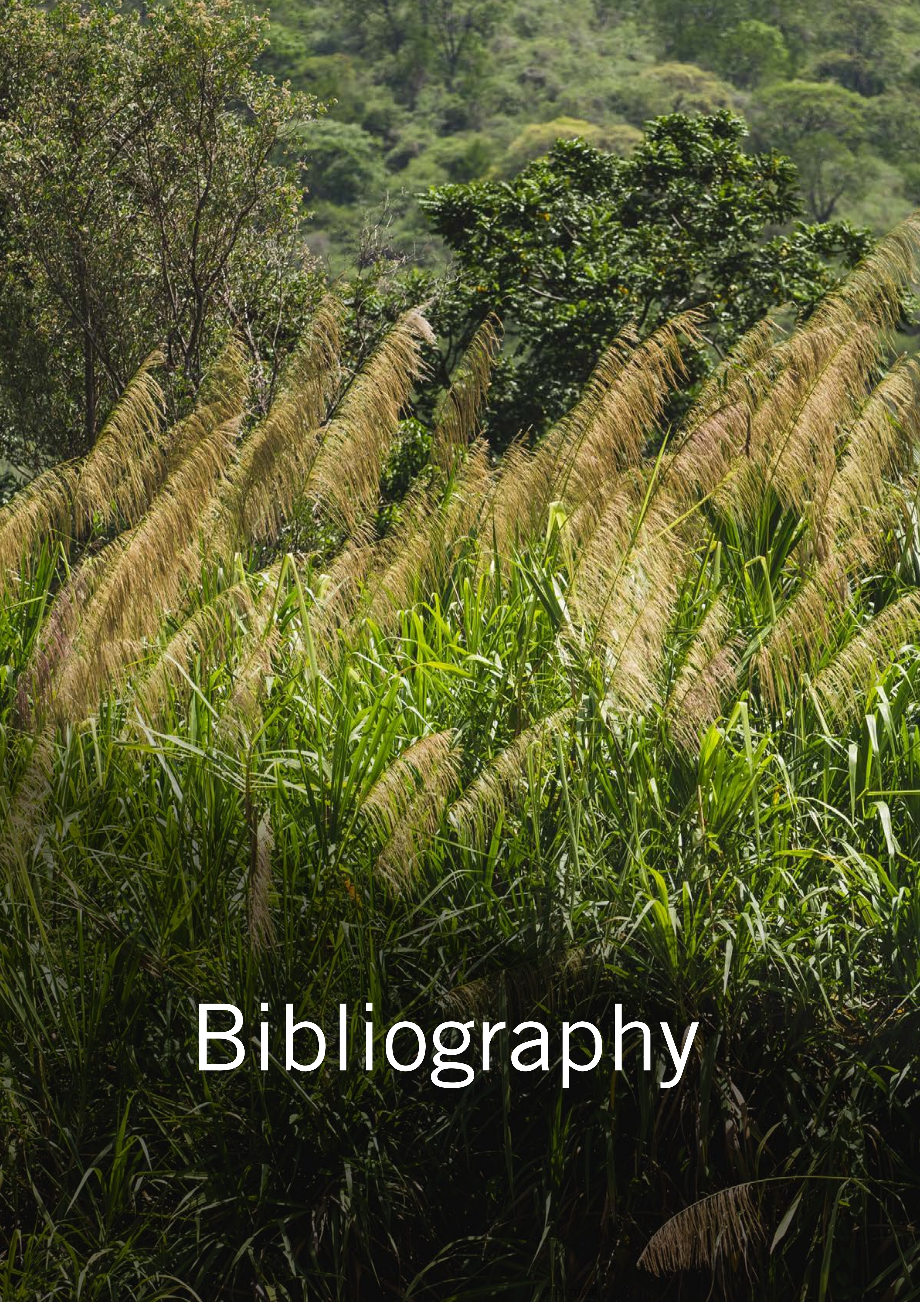

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