GEF-Satoyama Project

SATOYAMA INITIATIVE

GEF-Satoyama Project Working Paper:

Values, Knowledge and Governance of Socio-ecological Production Landscapes and Seascapes

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GEF-Satoyama Project Working Paper: Values, Knowledge and Governance of Socio-ecological Production Landscapes and Seascapes

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Values, Knowledge and Governance of Socio-ecological Production Landscapes and Seascapes

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2019

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GEF-Satoyama Project subgrantees:

Indo-Burma Biodiversity Hotspot:

Inter Mountain Peoples' Education and Culture in Thailand Association (IMPECT) / Chiang Mai, Thailand

Project title: Promoting and enhancing the Karen indigenous sustainable socio-ecological production system in northern Thailand

Fauna & Flora International (FFI) / Kachin State and Tanintharyi Region, Myanmar

Project title: Conservation and sustainable use of freshwater ecosystems in Myanmar

The Energy and Resources Institute (TERI) / Nagaland, India

Project title: Mainstreaming community-conserved areas for biodiversity conservation in Nagaland

Madagascar and Indian Ocean Islands Biodiversity Hotspot:

Wildlife Conservation Society (WCS) / Analanjirofo, Madagascar

Project Title: Integrated adaptive management to protect ecological integrity in the socio-ecological production landscape (SEPL) of the south-east watershed of Makira Natural Park

Environmental Protection & Conservation Organisation (EPCO) / Mahébourg, Mauritius

Project title: Mainstreaming the contribution of coastal wetlands biodiversity for sustainable economic & livelihood development at Cité La Chaux 'Barachois', Mahébourg.

Green Islands Foundation (GIF) / Mahé Plateau, Seychelles

Project title: The development of a co-management plan, designed by fishers, to minimise the impact of the Seychelles artisanal fishery on threatened species.

Dahari / Anjouan Island, Comoros

Project title: A landscape management model for conserving biodiversity in the Comoro Islands

Tropical Andes Biodiversity Hotspot:

Amazónicos por la Amazonía (AMPA) / Bolívar, Peru

Project title: Consolidation of the participatory management of the Alto Huayabamba Conservation Concession – AHCC as a production landscape, and strengthening of partnerships for conservation, production and research in the Peruvian Amazon

Fundación para la Investigación y Desarrollo Social (FIDES) / Manabí and Esmeraldas, Ecuador

Project title: Improvement of the livelihoods of the communities through the sustainable management of productive landscapes and biodiversity conservation in mangrove (Estuaries Chone and Portoviejo), the dry forest (Cordillera del Balsamo) and rainforest (Commune Playa de Oro).

Universidad Industrial de Santander (UIS) / San Vicente de Chucurí, Colombia

Project title: Reconciling biodiversity conservation and agricultural production in agroforestry cultivation systems in the Colombian Andes: a model for Colombia's post conflict era.

Foreword

This publication aims at compiling and disseminating good practices and lessons learnt from the outcomes of the GEF-Satoyama Project, which supported on-the-ground demonstration of sustainable management of socio-ecological production landscapes and seascapes (SEPLS) in ten countries in three biodiversity hotspots. Conservation International Japan had the privilege of serving as the lead Executing Agency for the project working closely with United Nations University Institute for Advanced Study of Sustainability, Institute for Global Environmental Strategies (IGES).

Conservation International has been actively contributing to the Satoyama Initiative, an international effort to promote synergies between people and nature in production landscapes and seascapes, with a belief that the only way to protect biodiversity in these areas of economic activity is to work together with local communities to maximize the flow and value of ecosystem services from biodiversity. In 2015, the Global Environment Facility gave us the opportunity to take the ideas and partnership developed under the Satoyama Initiative further to the field for demonstration and to compile knowledge generated from the Project for amplification and capacity building.

IGES, as one of the joint executing agencies, undertook detailed study on the values generated from sustainable management of SEPLS in the target regions in response to the barriers faced by the communities, particularly having the SEPLS' approach recognized and valued by society, capturing and sharing traditional knowledge, and improving governance of SEPLS.

We believe this document becomes a valuable resource as well as source of inspiration and innovation for those who engage in similar projects or geographies, as SEPLS can be a solution for sustainable development with nature and people in harmony.

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Executive Summary

The "GEF-Satoyama Project" (the "Project"), a global project funded by the Global Environment Facility since 2015, aims to mainstream conservation and sustainable use of biodiversity in socio-ecological production landscapes and seascapes (SEPLS) for a society in harmony with nature. This paper showcases the experiences of ten demonstration projects in SEPLS from the Indo-Burma, Tropical Andes and Madagascar and Indian Ocean Islands regions, which were selected through calls for proposals in these three regions and received financial support by the Project, focusing around the three questions that are important for SEPLS. These are: How can various stakeholders become aware of the values of SEPLS; how can traditional knowledge gained from SEPLS be maintained and used; and how can the governance of SEPLS be strengthened?

Review and analysis of the demonstration projects showed that they were tackling the issues pertinent to the values, traditional knowledge and governance as vital and interconnected constituents of SEPLS. The preliminary outcomes of their efforts were illustrated in various ways, such as reduced negative drivers affecting biodiversity (particularly resource overexploitation, land use and land cover changes, climate change and pollution) as well as stronger institutions to promote biodiversity conservation and sustainable forms of production in SEPLS. More specifically, we found that:

- SEPLS provide a wide array of values to people. Collaborative research on threatened species in SEPLS, and local entrepreneurship harnessing core values of SEPLS, particularly food, help people better recognize these values.
- Traditional knowledge is an integral part of SEPLS that enables people to use and manage various resources sustainably, but is in decline. Effective measures to address this decline include community schools that complement modern education and that facilitate knowledge exchange between elders and youths; reinforcing traditional ecological production; and institutional efforts to integrate traditional knowledge into science and policies, e.g. through adaptive co-management.
- Governance in SEPLS can be strengthened through effective collaborative management schemes and involving local communities in rule- and decision-making processes. Effective collaborative management consists of effective communications between all stakeholders, financial support and policies.

There are interlinkages among perceived and realized values, traditional knowledge and governance. This means that the development and implementation of polices related to SEPLS must systematically take into account the values of the different ecosystems that are relevant to the affected communities. They should, furthermore, draw from both scientific and traditional knowledge and be inclusive of and coherent between the different sectors and levels of governance. Effective communication and consensus-building between all the stakeholders is, therefore, key. In other words, public policies that are coherent among the different sectors and levels of government, and that recognize local values, traditional knowledge, customary rights and community institutions would provide enable environment for sustainably managing SEPLS.

Table of Contents

1 Introduction

1.1 Background and general description of the GEF-Satoyama Project

With increasing human population and ecological footprint, global conservation of biodiversity cannot be achieved solely by protected areas. It is thus important to extend conservation efforts beyond protected area boundaries. The areas where primary production activities support biodiversity and vice versa, or 'socioecological production landscapes and seascapes' (SEPLS), could be a priority for such efforts. They often are important as buffers against anthropogenic disturbance and provide vital connectivity between protected areas, but are also important for the conservation and sustainable use of biodiversity in their own right. In response, in 2015 the "GEF-Satoyama Project[1]" was launched.

The GEF-Satoyama Project (the "Project") is funded by the Global Environment Facility (GEF), implemented by Conservation International's CI-GEF Project Agency and executed by Conservation International Japan in cooperation with the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS), the Secretariat of the International Partnership for the Satoyama Initiative (IPSI) and the Institute for Global Environmental Strategies (IGES). The Project aims to achieve societies in harmony with nature, with sustainable livelihoods based on traditional and modern wisdom, and making significant contributions to global targets for the conservation of biological diversity.

The Project focuses on SEPLS, which integrate the values of biodiversity and diverse ecosystems with socio-economic production activities. Sustainable use of biodiversity and ecosystems underpins human wellbeing. The Project intends to address the barriers that SEPLS face globally, such as insufficient recognition of their values and dynamic nature, land use transformations, degradation and weak governance. In doing so, it contributes to the achievement of multiple global biodiversity targets and the Sustainable Development Goals.

Under its first and main component, "on-the-ground demonstration", the GEF-Satoyama Project invests in demonstration projects in three global biodiversity hotspots: Indo-Burma, Tropical Andes, and Madagascar and Indian Ocean Islands, to enhance livelihoods and the conservation and sustainable use of biodiversity and ecosystem services. Intended outcomes include effective conservation management in these areas, improved conservation status of globally threatened species and protection of traditional knowledge. The demonstration projects have been selected through calls for proposals in the three hotspots. The implementers of these demonstration projects partner with the GEF-Satoyama Project team to achieve the goal of the GEF-Satoyama Project: society in harmony with nature.

The second component focus on improving "knowledge generation" to increase understanding, raise awareness and promote mainstreaming of biodiversity in production landscapes and seascapes. The component supports the synthesis of relevant knowledge and information about SEPLS globally, through a global mapping of priority SEPLS and case study analysis addressing barriers that SEPLS face.

[1] For more information on the GEF-Satoyama Project, visit: http://www.thegef.org/projects; project ID: 5784 and http://gef-satoyama.net/

1.2 Research objectives, basic concepts and outline of the paper

The research component of the GEF-Satoyama Project explores ways in which local communities recognize the values of SEPLS; the indigenous and local knowledge associated with the use and management of SEPLS; and the forms of effective, transparent and inclusive governance for SEPLS, as well as their interplay for ensuring the sustainability and resilience of SEPLS.

The objectives of the research component of the GEF-Satoyama Project are to identify:

1) Ways of recognizing the values of SEPLS (including the drivers threatening these values), as well as strategies for the conservation and enhancement of identified values
2) Assess the relevance of indigenous and local knowledge for the sustainable use, management and conservation of high-value SEPLS
3) Develop an assessment tool for governance of high-quality SEPLS through a multi-stage and multi-stakeholder engagement process.

The totality of the values of SEPLS is not sufficiently understood. In SEPLS, people interact with nature in diverse ways, and thus attribute different values to SEPLS. SEPLS often fall under different ownership and management schemes in which various stakeholders are involved. Many producers prioritize short-term production gains over conservation of biodiversity. SEPLS do, however have the potential to serve as vital habitats for several globally threatened species, particularly in buffer zones of protected areas.

Traditional knowledge can promote sustainable use and management of natural resources. It includes knowledge of the use of animals and plants for food, medicines, and other necessities, and knowledge of "indicator species", such as frogs whose presence indicates clean water. Such knowledge is often embedded in resource management systems and social institutions: e.g., customary rules on tree and non-timber forest product harvesting, fishing restrictions and rotational farming. In addition, indigenous peoples often hold an animistic worldview on nature, such as beliefs in nature spirits and taboos, which influences how they treat the natural environment. Traditional knowledge, however, is in decline. Major causes of the decline include changing values and lifestyles, modern education, difficulties in knowledge transmission, population outflow from rural to urban areas, land transformation for commercial monoculture, and its limited recognition by governments.

Governance of SEPLS refers to all public and private interactions to solve problems affecting the SEPLS, to create opportunities through the formulation and implementation of innovative policies and measures. There are a variety of actors involved in addressing the drivers that affect biodiversity and ecosystem services. However, weak governance can impede the sustainability of SEPLS, such as insufficient participation of key stakeholders, particularly local communities, lacking recognition of customary ownership or management rights, lack of transparency and accountability, which often involves corruption, capture of decision-making processes by a few elites.

After introducing the methodologies employed, this paper presents individual case studies of the 10 GEF-Satoyama demonstration projects conducted in the Madagascar and Indian Ocean Islands, Tropical Andes, and Indo-Burma biodiversity hotspots. The paper then provides a synthesis of the values, knowledge and governance of SEPLS, and discusses the interlinkages between these three key aspects, based on comparative analysis between the case studies.

2 Methodologies

2.1 Analytical framework

In ten project case studies, we documented the values that local communities and other stakeholders associate with SEPLS, traditional knowledge of SEPLS and governance of SEPLS referring to the frameworks proposed by earlier studies. We also documented the efforts of the projects to enhance the recognition of the values of SEPLS among a wider range of stakeholders, to maintain and use traditional knowledge for managing SEPLS, and to strengthen the governance of SEPLS. Upon these, we analysed how the values, traditional knowledge and governance of SEPLS were interrelated.

The values of SEPLS for people could be well captured by adopting generic framework for eliciting the value of nature. Among diverse terminologies and frameworks used to explain the value of nature, including ecosystem goods and services, nature's gifts, nature's benefits to people, or nature's contributions to people, we adopted the recent categorization of nature's contributions to people (NCP) proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Box 1) (see IPBES (2017) for more detailed explanation). The NCP framework was useful to capture a wide array of the values of SEPLS comprehensively with clear and well-established categories. Referring to the NCP category, we investigated the state of these values recognized by different stakeholders, and how the projects envisage to enhance the recognition among a wider array of stakeholders.

Box 1. Nature's Contributions to People (NCP) categories

1. Habitat creation and maintenance
2. Pollination and dispersal of seeds and other propagules
3. Regulation of air quality
4. Regulation of climate
5. Regulation of ocean acidification
6. Regulation of freshwater quantity, location and timing
7. Regulation of freshwater and coastal water quality
8. Formation, protection and decontamination of soils and sediments
9. Regulation of hazards and extreme events
10. Regulation of organisms detrimental to humans
11. Energy
12. Food and feed
13. Materials and assistance
14. Medicinal, biochemical and genetic resources
15. Learning and inspiration
16. Physical and psychological experiences
17. Supporting identities
18. Maintenance of options

Source: IPBES (2017)

For describing traditional knowledge of SEPLS, we referred to the definition of traditional ecological knowledge proposed by Berkes (2008), that is, "cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living being (including humans) with one another and with environment". Described in other words as "*knowledge – practice – belief complex*", traditional knowledge encompasses:

Local knowledge of land, animals, plants, soils and landscape: Local empirical knowledge of animals, plants, soils, and landscape, including information on species identification and taxonomy, life histories, distributions and behavior, which has survival value and is readily accepted cross-culturally

Land and resource management systems: which uses local environmental knowledge and includes practices, tools and techniques

Social institutions: Sets of rules-in-use, norms and codes of social relationships, including social organizations for coordination, cooperation and rule-making, and also including institutions of knowledge that frame the processes of social memory, creativity and learning

World view: which shapes environmental perception and gives meaning to observations of the environment; has components of observational order and conceptual order providing the interpretation of our observations of the world around us; and also includes religion, ethics, belief systems and rounds out the knowledge-practice-belief complex that describes traditional knowledge.

The questions on traditional knowledge during the field study followed the three broad groups of questions on traditional knowledge outlined in the IPBES's overall approach to recognizing and working with traditional knowledge, or what IPBES determines as indigenous and local knowledge (ILK) (IPBES/5/L.6):

a. *What are the contributions of indigenous peoples and local communities in terms of their knowledge, practices and world views to the management and conservation of nature, delivery of nature's contributions to people and ensuring a good quality of life at the regional and global scales?*

b. *What are the most important pressures and factors undermining these contributions, as well as affecting the quality of life of present and future generations of indigenous peoples and local communities?*

c. *What policy responses, measures and processes exist to strengthen and improve the governance of nature and nature's benefits to people with regard to indigenous peoples and local communities and their knowledge and practices?*

Among different aspects of governance of SEPLS, we documented the ownership, use/management rights and stakeholders of land, waterbodies and resources in SEPLS, as well as the policies and measures for addressing the decline or degradation of biodiversity in SEPLS. For a project case study in Colombia in which in-depth investigation on governance issues was carried out, we assessed the effectiveness of governance referring to the generic framework of quality-of-governance (Table 1; Lopez-Casero, Cadman, & Maraseni, 2016).

Table 1. Generic framework of Quality-of-Governance Assessment

Principle	Criterion	Indicator
Meaningful participation	Interest representation	1) Inclusiveness
		2) Equality
		3) Resources
	Organisational responsibility	4) Accountability
		5) Transparency
Productive deliberation	Decision making	6) Democracy
		7) Agreement
		8) Dispute settlement
	Implementation	9) Behavioural change
		10) Problem solving
		11) Durability

Source: (Lopez-Casero et al., 2016)

For synthesis, we analyzed how the values, traditional knowledge and governance of SEPLS interact and hence can contribute to the sustainability and resilience of SEPLS. Such interaction can be illustrated by few examples, e.g., traditional knowledge associated with important benefits from SEPLS to people which in turn work effectively to maintain the sustainability and resilience of SEPLS, and the recognition of traditional customary ownership, rights, rules and practices in government/public policies contributing to the governance of SEPLS.

2.2 Methods

This study relied on multiple data and information sources, including documents available through the project operation, an online questionnaire surveys targeting all ten grant projects, field studies of selected grant projects, comparative analysis and synthesis, as well as the feedback from the grantees on the initial findings during the review process and at the project's consolidation workshop held in August 2018.

2.2.1 Reviewing project documents

The study extracted data and information from the documents submitted from the grantees in the course of the project selection and implementation, including project proposals, quarterly technical reports, highlights reports, as well as the annual reports. They provided baseline data on the profile of the SEPLS in their project sites, socio-economic status of the local communities and major threats to SEPLS, as well as the major efforts and achievements of the individual projects.

2.2.2 Online survey

The online questionnaire survey was developed using LimeSurvey[2] online platform, which allows for sequential queries that only provide to the respondents the relevant options to select and spaces to fill depending on their answers to the former questions. This not only minimizes the burden on the respondents to complete a long questionnaire, but also helps them better understand what the questions ask them to respond. The survey consisted of seven question groups, where the respondents were asked to answer to the questions on the major ecosystem domains that constitute the SEPLS in the project site (Box 2).

The focal person in each of the ten demonstration project proponents were invited to participate in the online survey by direct email sent between May 5th and 9th, 2017, in which the URL for the online survey was indicated. An oversight in the logic of this original survey required us to request project proponents by emails sent between August 16th and 18th, 2017 to complete a follow-up survey capturing information about drivers of declining trends in ecosystems and species populations. Reminder emails were sent to the focal person periodically, until both surveys were completed. The results of the online survey regarding the ten grant projects were analyzed and visualized using the CIRCOS[3] diagram and tabular formats, and also described based on rudimentary contents analysis.

[2] https://www.limesurvey.org/
[3] http://circos.ca/

Box 2. Question groups and their sequence in the online questionnaire survey

Question 1 - Nature: types and descriptions of major ecosystems
Question 2 - Nature: important species
Question 3 - Benefits to people from ecosystems and species
Question 4 - traditional knowledge
Question 5 - Drivers of decline and degradation
Question 6 - Governance: policies and measures
Question 7 - Governance: ownership, management right holders and stakeholders

2.2.3 Field investigation

We also conducted field studies to allow for more in-depth investigations on the three research themes, i.e. values, traditional knowledge as well as governance. In so doing we selected one project from one region that clearly featured one of the three themes, so that we could cover all the three regions and the three themes in a set of three projects. Also considering the access to the project site, we conducted field studies of the projects listed below:

- Values: Cite La Chaux and Mahebourg villages, Grand Port region, Mauritius (19 – 28 June 2017) [Madagascar and Indian Ocean Islands Biodiversity Hotspot]
- Traditional knowledge: Mae Tae Khee (Khun Tae), Mae Yod Khee and Mae Um Pai villages, Chiang Mai and Maehongson Provinces, Thailand (18 – 29 May 2017) [Indo-Burma Biodiversity Hotspot]
- Governance: San Vincente de Chucuri, Eastern Cordillera of the Columbian Andes (5 – 14 June 2017) [Tropical Andes Biodiversity Hotpsot]

In each project site, we conducted field survey employing a sequential mixed methods approach as described below in four steps:

1. Preparatory meeting with the representative of the project team: Semi-structured interviews and participatory mapping to validate their responses to the online survey and to obtain additional information on the SEPLS and their stakeholders.
2. Focus group interviews with local community members: Focus group interviews using both open-ended questions, based on a common interview guide, and quantification tools such as weighted ranking, participatory mapping and other stimuli.
3. Key informant interviews with government and public authorities: We identified key informants through the former steps 1 and 2, mainly from the officials or experts in government or public authorities being highly engaged in SEPLS. We interviewed them using interview guide and based on the outputs of the former steps.
4. Briefing the field study results to the project team: We briefly reported the initial results of the field study to and obtained feedback from the project team for data validation.

3 Project case studies

This section presents an overview of ten demonstration projects. The first three case studies are on SEPLS where an in-depth field investigation was conducted.

3.1 Thailand: "Promoting and enhancing the Karen indigenous sustainable socio-ecological production system in northern Thailand"

The Karen people in the mountainous northern Thailand have long been living based on mixed agroecosystems applying traditional rotational farming (RF) for over 300 years. This landscape is the main sources of their livelihood and food security. They have accumulated knowledge on species, ecosystems and managing the land and natural resource sustainably.

This section presents the benefits from ecosystems and species to the Karen people in northern Thailand, the role of Karen's traditional knowledge in their management of the land and natural resources, and importance of governance on traditional socio-ecological production landscape. The report used both primary and secondary data. The primary data were collected through field visits, questionnaires and focus group interviews with 62 villagers in three Karen communities and key stakeholders in May 2017, and an online survey conducted from April to June 2017. The secondary data came from the preliminary results of a GEF-Satoyama demonstration project in Thailand implemented by the Inter Mountain Peoples' Education and Culture in Thailand Association (IMPECT), and other sources.

Box 3. IMPECT project overview

IMPECT's project, titled "Promoting and Enhancing the Karen Indigenous Sustainable Socio-ecological Production System in Northern Thailand" aims to support three Karen communities to become a model of community-based sustainable development by building on their traditional knowledge and natural resource management systems.

The project combines this with innovative and technologically advanced community-controlled mapping, monitoring and information systems and with increased economic productivity both for human wellbeing and for biodiversity. The project seeks to raise public awareness in society at large about the role of the evolving Karen management systems in relation to sustainable development (SDGs) and biodiversity (Aichi Biodiversity Targets) and will seek to feed into the development and implementation of local and national policies and laws that enable and support community-based sustainable governance and management of biodiversity.

The methodology is based on very close collaboration with, and the highest possible level of participation of community members, including women and youth. It will combine methods for the documentation, appreciation and revitalization of traditional knowledge with state-of-the-art modern mapping technology.

3.1.1 Landscape description and project overview

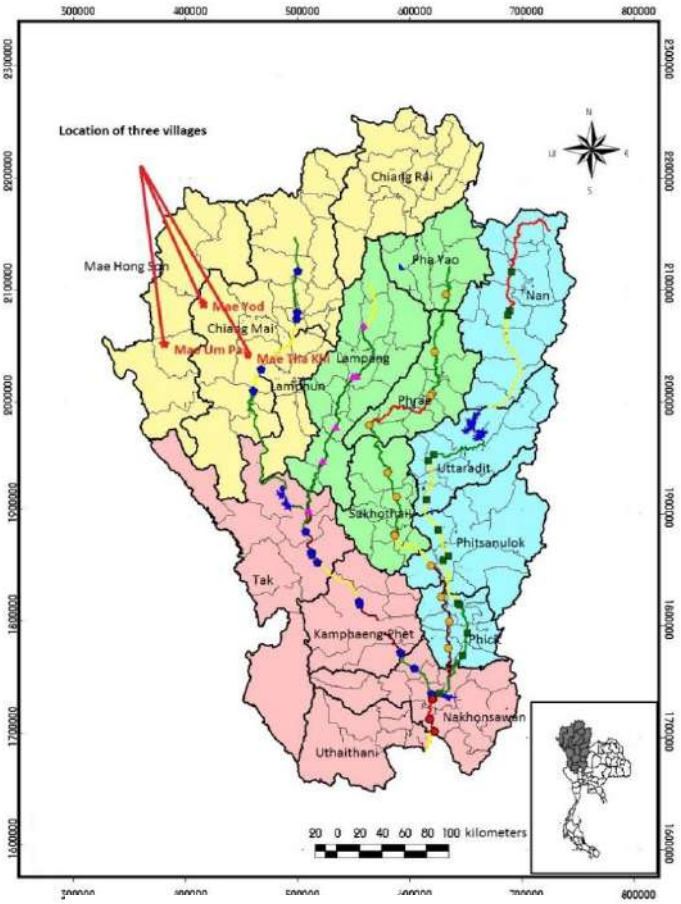
Three Karen villages (Mae Tae Khi, Mae Yod Khee and Mae Um Pai) are located in the mountainous areas with an elevation range of 800-1,800 meters in two provinces in northern Thailand (Figure 1). The villages are surrounded with diverse kind of forests. The major vegetation is the Hill Evergreen forest, followed by Pine forest, Deciduous forest and Dry Dipterocarps forest. Wildlife remains in the forests, such as barking deer, wild pig and wild birds.

The three villages share similar geographic and climatic conditions, while the patterns of land use are more distinct. The land uses in the three villages are classified as forestland, agricultural land and resident area (**Table 2**), but they have different proportions of forest and agricultural lands. The agricultural land dominates in the areas of Mae Um Pai. Forestland dominates in Mae Tae Khi and Mae Yod Khee. Agricultural land is divided into rotational farming (RF), permanent field and paddy field. The RF system involves cultivating land in a few plots within the RF area, while leaving other plots under fallow to regain their fertility, and maintaining forest cover around the RF areas (**Figure 1**). The rotational faming of native rice mixed with native vegetables and herbs is practiced in the higher altitude in agricultural lands. Permanent field is located in the lower altitude, including agroforestry, vegetable farming and paddy rice fields surrounding permanent fields.

Table 2. Land classes in three villages in year 2017

Villages	Type of land use			Total areas (rai)
	Forest lands (rai)	Agricultural lands (rai)	Residential areas (rai)	
Mae Tae Khi	12,622	3,867	364	16,853
Mae Yod Khee	15,644	15,546	328	31,518
Mae Um Pai	1,347	3,387	114	4,848

Note: One rai is equal to 0.16 ha



i) Location of the three Karen villages

ii) Landscape of Mae Yod Khee

iii) Landscape of Tae Khi Village

iv) Landscape of Mae Um Pai Village

Figure 1. Location of project site in Thailand

The total population of each of the three Karen villages in 2013 is shown in **Table 3**. The major sources of their incomes originated from farming. Rotational farming constitutes the main income source of Mae Yod Khee and Mae Um Pai, while paddy farming and commercial crops are the main sources of incomes of Mae Tae Khi. The Mae Tae Khi community was encouraged to plant paddy and commercial crops in the permanent fields, and most of the rotational farming was designed as protected forest areas under laws created by the Department of National Parks, Wildlife, and Plants Conservation (DNP).

Figure 2. Rotational farming in Mae Um Pai

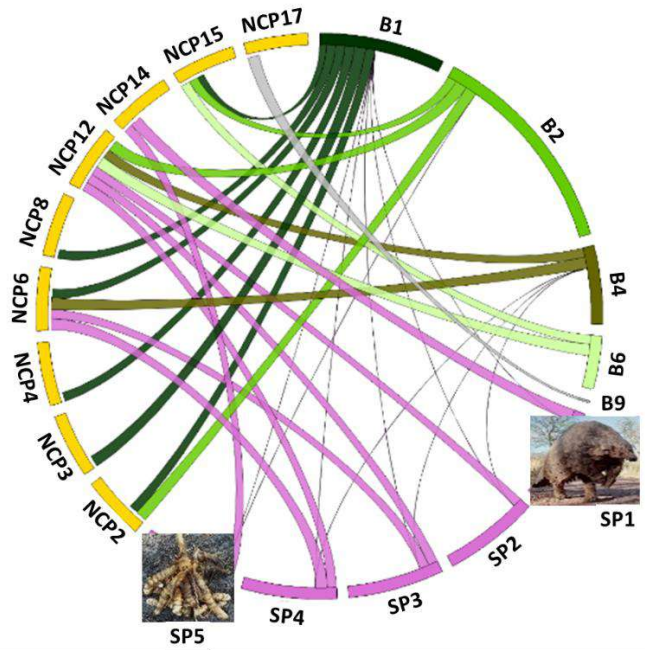
Table 3. Population size of the study villages in 2013

Villages	Male	Female	Total population	Households
Mae Tae Khi	375	385	760	212
Mae Yod Khee	266	235	501	104
Mae Um Pai	231	209	440	48

Sources: Bureau of Registration Administration, 2013

3.1.2 Values

In all three villages the Karen communities benefit from a range of different NCPs, which were identified through an online survey in 2017. Figure 3 illustrates the linkages between different ecosystem domains and important species and their values for the local communities. Natural forest and more intensively managed resource forest provide multiple contributions to people, including pollination and seed dispersal (NCP 2), air quality regulation (NCP 3), climate regulation (NCP 4), freshwater flow regulation (NCP 6), soil regulation (NCP 8) and learning (NCP 15). Managed forest and farmland were found to contribute to high levels of food and feed (NCP 12), but also provided places for learning and inspiration (NCP15) for older to younger generations on how the land and natural resources should be managed. These constitute Karen's view of nature. These, however, are not adequately taken into account in managing forest reserves by the Forest Department, which partially overlap Karen's land uses. The Forest Department sees Karen's land uses, including rotational farming, as the primary cause of deforestation. Divergent view of nature such as this underlies long arguments between the Karens and the government (See section 3.1.4 for details).



Ecosystem domain (dark green, light green, green, green, grey)
B1: Natural/ protected forest
B2: Managed/ resource forest
B4: Freshwater wetland
B8: Farmland
B9: Settlement/Urban

Important species (purple)
SP1: Yo Hhaw (*Pangolin*)
SP2: Hswai bau dei (Yellow Leg Crab)
SP3: Do P' Loo (Root Banana Fish)
SP4: Dei bu (Jub Frog)
SP5: Teen Hung Doi (*Paris polyphylla Smith*)

Ecosystem services (NCP) (yellow)
NCP2: Pollination and seed dispersal
NCP3: Air quality regulation
NCP4: Climate regulation
NCP6: Freshwater quantity, flow and timing regulation
NCP8: Soil Formation, protection and decontamination
NCP12: Food and feed
NCP14: Medicinal, biochemical and genetic resources
NCP15: Learning and inspiration
NCP17: Supporting identities

Figure 3. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

In addition, focus group interviews during the field study found important species and different ecosystem services from forest land and rotational farming. The study tried to distribute male and female participants equally in the focus groups to enhance the exchange of opinions (**Table 4**). The field survey included key informant interviews from seven institutes, including 1) Inter Mountain Peoples Education and Cultural in Thailand Association (IMPECT), 2) Indigenous Knowledge and People Foundation (IKAP), 3) Pgaz K'Nyau Association for Sustainable Development (PASD), 4) Karen Network for Culture and Environment (KNCE), 5) Op Luang National Park, 6) Cross Cultural Foundation and 7) Princess Sirinthorn Anthorpology Center (SAC).

Table 4. Number of villagers for focus group interviews in each village

Village	Sample size for focus group interviews		
	Male	Female	Total
Mae Tae Khi	12	8	20
Mae Yod Khee	10	8	18
Mae Um Pai	12	12	24
Total			62

The values from two ecosystem domains (forest and rotational farming) for three Karen villages are explained in **Table 5**. NCP4 (Ocean acidification) was omitted. All participants in three Karen villages agreed that both forest and rotational farming provided them sources of natural food and medical herbs (NCP11&13), conservation of native plant species (NCP1), freshwater quantity (NCP5), and increasing fresh air (NCP2).

The participants identified five major types of wildlife species and valuable plant species in forest land and rotational farming areas in their communities. Table 6 presents the several mammal and native plant species. All participants confirmed that there was high plant species diversity in rotational farming. Native rice species, in particular *Oryza sativa* and some species of vegetables and herbs are now difficult to find in the lowland. They pointed the importance of wildlife species that they found in the forest areas such as barking deer and wild birds.

Table 5. Description of values from forest and rotational farming in three Karen villages

NCP category	**NCP description**	
	Forest	Rotational farming
1.Pollination and dispersal of seeds and other propagules	➢ Stocks of native plants and animal species and varieties	➢ Diverse native plant species (vegetables, herbs, rice, fruits)
2.Regulation of air quality	➢ Increasing fresh air and moistures from trees	➢ Increasing fresh air and moistures from trees ➢ (DS) Increasing air pollution from burning the field
3.Regulation of climate	➢ Increasing carbon stocks	➢ Increasing carbon stocks ➢ (DS)Increasing GHG emissions from burning the fields
4.Regulation of ocean acidification	none	none
5.Regulation of freshwater quantity	➢ Increasing rainfall	➢ Water retention in the plots of years 5-12 rotational farming
6.Regulation of freshwater quality	➢ Increasing clean water supply	➢ Better quality of surface water by putting charcoal from burnet fields into streams
7.Formation, protection and decontamination of soils and sediments	➢ Soil erosion and sedimentation control	➢ Soil erosion and sedimentation control
8.Regulation of hazards and extreme events	➢ Reducing flush floods ➢ Providing wind breaking zone for the villages	➢ Reducing flush floods ➢ Providing wind breaking zone for the villages
9.Regulation of organism detrimental to humans	➢ Increasing animal and insect pests	➢ Reducing weeds, animal and insect pests from burning the fields
10. Energy	➢ Fuel wood	➢ Fuel from wood and crop residues from clearing fields
11.Food and feed	➢ Wild birds and animals ➢ Wild foods (i.e. mushroom, bamboo, insects, honey)	➢ Rice, bean, mix vegetables and fruits, insects and wild animals (i.e. rats, birds)
12.Materials and assistance	➢ Timber, Cotton	➢ Cotton
13.Medicinal, biochemical and genetic resources	➢ Local medical herbs	➢ Local medical herbs
14.Learning and inspiration	➢ Sacred groves for performing rituals ➢ Cemetery forest for burying the dead and respected objects ➢ Sacred watershed forest	➢ Festivals and rituals i.e. praying the gods of territory, gods of paddy fields, gods of mother of rice, gods of fire, gods of rotational farming and harvesting rice
15.Physical and psychological experiences	➢ Beauty of natural forests	➢ Green zone of villages
16.Supporting identifies	➢ Providing the natural learning center to local young people	➢ Traditional land management and rotational farming practices

Table 6. Important wildlife species and valuable plant species for people in three Karen communities

Villages	Ecosystem services from different land use types			
	Forest lands		Rotational farming	
	Wildlife species	Plant species	Wildlife species	Plant species
Mae Tae Khi	• Monkey (*Scientific name: Macaca mulatta*), • Barking deer (*Muntiacus*), • Drongo (*Dicruridae*), • Magpie (*Copsychus saularis*), • Reticulated python (*P. reticulatus*)	• Native herbs	• Wild birds	• Rice (*Oryza sativa*) • Cucumber (Cucumis sativus) • Corn (*Zea mays Linn*) • Native herbs (e.g. Haw Wor in local name)
Mae Yod Khee	• Deer (*Cervidae*), • Pangolin (*Pholidota*), • Wild pig (*Sus Scrofa*), • Barking deer (*Muntiacus*)	• Native herbs	• Cattle (*Bos taurus*), • Buffalo (*Bubalus bubalis*), • Wild pig (*Sus Scrofa*)	• Rice (*Oryza sativa*), • Cucumber (*Cucumis sativus*), • Pumpkin (*Cucurbita moschata Decne.*), • Native herbs, • Leaf mustard (*Brassica juncea*)
Mae Um Pai	• Barking deer (*Muntiacus*), • Jungle fowl (*Gallus*), • Asian palm civet (*Paradoxurus hermaphroditus*), • Red-whiskered bulbul (*Pycnonotus jocosus*), • Quail (*Coturnix japonica*)	• Bamboo (*Thyrsostachys siamensis*)	• Wild birds	• Rice (*Oryza sativa*), • Native herbs

3.1.3 Traditional knowledge

In line with Berkes' framework (see methodology section), the following subsection presents the local knowledge of land, animals, plants, soils and landscape and the local knowledge on the land and resource management systems, as well as the social institutions and world view of the community (Table 7).

3.1.3.1 Local knowledge of land, animals, plants, soils and landscape

Karen people hold a considerable body of knowledge of:

- Local names and habits of wild fauna & flora (most emblematic endangered species found usually in National Park area and rotational farming
- Pollinators (bees) and seed dispersing animals (birds), and pollination and seed dispersal of trees
- Knowledge of watershed forest
- Empirical knowledge of soil erosion and unstable conditions
- Empirical knowledge of maintaining soil fertility
- Role of natural vegetation in the prevention of hazards, such as flash floods and landslides
- Diseases/pests that affect crops; animals that help control the diseases/pests; some predators
- Some knowledge of edible wild fruits & vegetables
- Taxonomy and demography of useful trees

- Medicinal property of trees, e.g. Chor Tum Mae (local name), which is used to treat wounds, and Tod Kad Wa (local name) for treatment of snake bites

Table 7. Summary of traditional knowledge and its holders associated with ecosystems and important species

Ecosystem / Species	Traditional knowledge: Domain	Traditional knowledge: Description	Trend	Knowledge holders: Spiritual leader	Traditional doctor	Women	Elders	Local community
1.Natural/protected forest	1.Knowledge	Learning center of biodiversity knowledge	↘	○				○
	3.Social Institutions	Customary law used in area to take care forest	↘	○				○
		Sacred sites classified as taboo areas	↘	○				○
Yo Hhaw (Pangolin)	1.Knowledge	Medicine	↘		○			
2.Managed/resource forest	1.Knowledge	Herbal	↘					○
	2.Mgt. system	For Food security	↘					○
		For Social economic from non-timber forest product	↗					○
4.Freshwater wetland	1.Knowledge	Seeing animals in water indicates quality of water	↘					○
	3.Social Institutions	Sacred water sources as mechanism for protect it	↘					○
Hswai bau dei (Yellow leg Crab)	1.Knowledge	Indicator of clean and healthy water	↘			○	○	
8.Farmland	1.Knowledge	Seed variety knowledge keep going though in-situ process	↘					○
	2.Mgt. system	Rotational Farming Knowledge	↘					○
	3.Social Institutions	Spirituality, knowledge and practice	→					○
9.Settlement /urban	1.Knowledge	Knowledge about the geography of places location of village	→					○
	3.Socical Institutions	House style Knowledge	↘					○
Dei bu (Jub Frog)	1.Knowledge	Indicator of clean and healthy water, as well as of wet weather	↘			○	○	
Teen Hm Doi (White Turmeric)	1.Knowledge	Herbal	↘		○		○	

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

Source: Online survey

3.1.3.2 Local knowledge of land and resource management systems

Based on the information gathered from field survey and interviews with Karen people in the study sites in 2017, the study found that rotational farming (RF) is carried out based on their traditional knowledge for conserving and planting native plant species (e.g. rice, vegetables and herbs). Traditional knowledge and its implications to biodiversity and ecosystem services are described distinguishing three categories:

(1) **Regulating services**: The survey found that the Karen communities continue to apply organic pest control methods using homemade bio-pesticides, which are generally made from insect pests,

such as grasshoppers and ants. They maintain water permeability of the land and thus prevent erosion by gently piercing the soil surface for planting and weeding. The Karen methods of rotational farming (RF) maintain high land productivity in terms of biomass and nutrients. The RF practices allow regrowth of natural vegetation for the length of the fallow period. The soil is replenished from the nutrients stored in the vegetation

(2) **Material provision**: The study observed that RF continues to be practiced for subsistence food and cash crop production using various domesticated and native plant species, which constitute the rich agrobiodiversity in the Karen landscape. Some of the native rice varieties are now difficult to find in the lowland.

(3) **Non-material value**: The survey found that traditional and collective RF practices underpin strong social cohesion among the community members, e.g. through frequent exchanges of food and other products, as well as labor sharing among households. Moreover, generating and sharing knowledge of farming are important part of Karen social life. Their songs and folktales are mediums for passing on knowledge from old to young on how the land and natural resources should be managed. Many of their songs with folktale lyrics include norms relating to natural resource use.

3.1.3.3 Social institutions

Karen communities share the knowledge they have of farming and how the land and natural resources should be managed among their members in their traditional social institutions. Karen people share knowledge, labor and food throughout the cropping cycle. The have also formed corporations for watershed forest conservation

3.1.3.4 World view

Karen people's beliefs in spirits and gods have contributed to conserve the forests such as sacred groves for performing rituals and ancestor sanctuary, and watershed forests. These beliefs have shaped norms and taboos relating to natural resource use. The protected forest areas are places for learning about biodiversity and rituals from the spiritual leader to younger people. Karen beliefs in spirits and gods also contributed to classify forests. Karen songs and folktales are mediums for passing on knowledge from old to young on how the land and natural resources.

The study found main causes of the loss of Karen's traditional knowledge on forest and agricultural land management and use in the study sites are:

1) The Government of Thailand has been promoted the formal education system in Thai language to indigenous children and youth. Some youth who finished the elementary school in their Karen communities leave the villages to study in the city, and prefer to work in the city rather than in their villages because they can earn more and make their lives better. Numbers of youth who still live in villages and work in the RF fields are declining; and

2) The rights of indigenous people on the use of their land and resources may not recognized by the Government of Thailand. A policy to conserve forests and a policy to promote the planting of cash crops in the northern highland, which resulted in conversion of RF to permanent farming.

3.1.4 Governance

The governance systems in the landscape differ depending on the type of land-use and legal status of the area. **Table 8** shows the different ownership and management rights within the Karen communities.

Table 8. Ecosystem governance structure in three Karen communities

Land-use type	Protected/natural forest	Rotational farming	Stakeholder type
Ownership	Forestry Department and Department of National Parks.		Government
		Local Karen communities	Individual
Management right holder	Forestry Department and Department of National Parks.		Government
		Local Karen communities	Individual
Other stakeholders	Royal Forest Department (RFD)	Royal Forest Department (RFD)	Government
	Sub-District Administrative Organization	Sub-District Administrative Organization	Government
	Local Karen communities		Individual
		Cross Cultural Foundation	Non-governmental
		Princess Sirinthorn Anthorpology Center (SAC)	Government
		Provincial Cultural Office	Government
		Indigenous People Network Organization	People organization
		Inter Mountain Peoples Education and Cultural in Thailand Association (IMPECT)	Non-governmental

Source: Online survey

The levels of governance and the main key stakeholders involved in the management of natural resources and ecosystems in the three Karen communities are as follows.

1. National Administration:

- *Land rights and forest resource management*

The forest resources have been protected under laws created and enforced by the Royal Forest Department (RFD) and Department of National Parks, Wildlife, and Plants Conservation (DNP). The and the RFD and DNP hold the main responsibilities for forest management in Thailand, including the management of protected areas e.g. National Parks, Wildlife Sanctuaries, Non-Hunting Areas, Parks, Biosphere Reserves, First-Class Watersheds, and Second-Class watersheds.

Some parts of the protected forest overlapped with the Karen villagers' farmland, and this has resulted in conflicts and encroachment of forests for agriculture. The Government blames their rotational farming for extensive forest loss. Over the past two decades, the Karen communities claimed their rights of land that they used before the designation of protected area by the Government of Thailand, and represented to the Government that their traditional knowledge on land use in particular traditional rotational farming was not a major cause of forest loss and environment problems. However, there is no policy in Thailand that distinguishes the rights of indigenous people. The Karen's traditional RF contributes to conservation of biodiversity and ecosystems need scientific evidence and documents.

2. Sub-National Administrative and Local Level consists of Non-Government Organization, local authorities and Society Organization

- *Land rights*

In the past, the Cross-Cultural Foundation as non-government organization provided free legal services for indigenous people in Thailand to claim their rights of land and try to solve the conflicts between the officials and indigenous people in relevance in this issue. However, the process of judgement required more enforcement and time.

- Use *rights of land and natural resources*

The People organization and NGOs (Cross Cultural Foundation) and Princess Sirinthorn Anthorpology Center (SAC) under the Ministry of Culture has been collaborated with Provincial, District and Sub-district Administrative Organization to establish the Karen special cultural zone in the northern Thailand. The Karen people have rights on the use of their land and resources within the Karen special cultural zone. The areas of Mae Yod Khee villages in the study sites were recognised as the special cultural zone with approval from local authorities in Chiang Mai Province: Sub-district Administrative Organization, Provincial Cultural Office, and Indigenous People Network Organization.

- *Karen cultural and language conservation*

At present, the SAC in cooperation with the Inter Mountain Peoples Education and Cultural in Thailand Association (IMPECT) Pgakenyaw Association for Sustainable Development (PASD) and Karen Network for Culture and Environment (KNCE) support the Karen communities in the study sites to improve their child education system in the Karen's language, to conserve Karen's traditional knowledge and culture, and to promote slow food and conservation of biodiversity and ecosystem from Karen's traditional rotational farming system to the Government and urban people.

The study found that main direct drivers of deforestation and forest degradation over the past two decades were the clearance of forests for agriculture, urban development and mismanaging logging concession (Figure 4.). The Government of Thailand has promoted intensive monocrop agriculture for food industry development. The conversion from traditional agroecosystem to intensive monocrop agriculture have resulted in extirpation of wildlife and native plant species. The indirect drivers of deforestation and forest degradation were population growth, development of economics and technology. There is strong conservation policy in the National Park and Forestry Department but weak law enforcement to combat illegal logging activities. The Government need to develop policies for forest conservation and management in Thailand and increase the role of Karen communities in forest management and conservation of biodiversity.

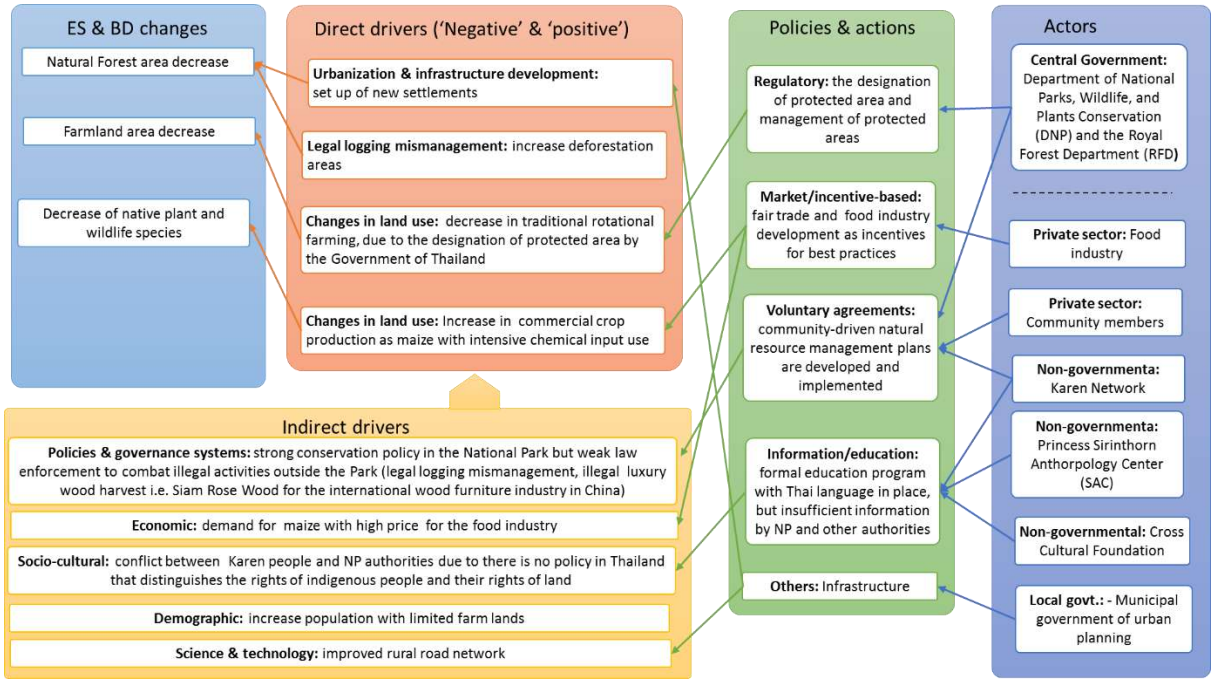


Figure 4. Ecosystem governance structure in the landscape of the Karen communities

3.1.5 Interplay between the values, traditional knowledge and governance

The study identified the interplay between values, traditional knowledge and governance contributing to the sustainable forest and agricultural land management and use, and conservation of biodiversity and ecosystem services as shown in Table 9. The results show that current policies constraint on community forest uses and reduce rotational farmlands. Conservation approaches must recognize Karen people' customary tenure and include local communities to manage the forest and farmlands as win-win solutions in conversion. The study shows that Karen people belief in spirits and gods and their traditional knowledge was used to conserve the sustainable forests and agricultural land management.

Table 9. Interplay of values

Ecosystem type	NCPs	Traditional knowledge	Governance: Stakeholders and issues
Natural Forest and Protected Forests	• Habitat creation and maintenance • Learning and inspiration	• Local knowledge on the use of land and resources within forest reserves and protected areas • Belief in spirits and gods were used to conserve the forests	1) The Department of National Parks, Wildlife, and Plants Conservation (DNP) **Main issue:** Development of policies for biodiversity conservation and forest management 2) The Royal Forest Department (RFD) **Main issue:** Promoting community-based forest management
	Regulation of freshwater quantity, location and timing	Belief in spirits and gods were used to conserve the watershed	Community groups **Main issue:** There was an agreement of public water using and management among communities
Rotational farming	• Habitat creation and maintenance • Pollination and dispersal of seeds	Local knowledge for conserving wild animals-insects(bees), and planting native plant species	The Karen Network for Culture and Environment (KNCE) **Main issue:** Promotion of slow food and conservation of biodiversity and ecosystem from Karen's traditional rotational farming system
	Formation and protection of soils	Local knowledge for maintaining soil and applying organic fertilizers and pesticides	Karen communities, Local Scientists **Main issues:** Sustainable farming system recognized by scientists of Chiang Mai University
	Medicinal plants and genetic resources	Local knowledge on medical herbs	Spiritual leader, Medicine man, Elders of communities **Main issue:** Traditional knowledge of using of herbs for treatment someone has been bitten by poisonous snakes, stomach wounds, and etc.
	Food and feed	Local knowledge on native plants and fruits, hunting wild animals (rats, wild pigs, wild birds)	Karen villagers (Male) **Main issue:** Traditional knowledge of making tools from woods for trapping rats and birds in the rotational farming
	Materials and assistance	Traditional knowledge on weaving	Karen villagers (Female) **Main issue:** Traditional knowledge on use of herbs and natural materials to color yarn and fabric
	Learning and inspiration	Their sharing of the local knowledge from old to young by using songs and folktales	The Princess Sirinthorn Anthorpology Center (SAC) **Main issue:** Establishment of the Karen special cultural zone The Cross Cultural Foundation **Main issue:** Improvement the Karen's education system in the Karen's communities

Note: the forest area of three communities are Research Forest (Pa Sanguan) under Forestry Department; only some part of Khun Tae farming area is in a national park.

3.2 Colombia: "Reconciling biodiversity conservation and agricultural production in agroforestry cultivation systems in the Colombian Andes"

In *Los Yariguíes* landscape in the Eastern Colombian Andes diversified agroforestry systems with cacao and coffee coexist within with fragments of natural and planted forests used to varying degrees, agroforestry schemes including fruit trees and cattle pastures. These production landscapes harbor a diverse fauna and flora and provide essential ecosystem services, but are threatened by agricultural intensification, conservation strategies, coal mining, post-conflict rural development and global market pressures. Within the landscape, located on the north-western slopes of the Yariguíes mountain range, lies the micro-watershed of *Las Cruces*, which constitutes the area of the GEF-Satoyama project conducted by Universidad Industrial de Santander (UIS) in the municipality of San Vicente de Chucurí, Department of Santander, Colombia (**Figure 5. Project area map**). The following section is based on the results of the questionnaire survey responded by individual researchers at UIS, but also the findings of a field study including key informant interviews and focus group discussions conducted in May 2017 and a review of complementary literature.

Box 4. UIS project overview

UIS is conducting the GEF-Satoyama project titled "Reconciling biodiversity conservation and agricultural production in agroforestry cultivation systems in the Colombian Andes" in the micro-watershed of Las Cruces which is dominated by cacao and coffee production of national importance and lies in the buffer zone of the Serranía de los Yariguíes National Park (PNSY).

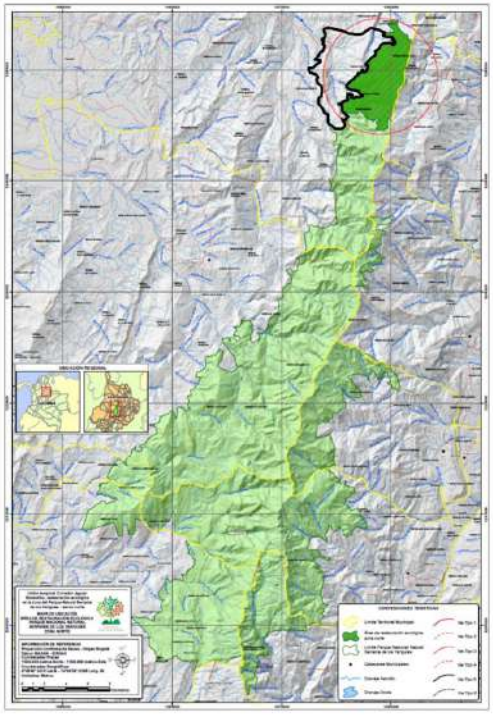
The landscape harbours a high level of biodiversity and endemism. The project aims to contribute to the conservation of these biodiverse production landscapes by: (1) identifying existing management strategies reconciling biodiversity conservation and ecosystem service provisioning with agricultural production and (2) Converting the autochthonous tacit knowledge about managing these diversified agroecosystems into explicit expert knowledge using a participatory approach. Through that the project aims to empower the local community to not only conserve their knowledge and meet future challenges, but also share it and inspire the emerging population of post-conflict farmers in Colombia.

3.2.1 Description of landscape/seascape and project overview

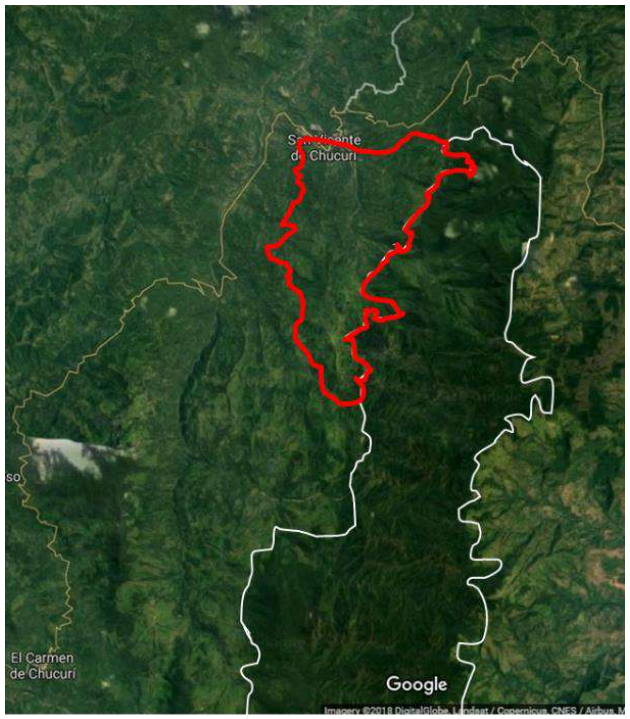
The wider landscape known as Los Yariguíes, named after the indigenous people who inhabited this landscape until the end of the 19th century is located in the central part of the Department of Santander in the North-West of Colombia. The landscape is shaped by the Serranía de los Yariguíes mountain range, which stretches from North to South and the parts of which with a higher elevation form part of the National Park (NP) Serranía de los Yariguíes (green areas, **Figure 5b**). With an average annual precipitation of over 2,000 mm, the western slopes are part of the municipalities of San Vicente de Chucurí and El Carmen de Chucurí and share similar geographic, climatic and socio-ecological features.

The socio-ecological production landscape that is subject of this case study is the micro-watershed of micro-basin (microcuenca) of the Las Cruces stream within the municipality of San Vicente. The SEPLS of Las Cruces is located in the northern part of the western slopes of the Los Yariguíes mountain range (Las Cruces micro-basin in **Figure 5c**), area with the black borders in Figure 5a and red borders in Figure 5b) and hosts the project area of UIS' GEF-Satoyama Project. The natural vegetation of these slopes is pre-mountainous humid forest as predominant natural ecosystem between 1,150 and 1,550 m.a.s.l. (Olaya, E., Velosa, R., Rodriguez, A., Bueno-Castellanos, J., Holguín, 2010, 75). The far

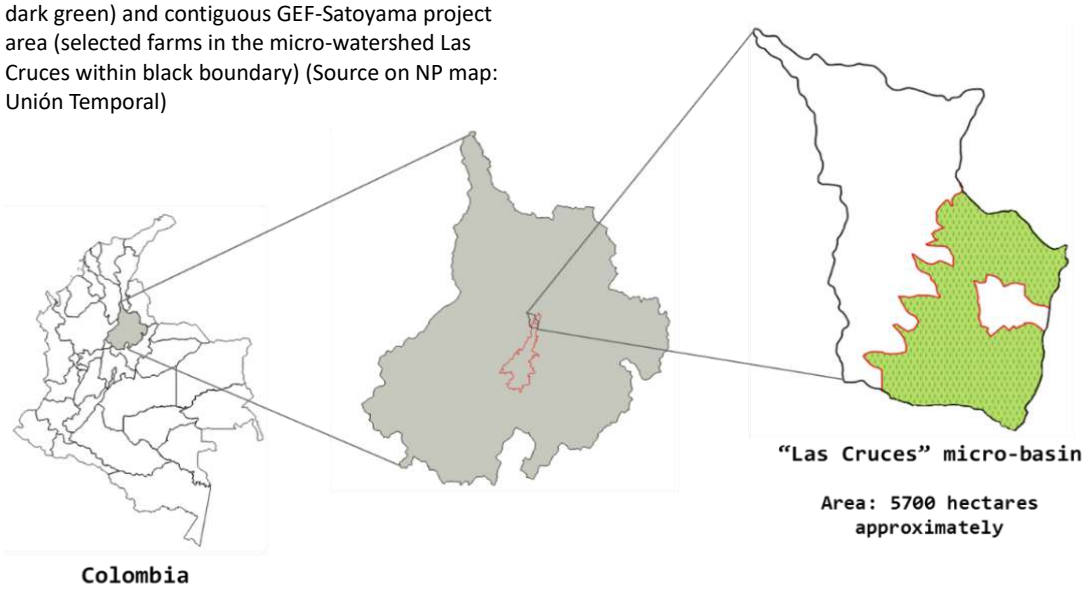
eastern area of San Vicente hosts the western part of northern tip of the National Park (NP) Serranía de los Yariguíes (area highlighted in dark green), which was declared in 2005 and which has a total of 59,063 ha.



a. National Park Serranía de Los Yariguíes (green colour, including the northern renaturation area in dark green) and contiguous GEF-Satoyama project area (selected farms in the micro-watershed Las Cruces within black boundary) (Source on NP map: Unión Temporal)



b. Micro-watershed Las Cruces outside the National Park (red boundary)



c. Map of Las Cruces micro-watershed: The red circled area indicates the Natural Park, and the green highlight area the NP fragment within the micro-watershed (Source: Tatiana Rodrigues)

Figure 5. Project area map

The micro-watershed of Las Cruces (hereafter 'Las Cruces') has a total approximate area of 5,700 hectares, out of which 2,200 ha are located within the National Park Serranía de los Yariguíes and consist of near natural forests and secondary forests in regeneration (Fundación Natura 2012). The rest of the micro-watershed (approx. 3,300 ha) forms the socio-ecological production landscape (SEPL) described in this paper and within which UIS' project activities have taken place. It consist of diverse ecosystems (**Figure 5c, Table 10**), including small-scale agroforestry schemes producing cocoa, coffee and fruits as well as grassland, forest fragments, settlements and freshwater bodies (Online survey).

The town San Vicente de Chucurí, which has an extensive municipal area that Las Cruces is only a fragment of, was founded in 1887 and was gradually colonized by settlers in the following decades. The recent armed conflict, which lasted more than 50 years, forced the displacement of the rural inhabitants. While San Vicente had over 54,000 inhabitants in 1985, its population started to decline reaching a minimum of less than 32,000 people between 1993 and 1998. It experienced a demographic recovery reaching 34,881 inhabitants in 2015 (DANE, 2015), as many farmers have returned.

Table 10. Main ecosystems in the Micro-watershed Las Cruces (Source: Fundación Natura 2012)

Ecosystem	Features	Estimated Area (ha)	Trend in area
Natural/ protected forest	Near natural forests and secondary forests in regeneration, within National Park Serranía de los Yariguíes	2,200	Substantially increasing
Managed/ resource forest	Agroforests with cacao and/or coffee, often polycultures with fruits and fragments of secondary forest	~500-1,000	Increasing
Farmland (cropland)	Fruit orchards, vegetables and crops: 15 ha (2 - 96 ha) seized farms, including fragments of pastures, agroforests and forest	1,600	Decreasing
Grassland/ rangeland	Cattle pastures as well as silvo-pastural schemes with NCPs (soil protection, water regulation, biodiversity conservation)	~800-1,000	Decreasing
Waterbodies	3 main streams: Quebrada Las Cruces, Quebrada la Seca, Quebrada La Verde	16	No change
Settlement/ urban	Includes urban area of San Vicente (approx. 127 ha) with green areas, such as Parque Munincipal de Miraflores	140	Increasing
TOTAL		5,700	-

3.2.2 Values

All ecosystems in the landscape fulfil a series of ecosystem values or nature's contributions to people (NPCs). The communities in the landscape of the UIS project attribute a series of values to the different ecosystems found in the area. The information obtained from the online survey, informant interviews and focus group discussions has been complemented with information available from studies that have been conducted in the landscape of UIS' GEF-Satoyama Project area.

Figure 6 illustrates the linkages between the ecosystems identified by the project implementer (UIS) in the landscape and the NCPs each of these provide in the understanding of UIS (online questionnaire survey). A key finding is that both the natural and managed forest ecosystems (B1 and B2) provide the largest number of values or NCPs – largely the same ones, even though to varying degrees (**Table 11**). The table also clarifies that different stakeholders, e.g., farmers, local development authorities, water suppliers, women and school teachers associate different values with the SEPLS.

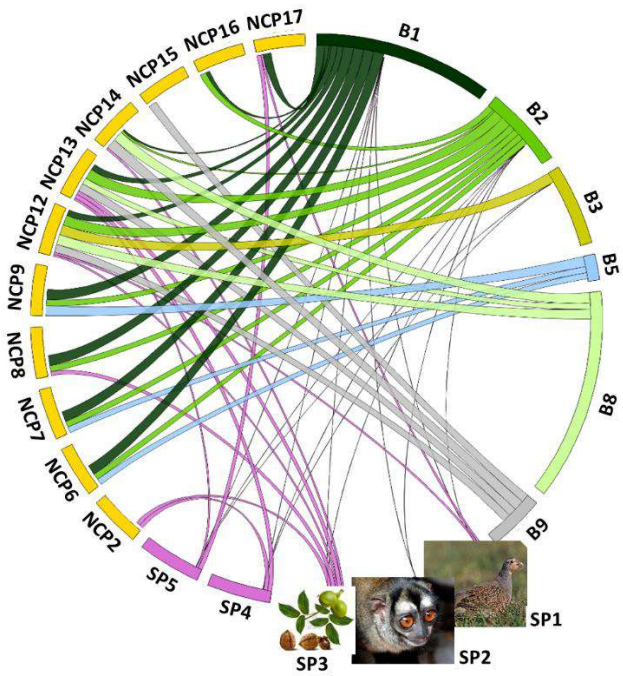
The provision of "food and feed" is the only NCP that all ecosystems contribute to, which stresses the socio-ecological importance of this landscape in addition to its ecological importance in terms of biodiversity conservation. Grassland (B3) is the ecosystem that provides the least NCP according to UIS, specifically the NCP of "food and feed". The number of NCPs is higher in the case of silvo-pastural schemes: soil protection, water regulation and biodiversity conservation. **Figure 6** also shows the

relevance of the species of flora and fauna identified as particularly important for the local community by UIS. Of these, the walnut, *Juglans neotropica* (SP3), contributes to the largest number of NCPs.

The role of animals for *pollination* (bees, butterflies, other insects), and *dispersal of seeds* (bats) is recognized by the farmers and other community members interviewed during the survey. Commonly found insects include wasps and ants (Interview with farmer L). Another important NCP is r*egulation of climate* as air quality and the microclimate of the western slopes of the *Los Yariguíes* mountain range, which is characterized by regular rainfall, frequent fog, lack of drought conditions and high evapotranspiration. A range of NCPs are subsequently presented in detail, including habitat provision.

Table 11. Nature's contribution to people (NCP) in the natural forest and agroforestry ecosystems

NCPs	Natural forests	Agroforestry	Source
1. Habitat creation & maintenance	Endangered and vulnerable species, included undescribed ones, e.g. *Odontophorus strophium* (EN), *Juglans neotropica* (EN), *Caryodaphnopsis* (undescribed), *Magnolia* (undescribed), *Aotus lemurinus* (VU); *Tremarctos ornatus* (VU); etc. Wildlife not perceived as a NCP by some farmers	Mammals (Armadillo, porcupine, anteater, bat, agouti), birds, insects, reptiles, amphibians, etc.	Farmers, women's organization, FedeCacao, high school
2. Pollination & seed dispersal	Facilitation by animals of pollination (bees, butterflies, other insects), and dispersal of seeds (bats) [Farmers]		Farmers
3. Regulation of air quality	Regulation of CO2/O2 balance: Forests recognized as a 'lung'	More limited than in natural forests	Women, high school
4. Regulation of climate	Microclimate (western slopes of Los Yariguíes mountains); regular rainfall, frequent fog, lack of drought conditions, etc.		Farmers, FedeCacao
5. Regulation of freshwater quantity, location & timing	Recognition that forests provide pure water. Water springs (located in NP) used for drinking water, occasional irrigation during drier periods and for coffee cherry washing and livestock.	More limited than in natural forests. Humid soil requires almost no irrigation.	Farmers, NGO Natura, Water supplier
6. Regulation of freshwater quality	Filtration of particles, pathogens, excess nutrients, and regulation of water quality (e.g. drinking water, coffee cherry washing)	More limited than in natural forests, but recognized	Farmers, Water supplier
7. Formation and protection of soils and sediments	Sediment retention and erosion control on slopes Soil formation & maintenance of soil structure & processes: local soil not very fertile, but with moderate to high contents of organic materials Cocoa growing contributes to soil improvement Degradation or storage of chemical and biological pollutants in soils		Farmers, Women, FedeCacao, NGO Natura
8. Regulation of hazards and extreme events	Some mitigation of impacts on humans or their infrastructure caused by e.g. hazards (floods, landslides, avalanches) wind, storms, droughts	More limited than in natural forests, but recognized	Farmers NGO Natura
9. Regul. of detrimental organisms	Regulation of pests, pathogens, predators etc. that affect humans, plants and animals		Women
10. Energy	Production of fuelwood, electricity (Hydropower)		Farmers, JAC
11. Food and feed	Honey, food (jams, jellies, beverages) from edible wild fruits (blackberries, *Madroño* [*Garcinia madruno*]) and tubers (yucca) Game through hunting or poaching Feed for domesticated animals	Food from managed/ domesticated organisms, e.g., cocoa, coffee, fruits, eggs, cattle, fish, poultry, dairy products (milk)	Farmers
12. Materials and assistance	Production of materials from organisms in forest and agroforestry ES for: Construction (bamboo, wood) & ornamental purposes Direct use of living organisms for decoration (ornamental plants), company (pets), transport and labour (incl. herding, guidance, guarding)		Farmers, FedeCacao
13. Medicinal & genetic resources	No indigenous knowledge about medicinal herbs, but some plants used for medicinal purpose, e.g. infusion from bark to reduce fever (*Madroño*)	Some plants used, e.g. *Artemisia*: mosquito repellent	Farmers
14. Learning & inspiration	Provision for education (school project) Acquisition of knowledge and development of skills for well-being, scientific information, and inspiration for art		High school students, NGO ProAves
15. Physical and psychological experiences	Eco-tourism, including birdwatching in ProAves reserve for national and international tourists. Relaxation, recreation, aesthetic enjoyment, hiking, birdwatching, hunting, poaching	Cacao tourism Aesthetic enjoyment Gardening Bird watching	High school students, women, NGO ProAves
16. Supporting identities	Landscape as basis for religious, spiritual & social experiences. Opportunities for people to develop a sense of place; source of satisfaction Basis for narratives and myths, celebrations, habitats, species or organisms		Farmers, FedeCacao



Ecosystem domain (dark green, green, ochre, blue, light green)
B1: **Natural/protected forest**
B2: **Managed/resource forest**
B3: Grassland /rangeland
B5: Freshwater wetland
B8: Farmland
B9: Settlement/Urban

Important species (purple)
SP1: *Perdiz santandereana* / Gorgeted wood quail (*Odontophorus strophium*)
SP2: Gray-bellied night monkey (*Aotus lemurinus*)
SP3: *Nogal* / Colombian walnut (Juglans neotropica)
SP4: *Panela quemada* (*Caryodaphnopsis* [undescribed])
SP5: *Molinillo* (*Magnolia resupinatirolia*)

Ecosystem services (NCP) (yellow)
NCP2: Pollination and seed dispersal
NCP6: Freshwater quantity, flow and timing regulation
NCP7: Freshwater and coastal water quality regulation
NCP8: Soil formation, protection and decontamination
NCP9: Hazards and extreme events regulation
NCP12: Food and feed
NCP13: Materials and assistance
NCP14: Medicinal, biochemical and genetic resources
NCP15: Learning and inspiration
NCP16: Physical and psychological experiences
NCP17: Supporting identities

Figure 6. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.2.1.1 Habitat provision for threatened species of flora and fauna

The two main ecosystems for the habitat provision for threatened species of flora and fauna in the Las Cruces watershed are natural forests and, to a lesser degree, managed forests including agroforests. The natural forest ecosystem on the western slopes of the Los Yariguies range is pre-montane, humid forest (Bosque húmedo premontano): 800 – 1,800 masl, which includes two biomes in Las Cruces: subandino and andino (**Figure 7**). Both are very rich in tree species some of which are rare as a result of a high degree of human intervention. An important tree in the higher altitude is the Pink trumpet tree or *roble* (*Tabebuia rosea*), which is key for the habitat of the Spectacled Bear, which feeds on its fruits. Highly appreciated for their timber are *punte* (*Aniba perutilis*), *anime* (*Protium aracouchini*), *móncoro* (*Cordia gerascanthus*), *cedro carmín* (*Cedrela odorata*) and *sapán* (*Chianthratropis brachipetala*). The natural forest ecosystem hosts at least two rare undescribed tree species and an endangered tree species identified by UIS researchers (**Table 12**).



Figure 7. *Subandino* (left) and *andino* types (center) of pre-mountainous, very humid forest, and agroforest with coffee and banana

Table 12. Endangered or rare species in the ecosystems of (near) natural (or protected) forest and managed forest (agroforestry) in the micro-watershed Las Cruces

Classification	Endangered/rare species & IUCN category	Trend	NCP
Plants (903 vascular plant species counted in Los Yariguíes)	*Panela quemada* (*Caryodaphnopsis, undescribed*) (NE)	Decreasing	High quality timber Source of food for bees
	Molinillo (*Magnolia resupinatifolia* recently described by Aguilar-Cano et al. 2018)) (NE)	Decreasing	High quality timber Kitchen utility to grind chocolate bar Sense of place (ornamental tree)
	Colombian walnut or *nogal* (*Juglans neotropica*) (EN)	Decreasing	Medicine (herbalist) Extraction of poison for fishing Source of food for bees Source of nitrogen
Mammals (82 species counted in Los Yariguíes: 26 bats and 56 terrestrial mammals (CAS, 2017).	Gray-bellied night monkey (*Aotus cf. lemurinus*) (VU)	Not known	Aesthetic value (Ecotourism) Pet (Donegan, et al., 2014, 78)
	Spectacled Bear (*Tremarctos ornatus*) (VU)	Decreasing	Expression of sense of place Aesthetic value (Ecotourism) Poaching (Donegan et al., 2014, 78)
	Ocelot (*Leopardus pardalis*) (VU)	Decreasing	Aesthetic value (Ecotourism), hunting
	Puma (*Puma concolor*) (NT)	Not known	Aesthetic value (Ecotourims), hunting
Birds (501 species in Los Yariguíes and 346 species counted in Bird Reserve, out of which 13 are included in the IUCN Red List) (Interview with reserve representative)	Black Inca (*Coeligena prunellei*) (EN)	Not known	Aesthetic value (Ecotourism)
	Gorgeted wood quail or *Perdiz santandereana* (Odontophorus strophium) (EN)	Increasing	Hunting (food) Sense of place Aesthetic value (Ecotourism)
	Chestnut bellied hummingbird (*Amazilia castaneiventris*), endemic	-	Aesthetic value (Ecotourism)
	Cerulean Warbler (*Setophaga cerulea*)	-	Aesthetic value (Ecotourism)
Amphibians (31 species in Los Yariguíes)	*Rana Venenosa* (*Myniobates virolinensis*) (EN), endemic	-	-
Reptiles (26 species in Los Yariguíes)	*Talla Equis* (*Bothrops asper*)	-	-
	Coral (*Micrurus dumerilii*).	-	-

The fauna of *Serranía de los Yariguíes* is rich and abundant, including a number of threatened species, which are included the IUCN Red List 2017-2 (IUCN, 2017). The premontane forests support the world's largest remaining population of the critically endangered Gorgeted Wood-Quail (*Odontophorus strophium*). Montane forests also support the Mountain Grackle (*Macroagelaius subalaris* [CR]) and threatened mammals such as Spectacled Bear (*Tremarctos ornatus* [VU]). The presence of 82 species of mammals could be confirmed in the *Los Yariguíes* landscape: 26 bats and 56 terrestrial mammals (CAS, 2017). Two of the species are endemic within the context of Colombia: grey bellied night monkey (*mico nocturno andino*, *Aotus cf. lemurinus*) (VU), and a squirrel known as *ardilla run-*

cha (*Microsciurus santanderensis*). With respect to birds, in the National Park 501 species have been counted, out of which 15 are endemic, and 14 are included in the IUCN Red List (2 CR, 6 EN and 6 VU) (CAS, 2017). One of the endangered species is the gorgeted wood quail (*perdiz santandereana*, *Odontophorus strophium*), as identified in the landscape by the GEF-Satoyama project implementer. 35 migratory species pass the area (T. M. Donegan et al., 2010). In ProAves' bird reserve, apart from the gorgeted wood quail, 346 bird species are found, including 13 IUCN listed birds, such as the endemic chestnut bellied hummingbird (Amazilia castaneiventris), white-mantled barbet (*Capito hypoleucus*), parker's antbird (*Cercomacra parkeri*), and Cerulean Warbler (*Reinita Cielo Azul*, *Setophaga cerulea*).

Not all stakeholders perceive habitat creation for wildlife as an NCP. While some farmers, and particularly environmental NGO representatives and school children do appreciate the presence of wildlife, "some participants perceive wild animals as a problem rather than a positive matter" (Resilience assessment workshop). Many also see no benefit in having a protected area (ibid.)

Overall, the biological values are particularly high from natural forests in both the National Park and ProAves´ bird reserve. However, natural forests and agroforestry outside the National Park are also important for habitat maintenance. People appreciate the "very high agro-biodiversity" in their landscape (ibid). Many of the above tree species are used in *agroforestry systems* (**Table 11**): *Móncoro* and *balso blanco* provide shadow for cocoa and *cedro carmín* is used in both coffee and cacao plantations, but they are also planted for their timber, including a*nime*, which has a very good aroma. The fruit of *madroño* (*Garcinia madruno*) is mainly eaten in its natural form, but the pulp is used to elaborate jellies and juices. The infusion made out its bark is used to reduce fever (Farmer L).

While the National Park and bird reserve represent the main sanctuary of threatened species, rare species are also found occasionally in the agroforestry schemes, such as deer (*Mazama americana*), paca (*tinajo*, *Cuniculus paca*) Northern Naked-tailed Armadillo (*cola de trapo*, *Cabassous centralis*) and puma (*Puma concolor*). Still quite commonly found in agroforests and secondary forests are armadillo (Dasypus movemcintus), Central American agouti (*ñeque*, *Desyprocta punctata*), anteater (*oso hormiguero*, *Tamandua mexicana*), porcupine (*Coendou prehensilis*), common vampire bat (*murciélago vampiro, Desmodus rotundus*) and tayra (*Eira barbara*) (Interviews with farmers). Five of the 13 IUCN listed bird species are associated with the coffee agroforestry scheme (Interview with ProAves staff). Overall, while the biological values are particularly high from natural forests in both the National park and ProAves´ bird reserve, managed forests and agroforests outside the NP are also important for habitat maintenance.

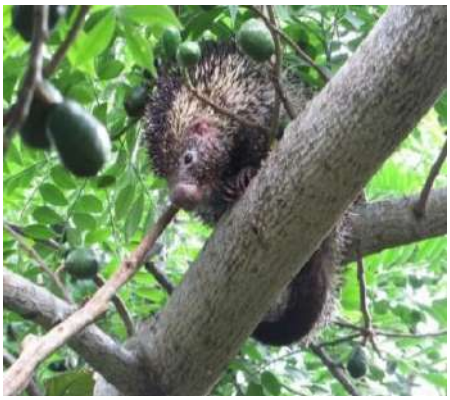


Figure 8. Porcupine on avocado tree in agroforest system

3.2.1.2 Regulation of freshwater quantity and quality

At least 68 rivers and streams emerge in *Los Yariguíes* mountain range. Many supply the municipal water systems of San Vicente de Chucurí, including the El Chucurí River and the Quebrada (mountain stream) Las Cruces. *Quebrada Las Cruces* is the main water source of the aqueduct supplying the urban area of San Vicente. Its spring is inside the National Park *Serranía de los Yariguíes*.

Stakeholders recognize the importance of freshwater provision through the mountain streams as main waterbodies. However, the contribution to hazard reduction is less clear. The areas is affected regularly by intense rainfalls, which have led to landslide and flash floods in 2005, 2009 and 2011. As a result, the farmers perceive both benefits and danger from the freshwater ecosystem. The contribution of the forest ecosystem to the mitigation of hazard risks and to regulating freshwater quantity and quality was traditionally less perceived (Resilience indicators assessment). Awareness of the importance of properly managing the mountain streams including their shores and riparian forests increased with the launch of a payment for ecosystems services (PES) scheme known as ARA in 2009 (see below).

3.2.1.3 Formation and protection of soils and sediments

The landscape provides two main ecosystem services with respect to the soil:

- Sediment retention and erosion control (steep slopes)
- Soil formation & maintenance of soil structure & processes (very fertile, rich in nitrogen)

On the western slopes of *Los Yariguíes* mountain range, the slope gradients usually range between 25% and 50%, and occasionally over 50%. The soils have a low level of evolution (tropepts and orthents) and are well drained, superficial to moderately deep (Mantilla Blanco, Argüello Angulo, & Méndez Aldana, 2000), and susceptible to erosion (interviews with farmers). It is estimated that 60% of the soils are extremely acid (pH lower than 5.5), and 40% are classified as moderately to slightly acid (pH 5.5 to 6.5). The content of organic materials is low (less than 1.9%) on 19% of the soils, medium (2.0-2.6%) on 30% and high (more than 3.0%) on 51% of the soils (ibid). In conclusion the soil fertility is sufficient to grow a variety of crops, including cocoa and coffee, but to achieve higher yields the application of fertilizers Is required (Interview FedeCacao).

3.2.1.4 Food provision

Both natural and managed forests provide some food sources, particularly honey but also edible wild fruits (e.g. blackberries, *madroño*) and tubers (yucca). Managed forests may include fruit production under agroforestry besides the typical cocoa and coffee production. Many of the cultivated fruits, including cocoa, and some wild fruits are used to make jams, jellies, wines.

The principal ecosystem for food provision is farmland, usually coffee and cocoa plantations fruit orchards and vegetable fields. Cocoa and coffee are traditionally grown under agroforestry or with other fruit trees such as avocado, which used to be the main fruit produced in San Vicente earlier, or citrus trees, which provided shadow conditions (‘*sombrío’*). However, while the ideal farm includes other crops apart from cocoa, it is not required to grow all together as a ‘stew’ (‘*sancocho*’), but it is preferable to plant different fruit trees separately (Interview FedeCacao). Most farms in *Las Cruces* are farms are low-intensive in the use of chemical inputs, as farmers traditionally use little and mainly organic fertilizers. The highest production is around 1,200 kilos per hectare, which is still profitable. If the production is 1,200 kilos per hectare a farm with 4 hectares can only be profitable if all family members are involved in its management (ibid). For both sale and subsistence, the farmers produce mainly citric fruits and tropical fruits including avocados, and in higher elevation blackberries, as well as a range of different vegetables. Additional food products are obtained from other ecosystems, such as eggs and poultry in settlements, cattle and dairy products (milk) on grasslands, and fish from freshwater bodies (ponds).

3.2.1.5 Physical and psychological experiences, including ecotourism

Physical and psychological experiences are particularly linked to the ecosystems of natural forests, managed forests and farmland. For both natural and managed forests farmers, both male and female, and high school students, including urban and rural, mainly mentioned relaxation, recreation, aesthetic enjoyment, hiking and birdwatching. In the natural forest hunting is another experience practiced either by some landowners or illegally as poaching by others.

In terms of tourism the landscape is already a known destination for cocoa – and particularly chocolate – production, but without reaching yet its full potential. The products of the region include "Chocolate Chucureño" (Chucurí chocolate and hot chocolate) and "Café Chucureño" (Chucurí organic coffee). An experimental cocoa farm managed by FedeCacao is open to visitors. Ecotourism in the landscape exists, but is still rather limited considering the potential for observing nature and wildlife near or in the National Park (NP). San Vicente has additional ecotourism attractions, such as:

- The forests and mountains of *Los Yariguíes* and their threatened fauna and flora;
- The *Camino de Lenguerke*, a historic stone trail built in the 1800s, which leads through the NP;
- The indigenous history and artefacts of the region, some of which are within San Vicente town; and
- San Vicente and other old towns surrounding the mountain range with colonial architecture.

Ecotourism is best possible in a privately owned bird reserve managed by the NGO ProAves (below). The reserve is named Reinita Cielo Azul after one of the threatened bird species, the Cerulean Warbler Bird, and currently covers 207.6 ha of tropical rainforest. Its altitudinal range is between 1600 to 2500 m.a.s.l. It was the first reserve in Latin America established specifically for the protection of migratory birds as an Alliance for Zero Extinction (AZE) site in 2005. Most of the reserve is located within the National Park. Camera traps in the reserve have also photographed the endangered or rare mammals such as the spectacled bear and the puma. The reserve is largely natural forest but includes a small coffee plantation under agroforestry, which partly sustains the expenses of maintaining the reserve. The reserve is visited by tourists, who generally come from outside the landscape and are able to afford staying overnight at the accommodation of the reserve. Most of the tourists are foreigners, which has let locals to believe that that the reserve is "reserved" for foreigners. Moreover, some locals even believe that the reserve wants to capture their oxygen. ProAves is countering with communication efforts to reduce prejudices and raise environmental awareness (Interview ProAves).

3.2.3 Traditional knowledge

Traditional knowledge was lost with the end of indigenous settlements in the area. Local knowledge exists, particularly on tree species, and animals affecting crops (Key informant interviews). In line with Berkes' framework (see methodology section), the following subsection presents the local knowledge of land, animals, plants, soils and landscape and the local knowledge on the land and resource management systems, as well as the social institutions and world view of the community.

3.2.1.6 Local knowledge of land, animals, plants, soils and landscape

Farmers, both male and female, are the key knowledge holder, having local empirical knowledge with respect to most of the NCPs found in the landscape (**Table 13**). They generally have knowledge of:

- Local names and habits of wild fauna, particularly the most emblematic endangered species found usually in the NP area but occasionally also in managed forests, including agroforests.
- Pollinators (bees, other insects and bats), as many farmers produce honey
- Watershed dynamics, including differential water flow rates per stream
- Chemical water characteristics, including its color and indication about the mineral contents

- Soil erosion and unstable conditions that can lead to landslides
- Soil fertility and the specific soil requirements of crops
- Diseases that affect crops and how to control these
- Taxonomy and demography of useful trees, and its pollination and seed dispersal features.

Farmers have more limited knowledge on the use of small wild plants, including herbs and edible wild fruits and tubers. This includes the production local beverages, jams, jellies from wild fruits and the uses of wild fauna as game. Blackberries are mostly cultivated in higher elevations. Medicinal property of trees, e.g. infusion made from the bark of *madroño* (Garcinia madruno). Farmers are able to recognize many birds through their sounds. Many urban dwellers have knowledge of recreational spots and local trails including for hiking (Interviews). There are local guides, who have knowledge on species' names. Hunters and poachers have local empirical knowledge on the animals they hunt (online survey). The wild fruits of molinillo (Magnolia sp.) are used as a kitchen tool, especially to grind solid chocolate when preparing hot chocolate (Figure 9).

Figure 9. Molinillo tool (for chocolate grinding)

3.2.1.7 Local knowledge of land and resource management systems

Farmers, both male and female, have local empirical knowledge of land and resource management systems that are relevant when obtaining benefits from nature in terms of:

a) Regulation of freshwater quantity and quality: Aqueducts and their maintenance, sewer systems
b) Formation & protection of soils and sediments, particularly by the complex agroforestry schemes
c) Food and feed: The farmers have knowledge of the diverse agroforestry schemes for the production of coffee, cocoa or diverse fruits, such as the optimal shadow conditions and possible impacts of trees on the crops in terms of water and nutrient competition. Farmers also know how to rear livestock in silvi-pastoral schemes, including some veterinary skills (online survey). Farmers also have knowledge of organic cultivation and pest control methods on their farmland.
d) Materials & assistance: Production and use of locally sourced wood in construction and as fuelwood.

3.2.1.8 Social institutions and World view

Local communities have local knowledge and the practice of organizing in both formal and informal groups for the management of common resources in their community, including the provision of social support as a safety net. These groups also have skills in infrastructure development and maintenance, complementing the municipal authorities. In terms of their world view, ILK is linked to two NCPs:

a) Physical & psychological experiences, particularly spiritual experiences and religious traditions: These include knowledge, myths and legends related to unusual growth of water levels and avalanches (online survey), but also features of rare animals/plants (e.g. *Toxicodendron striatum*).

b) Supporting identities: The social, economic and ecological features of the landscape provide local people with a sense of both place and pride, e.g. the production of cocoa, chocolate, avocados and coffee. This is also true for the most emblematic endangered species. Social traditions and festivities are important as a source of identity and satisfaction.

Table 13. Summary of ILK and ILK holders associated with ecosystems and important species (based on online survey)

Ecosystem / Species	ILK: Domain	ILK: Description	Trend	ILK holders: Hunters	Loggers	Farmers	City dwellers
2.Managed/ resource forest	1.Knowledge	mainly of timber species and animals used by hunters	↓	○		○	
		Medicinal properties of trees	↓			○	
		plant taxonomy and demography of useful trees, and its pollination and dispersal syndromes	↓	○	○	○	
3.Grassland /rangeland	1.Knowledge	how to grow livestock and food for their animals	→			○	
		how to heal animals	→			○	
5.Freshwater /inland waterbodies	1.Knowledge	watershed dynamics, differential water-flow rates per stream	→			○	
		physical-chemical characteristics of water (explanations about the color and minerals on it)	↘			○	
	4.World view	Myths and legends related to the unusual growth of water levels and avalanches	→			○	○
8.Farmland	1.Knowledge	crops soil and temperature requirements	→			○	
	1.Knowledge 2.Mgt. system 3.Soc. Institutions 4.World view	Local empirical knowledge of pest management and Local environmental perception, summarized in Peasant Culture: Food, building techniques (including local timber), local beverages, social traditions, religious traditions.	→			○	
Molinillo	1.Knowledge	identification and taxonomy of the specie, seed nursing, seedling requirements, trees demography and fruit processing as kitchen tool	↘			○	
Nogal	1.Knowledge	identification and taxonomy of the specie, seed nursing, seedling requirements, trees demography and wood processing	↘			○	
Panela quemada	1.Knowledge	identification and taxonomy of the specie, seed nursing, seedling requirements, trees demography, wood processing and house and fence building using this wood	↘			○	
Perdiz santandereana	1.Knowledge	habits and daily activity, preferred food sources, reproductive biology and demography. (because was a highly hunted specie in the past)	↘			○	
		Specie recognition through the bird sound as a scientific level	→			○	

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

Knowledge of the forest (natural and managed) ecosystems and their components and uses is decreasing, but not the knowledge on other ecosystems (farmland, grassland and waterbodies). The reasons for the loss of ILK with respect to forest ecosystems include the decrease in rural population and changes in ways of life, which reduces the intergenerational knowledge transmission.

3.2.4 Governance

Three levels of governance are relevant for the management of ecosystems in Las Cruces:

1) the national level: Central government, particularly the management of the National Park
2) the subnational level: particularly the environmental agency Autonomous regional corporation of Santander (*Corporación Regional Autónoma de Santander* - CAS); and
3) the local level, which comprises the local administration of the municipality and the ward level: civil society organisations, particularly the community associations.

Figure 10 presents an overview of the ecosystem governance structure including the main actors and their main forms of interaction in *Las Cruces* micro-watershed within the landscape.

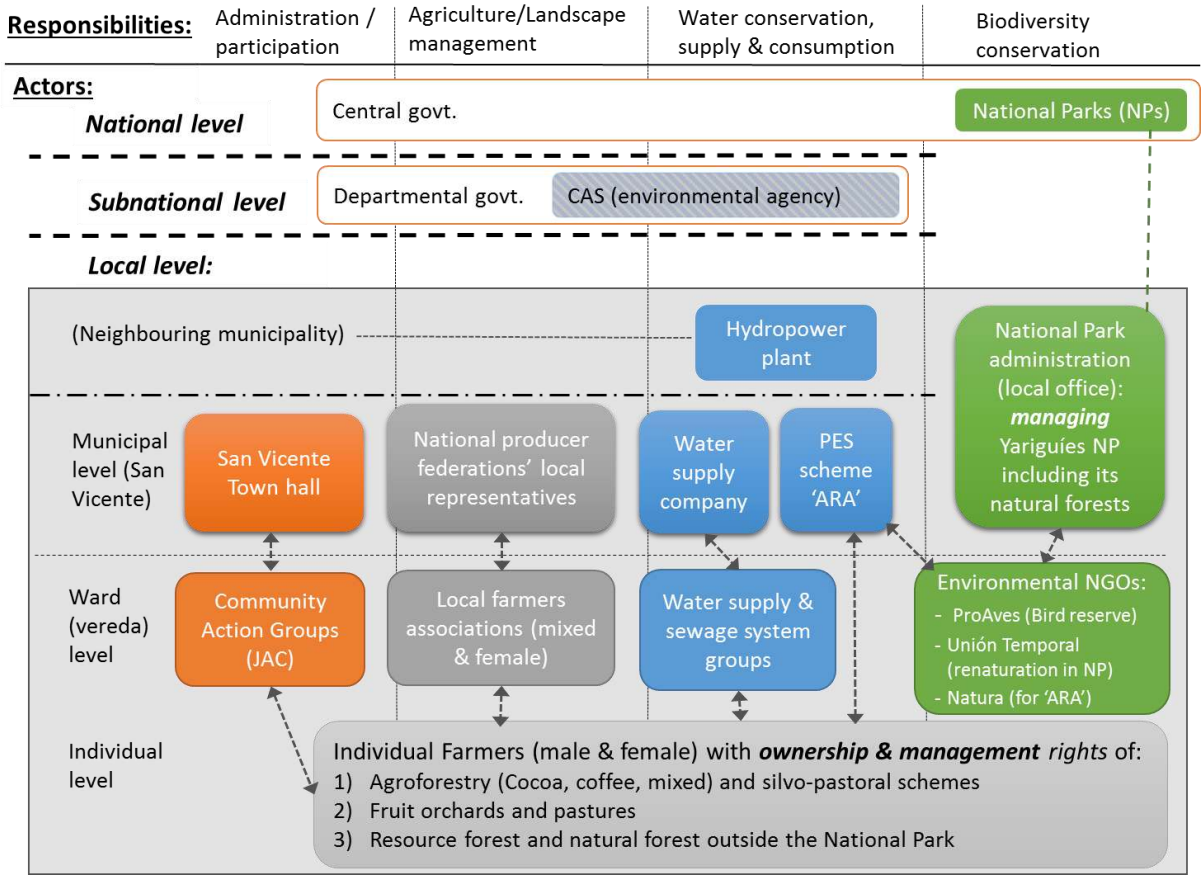


Figure 10. Ecosystem governance structure in the micro-watershed *Las Cruces*, *Los Yariguíes* landscape (Own elaboration with contribution from Corina Buendía)

3.2.1.9 Key stakeholders

The key stakeholders of ecosystem governance in the SEPLS of UIS' GEF-Satoyama Project include:
- Farmers in the micro-watershed of *Las Cruces*, including landowners within the National Park
- Local community organizations in the watershed
- Representative of cocoa producers, including their federation and local growers' organizations
- National Park authorities: Parque Nacional de La Serranía de los Yariguíes (Local office in San Vicente)
- Environmental NGOs ProAves (dedicated to the conservation of birds and threatened flora/fauna) Fundación Natura (managing a payment for ecosystem services scheme known as 'ARA'), and Unión Temporal (undertaking National Park renaturation activities)
- Water supplier: APC *Manantiales de Chucurí* (Community owned private company)

The ownership and management rights of most of the farmland and forests are held by private farmers, except for the National Park, which is public land owned by the State and managed by the local NP office staff. The farmer communities participate in the public management of their landscapes through their Community Action Groups (Juntas de Acción Comunal - JCA) and Water Supply and Sewer System Corporations (Corporaciones de Aqueductos y Alcantarillados – CAA).

- *Community Action Groups (JAC) and Water Supply and Sewer System Corporations (CAA)*

According to Colombian law a "Community Action Group is a social organization […], not for profit, with solidarity purposes, the status of a legal person and its own assets, and is integrated voluntarily by the residents of an area, who join efforts and resources seeking integrated and sustainable development on the basis of participatory democracy" (Law 743/02, Art. 8, a.). There are seven JAC in the Project area, one for each major settlement outside the urban area of San Vicente. They are organized by their own statutes which elaborate on the general regulatory principles provided by *Asojunta* (*Asociación de Juntas de Acción Comunal*), the umbrella organization. The JAC consist of committees and have a president, secretary and treasurer. Regular member come together in general assemblies that take place regularly or as needed. Engagement in the JAC is voluntary, and the main motivation is "to help the local people" (Interview President L). In terms of gender representation, female participation is considerable, but most presidents are male. The JACs' main objectives and activities focus on the infrastructure development, such as the construction and maintenance of rural roads and improvements of settlements, including the provision of electricity access. The JAC are not dedicated to the management of natural resources. Another important role of JAC support to community members in need. Neighboring JACs typically collaborate and interact with the municipality in joint implementation of activities and sharing the costs. For any of their initiatives, the JAC need approval from the town hall, providing proof of available funding.

The CAA are responsible for the management of the aqueducts and play an important role in early warnings regarding possible landslides. Five corporations cooperate with the town hall and participate in the community-based water supply company (see below). The statutes of the CAA are stricter than the JAC's (Interview CG). Water management by the local communities is not free of conflict with the NP authorities. The CAA have a water concession for five years (previously 10 years), which will be renewed only if the CAA agree to install water meters. Currently the issue is with the town hall. The nearby private hydropower plant ISAGEN has supported local farmers with the provision of tools and fertilizers. However, communities see vested interests in ISAGEN's funding for land purchases by NP.

- *Water supply company: Administración Pública Cooperativa Manantiales de Chucurí*

The water supply company, *Administración Pública Cooperativa* (Cooperative Public Administration) *Manantiales de Chucurí* (APC) began to function in 2007 (Interview APC manager). This was possible after a change in legislation in Colombia, which allowed for the creation of community-based companies by local mayors. The legal status is of the APC is that of a private company, because it is owned by the community. For the foundation of the APC in San Vicente all major local stakeholders

were consulted, including five JAC, and representatives of traders, businesses, TV, radio, the fire brigade, etc. The APC now has 21 diverse member organizations, which are able to outvote the Town Hall. Before the community took control of the APC, users did not pay for the water, chlorine was not added to the water, and the water tubes were not well maintained. The APC introduced a payment scheme and secured a stable supply of water and to improve water quality partly through the below PES scheme ARA. The company can generate some profit but needs to reinvest in the community. The APC has supported projects proposed by the community, such as educational facilities, but also the provision of subsidies for the CAA, which manage the aqueducts in the upstream areas (ibid.).

- *PES Scheme 'ARA' (managed by Fundación Natura)*

Both the effects of a serious drought and disastrous flash flood in 2011 increased the recognition for the value of clean water and other ecosystem services, such as hazard control. The NGO Fundación Natura proposed the introduction of a payment for ecosystem services scheme, and concluded an agreement with the Town Hall of San Vicente on the *Programa Acuerdos Recíprocos por el Agua* (ARA – Programme for Mutual Agreements on the Water). Fundación Natura, the Town Hall and the APC work closely together in the Work Committee, which manages the PES scheme. ARA aims to promote the conservation of the forests in *Las Cruces*, in order to improve the regulation of the quantity and quality of the water for the urban center of the municipality. This PES scheme constitutes an initial effort of shared environmental responsibility of the institutions, the private owners of the land that important for the water regulation, and the beneficiaries of the ecosystem services. ARA has converted:

- Landowners to providers of environmental services, which they are aware of and committed to
- Institutions and the Municipal Town hall to agents responsible for financing the provision of environmental services for the water regulation of San Vicente
- Beneficiaries of the municipal aqueduct to funders of the system through a voluntary contribution, in exchange for the obtained environmental services (Inteview Fundación Natura).

Since its introduction, 59 landowner families have participated in ARA with 61 pieces of land based on individual agreements concluded since 2011. The farmers committed to keeping a belt of at least 30 meters on each side of the mountain streams under conservation. This includes allowing for the original vegetation to naturally regenerate and stopping deforestation. The landowners who participate do not receive cash, but a compensation for conservation in the form of supplies, such as organic fertilizers, seeds, materials for construction, tools or even septic tanks. As a result of ARA, the forested area has increased and the content of mud in the water has significantly decreased (ibid.)

- *Cocoa and coffee producer organisations and their initiatives*

The National Federation of Cocoa (*Federación Nacional de Cacaoteros* - FedeCacao) was established in 1960, responding to the need for an organization to represent and defend the interests of farmers nationwide. Overall cocoa grows on approximately 180,000 hectares in Colombia, an estimate based on the total national production of 56,000 tonnes. The membership fee is 3% of the cocoa produce sold to FedeCocoa, which goes into a National Cocoa Fund, which serves three purposes: Marketing, research (on agroforestry, genetic material, fertilizers, quality, diseases, etc.) and technology transfer. In terms of internal governance, the farmers elect their municipal representatives in an assembly every four years. FedeCacao has an office in San Vicente de Chucurí, which is known as the "national capital of cocoa", its main agricultural product.

In the municipality, around 3,500 cocoa producers are members of FedeCacao with a total area under cocoa cultivation of approximately 14,000 to 15,000 hectares. Cocoa producers with an area not less than half a hectare or at least 500 cocoa trees in full production are eligible to become members. Production in San Vicente is rather high at 800 – 3,000 kg per hectare, which is considerably higher than the national average of 400 kg/ha (Interview FedeCacao). The local FedeCacao collaborates with other stakeholders, including NP authorities and ARA in awareness raising of cocoa growers that the natural resources need to be well managed and conserved. FedeCacao conducts a series of activities

such as promoting good agricultural practices through the certification scheme *Buenas Prácticas Agrícolas* (BPA). BPA certifies proper management practices, an orderly production process and about determining the production costs, income and profitability. BPA certification serves as a first step in achieving certification, such as UTZ, Rainforest Alliance and Fair Trade. A few farms are certified as organic, but generally cannot achieve a price premium. However, some buyers would be willing to pay 10-15% higher prices for certified organic cocoa (ibid).

Apart from FedeCacao, local cocoa farmers organisations include Asocaviz, Fuinmucar and Aprimujer, a women's organisation. As an organisation representing women of farm households, *Aprimujer, the "*association for the integral promotion of rural women" *(Asociación Municipal para la Promoción Integral de la Mujer Rural)* was founded in 2000. The association now has 128 female members, all belonging to farm households that grow cocoa. The members usually sell their cocoa produce to the head office of Aprimujer, which in turn sells to FedeCacao. Aprimujer has contributed to women being more involved in cocoa cultivation and gradually benefitting more from the farm income. It has also promoted the production of jams, jellies and wines based on the mucilage of cocoa beans, and been active in motivating young people to continue with the farm activities of their parents. Aprimujer has received support from various organizations, including FedeCacao for capacity-building activities.

With respect to coffee, 160 farms are certified by the Rainforest Alliance (Interview with CG). The background is that many farms were contaminating the creek with pesticides and as part of the coffee cherry washing process. As part of the program, basins were constructed for the washing and gradual decomposition of the coffee cherries including a filtering process through several pits, to prevent the polluted water to reach and water flows. Farmers have to keep a natural barrier of 15-20 meters between their field and any stream. Once certified the farmers are able to sell their coffee as Rainforest Alliance certified with a slight price premium. Currently they are not obtaining a benefit from their certification (ibid).

- *National Park Administration Serranía de Los Yariguíes and environmental agency CAS*

The Colombian System of National Natural Parks is a national Special Administrative Unit without juridical personality but with administrative and financial autonomy and jurisdiction in all the national territory. The entity is in charge of the administration and management of the Systems of National Natural Parks and of the coordination of the National System of Protected Areas. The administration of the National Park (NP) Serranía de los Yariguíes has its office in San Vicente de Chucurí.

Colombian law (Decree 622/1977) prohibits implementation of agriculture, livestock rearing inside the national park areas. National Parks has developed a strategy of "sustainable systems for conservation", which consists of linking productive systems with biodiversity conservation activities. However, legally this strategy can only be implemented around, not inside the park area. Moreover, implementation of the strategy is less advanced in the case of the NP *Serranía de los Yariguíes* as compared to other NPs (Expert interview, 2017). As private farms constituted part of the area on which the NP was declared, the NP Administration concluded 22 land purchase agreements with farmers in Las Cruces. However, 14 private properties remain with the NP (Expert interview), as the owners have so far objected selling their land to the NP. Although the relationship with local communities in San Vicente is affected by issues such as restricted access and water use, in comparison to other areas of the NP and to other Parks conflicts are relatively small. For instance, in the south-west of the NP the drivers (illegal logging, poaching, deforestation, etc.) are higher (ibid.) The NP Administration has commissioned biologists organized in Unión Temporal to undertake renaturation activities on the former private farms.

The subnational environmental administration is highly centralized. The environmental agency Autonomous Regional Corporation of Santander (CAS) is in charge to support the implementation of policies, plans, programs and projects on the environment and renewable natural resources and implement legal provisions on their disposal, administration, management and use, as to regulations,

standards and guidelines issued by the Ministry of Environment. CAS has its office in Bucaramanga, the capital of the department, and their staff visit the municipality only occasionally. Farmers need to request special permits to extract wood of native species from their farms. This had led to conflicts with the CAS, which strictly controls the logging of native species (Expert interview).

- *ProAves NGO*

The environmental NGO ProAves is a Colombian organization, legally recognized since 2002. ProAves has 27 reserves in Colombia, three in Santander, including the above Reinita Cielo Azul.

3.2.1.10 Drivers

There are a series of drivers of changes in ecosystems and biodiversity in the landscape and policies in place to address these (**Figure 11**). A number of negative drivers have led to a significant decline and degradation of the typical agroforestry schemes in the landscape in the past decades. The main driver was the armed conflict, which displaced many rural inhabitants particularly in the 1980s and 90s. Since then some farmers have returned which has led to a demographic recovery. Other main direct drivers of ecosystem degradation include:

- Changes in land use due to the establishment of the National Park and farm abandonment
- Increasing demand for certain crops (coffee, cocoa) and decreasing local production of meat
- Urbanization and infrastructure development, despite rural abandonment
- Resource overexploitation (endangered plant and animal species for food and wood)
- Bad agricultural practices, including pollution of streams, e.g. due to coffee bean washing, erosion and soil degradation.

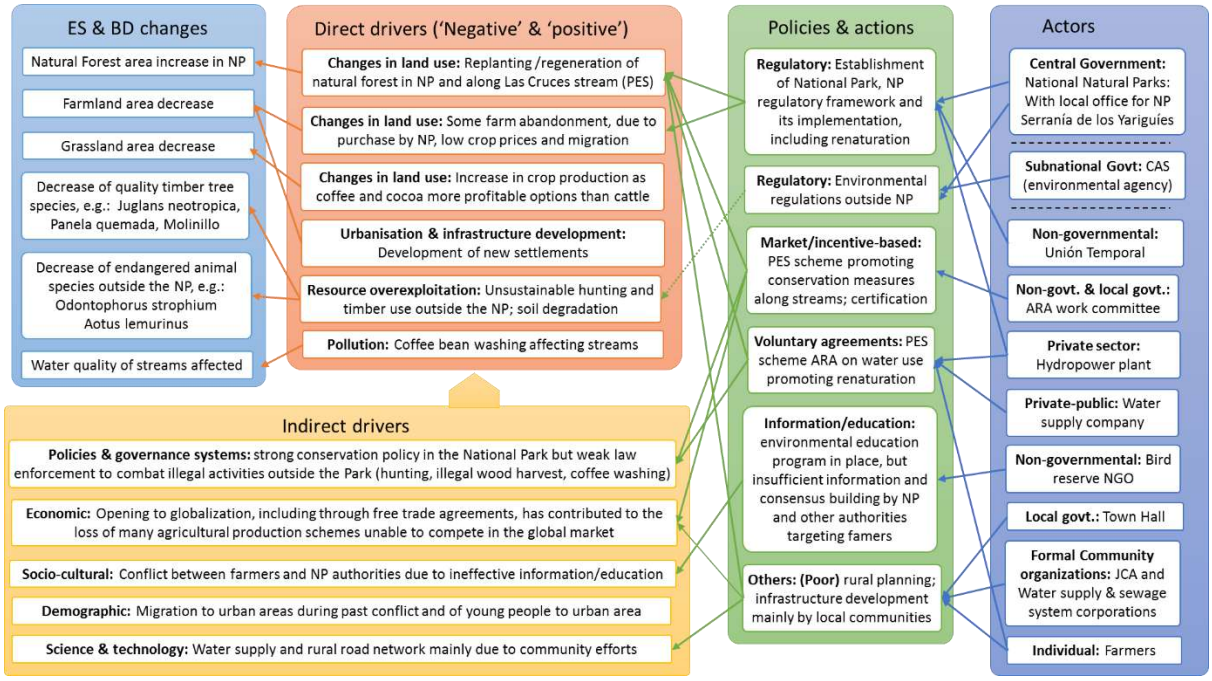


Figure 11. Configuration of the linkages between ecosystem degradation and species decline, direct drivers and the existing policies for targeting the drivers in the micro-watershed Las Cruces

Indirect drivers include:

- ***Policies and governance system:*** After the declaration of the National Park, the newly protected areas in higher elevations have experienced an increase in natural forest and biodiversity, because of reforestation and other renaturation measures on previous farmland. On the other hand, public environmental policies outside the NP on curbing illegal logging, hunting and re-

ducing pollution through coffee bean washing have been largely ineffective, partly given the lack of interaction between local communities and environmental authorities in the landscape. Initiatives by NGOs promoting the conservation of the forest along streams and environmentally friendly farming practices such as the PES scheme 'ARA' and certification schemes have been more successful in contributing to erosion control on slopes and the regulation of freshwater quantity, location and timing. The most difficult, if not conflictive, relationship in *Las Cruces* is between the local community, represented by the JACs and CAAs, and the National Park authorities as outlined above. This conflict is due to the restricted access to the Park, the pressure on the remaining landowners within the PA to sell their land and the control over the water sources from the NP area that the downstream communities use. Interviewees agreed that CAAs for the water issue but also JACs as broader community-based organizations have a potential key role in representing the community in any conflict settlement. While many local representatives of the NP office and environmental NGOs favor a more participatory approach to ecosystem management, a move in this direction would require a stronger commitment of the line agencies at the subnational/and or national level. Power struggles have also existed the management of the water supply company APC, but the recent involvement of local people in the interaction with the farmers has been key to reduce mistrust. Good interaction exists between the APC and National Parks, but interaction with the subnational environmental agency CAS is reported as poor (Key informant interviews).

- ***Economic***: Colombia's opening to globalization, including through free trade agreements, has also contributed to the loss of many agricultural production schemes, which were unable to compete in the global markets. A higher domestic and international demand for coffee and cacao production has led to a decrease of cattle rearing and the area of grassland. The increasing certification of cocoa and coffee plantations opens new opportunities for the farmers.
- ***Socio-cultural***: Mistrust of local communities, partly due to negative experiences with promises made by authorities and other external actors in the past, has been an important driver for in the delayed or ineffective implementation of projects and policies for ecosystem management. This includes initial obstacles in the introduction of the ARA PES scheme but also the conflicts between the National Park authorities and the farmer and water user communities.
- ***Demographic****:* While migration to urban areas has decreased with the end of the armed conflict, many young people are attracted by perceived opportunities in urban areas and cities.
- ***Science and technology:*** Efforts by the local community have maintained and further developed the water supply infrastructure and rural road network.

During the field survey a trial assessment workshop was conducted with 11 participants – farmers, who have land in the National Park area and have formed an informal interest group. Participants defined their landscape with a mapping exercise and a discussion what the term 'territory' (*territorio* – term generally used in Colombia for the surrounding landscape) and 'management' (*gestión*) mean to them. Subsequently the participants were asked to conduct both a quantitative and qualitative assessment against a set of generic indicators of quality of governance in terms of their perceived involvement in the ecosystem management of their SEPLS.

The results of the quantitative assessment are summarized in **Table 14.** Generally, the participants assessed the quality of governance in the management of the overall landscape from the perspective of their involvement, and gave a low scoring for most indicators. For indicators 9 and 10 they preferred to distinguish between behavioral change and problem solving of issues surrounding their land (located in the National Park) and the overall landscape. A follow up assessment is planned.

Table 14. Ranking of governance quality in the management of the landscape by farmers group that participated in the trial governance assessment workshop organized during the field survey

Indicators (See Table 1)	1	2	3	4	5	6	7	8	9		10		11
Ranking (1: low, 5: high)									Overall SEPLS	Own land	Overall SEPLS	Own land	
1		X	X	X	X	X				X		X	X
2	X						X	X					
3													
4									X				
5											X		

3.2.5 Value-knowledge-governance interplay in Los Yarigues landscape

The thematic focus areas of this study, the values, traditional knowledge and governance of ecosystems in the landscape, are interlinked and influence each other. **Table 15** illustrates the interplay for two types of ecosystem, Natural forest and agroforestry systems.

The table shows that for each major ecosystem and most of the NCPs it provides, farmers, community organizations and other key stakeholders hold a considerable body of local knowledge, despite the comparatively late settlement of the SEPLS and little knowledge exchange between some stakeholder groups. However, the migration and widespread lack of interest in agriculture of the younger generation in Las Cruces does not bode well for the maintenance of the existing rich local knowledge and practices. With respect to governance, as the existence of conflicts of interests discussed above demonstrates, the structure and processes of ecosystem governance are in many cases not efficient, transparent and effective enough to ensure meaningful stakeholder participation and productive decision-making and implementation processes. Mistrust, largely due to the past armed conflict and unfulfilled political promises, lack of communication and regulations that do not provide for the inclusion of key stakeholders in the management of key ecosystems constitute barriers that need to be overcome to improve the relationship between key stakeholders and strengthen the ecosystem governance structure and processes in Las Cruces.

UIS' GEF-Satoyama project, which has established model farms for knowledge exchange and promoted significant stakeholder dialogue, is therefore a key process that has the potential to create a durable impact in the management of the landscape. It will be key to ensure the durability of the knowledge exchange and build long-term relationship build on trust between farmers, other community members and stakeholders from outside the landscape for the sustainable management of Las Cruces.

Table 15. Interplay of values, traditional knowledge and governance in the Las Cruces watershed, Los Yariguies landscape

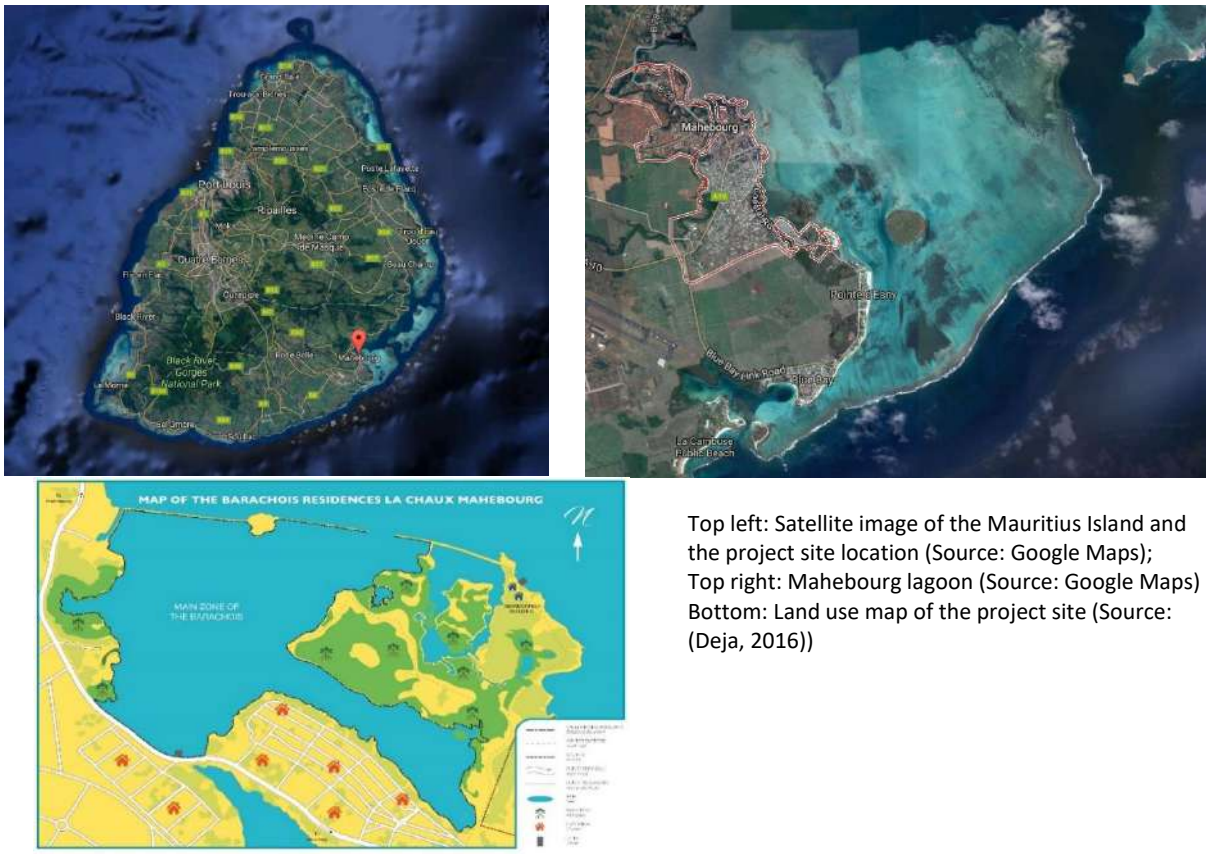
Ecosystem	NCPs	Traditional knowledge	Governance: Stakeholders and issues (if any)
Protected natural forest	*Habitat creation and maintenance* *Regulation of air quality*	NP management based on scientific knowledge Local stakeholders: Local names and habitats of wild fauna and flora	• National Park Administration (NP) • Issues: Local stakeholders largely excluded from access and jobs in the natural regeneration activities. No knowledge ex-change between NP and local communities. Remaining landowners unwilling to sell.
	Regulation of freshwater quantity, location and timing	Local knowledge (LK) of location, quantity and timing of water sources	• Water Supply & Sewer System Corporations • APC Manantiales de Chucurí: Public-private partnership-based water supply company • NCP recognized by 'ARA' PES scheme • NP: managing the area of main water sources • Main issue: Water ownership disputed between communities and NP authorities
	Regulation of water quality	LK of aqueducts Modern technology to measure quality	• Water Supply and Sewer System Corporations (community group) • APC Manantiales de Chucurí (see above)
	Energy	LK of production of fuelwood	• Farmers (for own consumption) • Issue: Communities see vested interests in ISAGEN's funding for land purchases by NP
Private (near) natural forests and agroforests	*Pollination and dispersal of seeds*	LK of pollinators and see dispersing animals	• Farmers mainly on agroforests • NP scientists mainly on natural forests • Issue: No information exchange between NP administration and locals
	Regulation of hazards and extreme events	LK of appropriate species considered in PES scheme	• NGO Fundación Natura: PES scheme 'ARA' • Farmers as landowners (suppliers) • Dwellers in urban area (beneficiaries) • Water Supply & Sewer System Corporations
	Formation and protection of soils	LK of tree species that prevent soil erosion	• Farmers (male and female) • Sustainable farming practices for erosion control on slopes recognized by PES scheme
	Detrimental organisms regulation	LK of diseases affecting crops, predators	• Farmers (male and female) • Community Action Groups (JCA):
	Medicinal plants and genetic resources	LK on wild plants limited, but some examples	• Farmers (male and female) • Issue: Traditional knowledge party lost [?]
	Food and feed	LK of edible flora & fauna	• Farmers (male and female)
	Materials and assistance	LK of use of specific natural material	• Farmers (incl. Women's group) • Community Action Groups
	Learning and inspiration	Skills for well-being, inspiration for art	• Students and school teacher • Farmers (incl. Women's group)
	Physical and psychological experiences	LK of hiking trails. Guides', hunters', farmers' LK of bird & other species Spiritual experiences	• Farmers (incl. Women's group) • Students and school teachers • Local tourist guides and tourists • ProAves staff and visitors of bird reserve
	Supporting identities	Sense of place Source of satisfaction	• Students and school teacher • Farmers (including Women's group)
Agroforestry, silvo-pastoral schemes	*Food and feed*	LK of diverse agroforestry and crops and pastoral livestock rearing	• Farmers (male and female) • Farmer organizations: FedeCacao & FedeCafe

3.3 Mauritius: Mainstreaming the contribution of coastal wetlands biodiversity for sustainable economic & livelihood development at Cité La Chaux 'Barachois', Mahébourg.

3.3.1 Description of the Barachois seascape and project overview

The Mauritius Island's coastal seascape is comprised of seven major ecosystem domains, i.e., beaches, lagoons, coral reefs, estuaries, saltmarshes, mangroves and sheltered bays (Fagoonee, 1990). "*Barachois*" indicates a coastal lagoon segregated from the ocean by permeable stone walls established for fish raring (**Figure 12** and **13**), mostly before 1800 under the French rule (Paul & Balkema, 1987). Now 33 barachois are recognized along the Mauritius Island's coastline, located in estuaries or nearby groundwater outlets where a complex brackish water ecosystem is formed (Coche, 1982). It however has become increasingly abandoned mainly due to management difficulties and subsequently turned into waste dumping sites. The project aims to pilot barachios rehabilitation in so-called "Mahebourg Barachois" located on the south-eastern coastline nearby Mahebourg, the Grand Port district center (Box 5). The barachois waterbody (24 ha) with the stone walls that segregate it from the outer sea, mangroves, dry scrubs along the outer coastline (7 ha) as well as an adjacent community in a township called "*Résidences La Chaux*" (18 ha) constitute the project site (**Table 16**).

Figure 12. Mahebourg Barachois from the sea
Photo: John Olsen (www.photopirate.com/)



Top left: Satellite image of the Mauritius Island and the project site location (Source: Google Maps);
Top right: Mahebourg lagoon (Source: Google Maps)
Bottom: Land use map of the project site (Source: (Deja, 2016))

Figure 13. Project site map

Box 5. An overview of the EPCO's "*Barachois Project*"

The project aims to establish a sustainable and collaborative development model for the restoration, conservation and active management of degraded natural resources, ecological processes and biodiversity of a coastal wetland in order to support local livelihood and enhance quality of life. It will pilot reinstating ecosystem services offered by coastal wetlands to strengthen local and national capacity, and to harmonize policy and institutional frameworks.

Giving a second life to the Barachois will make the area productive, healthy and more appealing, and demonstrate the tremendous contribution of biodiversity to sustainable economic development. It also will create local community business and additional income through the means other than direct fishing for the most needy who are entirely dependent on coastal resources, which will in turn decrease pressure on lagoon fishing and will allow natural resources and biodiversity to gain ground.

The project encompasses the following five major activities:

- Restore the natural ecological processes of the coastal wetland through conservation and active management;
- Rehabilitate the barachois for sustainable mariculture activities development;
- Build local capacity for sustainable use and management of coastal resources;
- Develop alternative employment opportunities for local residents; and
- Develop a sustainable model of collaborative management and raise awareness about the necessity of the link between natural resources and human wellbeing among stakeholders, government agencies and the general public.

3.3.2 Values

The configuration of the linkages between different ecosystem domains, important species found in these ecosystems, and the ecosystem goods and services deriving from different ecosystems in the barachois seascape was initially captured by an online survey and presented in a CIRCOS diagram (Figure 14). Here food (NCP 12) was the value commonly derived from all ecosystem domains. Other values ware attached to different ecosystem domains, e.g. mitigation of storm and cyclone hazards (NCP 9) by mangrove, sea urchins and shells from lagoon as materials (NCP 13) for ornament crafts, medicinal ingredients from mangrove tree roots (NCP 14) from mangrove, and recreation for local people and tourists (NCP 16) in barachois and lagoon. The diagram also indicates the importance for local community of the commodities brought from outside the seascape, and opportunities for recreation, available within the township area.

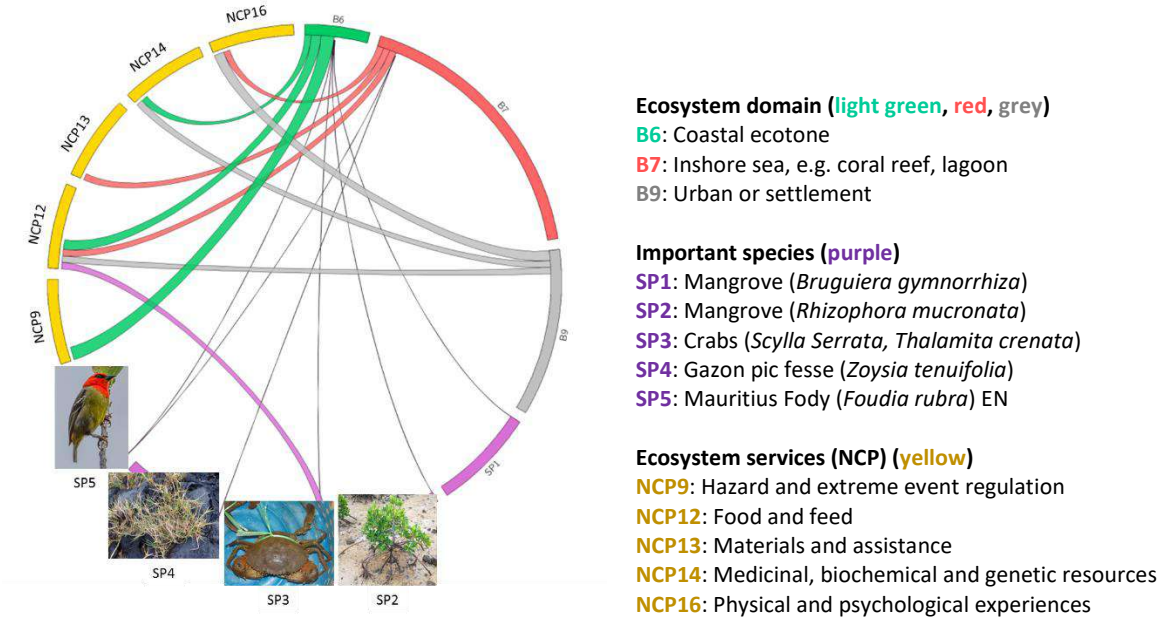


Figure 14. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

In addition, focus group interviews during the field study elicited the values that different groups of people in the Résidences La Chaux community hold towards different aspects of the three ecosystem domains, except for the township area (**Table 16**). Also value scores assigned to different aspects of the three ecosystem domains by the five focus groups are presented in **Figure 15.**

Overall five groups agreed on the highest importance of two major functions of the coastal landscape. One is the mangrove's functions to provide a shelter against cyclones/storm waves, surges and wind. The other relates to fish reproduction and harvesting, where the functioning of the three ecosystem domains are slightly different but inseparably linked. Mangrove has a critical role in fish reproduction by the provision of spawning and nursing ground, and also produces crabs which are mainly harvested by kids for household consumption. Barachois provides a wider variety of marine vertebrates and invertebrates, such as mollusks, crabs, eels and shrimps, which are harvest by local people mainly for their household consumption. This has high importance for households to cope up with the period of joblessness. Lagoon is the main fishing ground for professional artisanal fishers, which pro-

vides the main cash income sources to the community. In a survey with 49 fishers in Résidences La Chaux and Mahebourg, 76% of fishers stated that their monthly income are not sufficient to cover their daily expenses, and 90% expressed constantly declining fish catch over time (Deja, 2016).

The value scores across the five focus groups differed in several aspects of the seascape. Fishers stressed that they are still learning to utilize barachois wisely, and thus placed priceless value on it. They also emphasized the importance of live baits for fishing that they collect in mangroves and barachois. Skippers appreciated the value of barachois waterbody and endemic birds for tourist attraction –the aspect that were entirely not recognized by the fishers' group. Women and elders group tend to appreciate the beauty of seascape and animals. The women's group emphasized the importance of mangrove and the barachois for children to learn swimming, and also to enhance environmental awareness.

Table 16. Description of the values that five stakeholders associated with three ecosystem domains in the Mahebourg barachois seascape

Ecosystem	Species	NCP category	NCP description	Beneficiaries
Mangrove		01.Habitat creation and maintenance	Nursery for juvenile fish, crabs and shrimps -mangroves protect them from predators and provide shade to keep water temperature stable. Bird nests in mangroves. Important for maintaining all elements people obtain in coastal sea (maintain coastal ecosystem functioning)	Fishers
		07.Regulation of freshwater and coastal water quality	Filtration of water	
		08.Formation, protection and decontamination of soils and sediments	Prevents erosion	Whole community
		09.Regulation of hazards and extreme events	Barrier against cyclone/storm wave, surge and wind	Fishers and skippers
		15.Learning and inspiration	Parents teach their children not to cut mangrove trees	
		16.Physical and psychological experiences	Beautiful scenery -tourists visit to take pictures	tourists
		17.Supporting identities	Beauty (seascape)	Whole community
	Mangrove tree (*Bruguiera gymnorrhiza*; *Rhizophora mucronata*)	14.Medicinal, biochemical and genetic resources	Mangrove roots used as medicinal ingredient for diabetes treatment	whole community
	Crabs	12.Food and feed	Supplemental food for local people (Kids collect crabs at night and sell them for pocket money)	Whole community
	Fish, shrimp, worm, small crams/snails, algae, crabs	12.Food and feed	Baits for fishing (fish, shrimp, worm, etc.)	Fishermen
Barachois		09.Regulation of hazards and extreme events	Safe place to keep and repair boats. Boat owned by hotels are kept in the barachois when cyclones come	Fishermen, skippers and boat owners
		12.Food and feed	Worms used for fishing baits	
		15.Learning and inspiration	Kids learn swimming and fishing	Local community (Mostly kids)
		16.Physical and psychological experiences	Relaxation and recreation e.g. Safe place for elders and kids to swim, picnics, recreation fishing	Local community
		16.Physical and psycho-	Tourist destination, e.g. kayaking	Skippers

		logical experiences		
		18.Maintenance of options	People are still learning to use barachois more effectively; unforeseen values anticipated by some	Whole community
	Crabs, fish	12.Food and feed	Mollusks (tektek, bigorno), sea urchins, fish, crabs, eels, shrimps are harvested and collected by local people, especially for coping with temporal unemployment period. Kids collect crabs and sell for their pocket money	Whole community
	Gazon pic fesse	08.Formation, protection and decontamination of soils and sediments	Prevents coastal erosion	Whole community
	Migratory birds	16.Physical and psychological experiences	Some local people are curious about the birds that are only seen in limited periods (summer) of a year	Whole community
Lagoon		16.Physical and psychological experiences	Tourist destinations (coral reefs, lagoons and islands) and activities e.g. diving and sailing. Not only used as tourist destination, but also used by locals for boat trips and fishing for leisure. Beautiful seascape.	Tourism sector (e.g. skippers)
		13.Materials and assistance	Sea urchins and shells harvested for manufacturing ornaments. Used for room decorations and for presents	Tourists, local beach hawkers and craftspeople
	Fish, octopus	12.Food and feed	Fish, lobsters, squids, octopus and other seafood species	Local fishermen /whole community
	Dolphins	16.Physical and psychological experiences	Tourist attraction (tourists pay tips to skippers when skippers successfully locate and show dolphins to them)	Tourists, skippers
N/a	Mauritius Fody (EN)	16.Physical and psychological experiences	Tourist attraction	Skippers

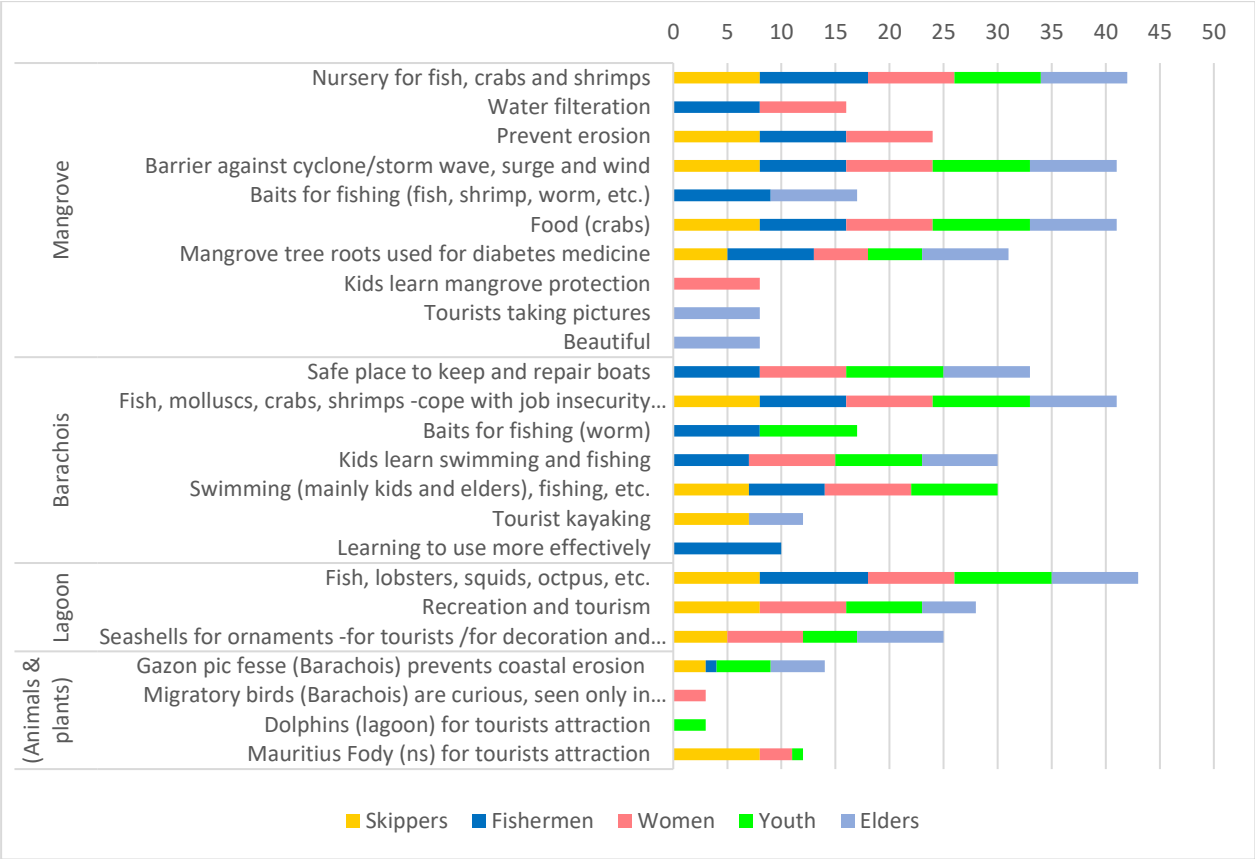


Figure 15. Aggregate of the ecosystem value scores by five focus groups (the highest value score by individual group is 10, meaning that the highest aggregate score is 50)

3.3.3 Traditional knowledge

The responses to the online survey indicated no traditional or local ecological knowledge existing in the local community for the sustainable management of the coastal seascape. All focus groups were unanimous that they have not inherited any collective knowledge on sustainable use and management of seascapes handed down from their ancestors, aside the use of mangrove roots for diabetes medication and individualized knowledge on fishing grounds. They instead claimed that they have started learning and accumulating knowledge with the project.

Collaborative learning and knowledge generation thus constitute a critical part of the project. In this regard, crab aquaculture testing in barachois is one of the core activities (**Figure 16**). It also is worthwhile referring to a successful case in crab and oyster aquaculture in another barachois located in Poudre d'Or on the northern coast, which can provide good insight to crab aquaculture in the Mahebourg barachois. Given no traditional knowledge on seascape management handed down through generations, the project can play pivotal role in generating new knowledge, and brokering outside knowledge into the project site, to establish sound knowledge basis for sustainable seascape management.

Table 17. Traditional knowledge on seascape management

Category	Ecosystem	Knowledge holder			Description
		Fishers	Elders	Whole community	
Local and empirical knowledge	Mangrove	Yes	Yes	Yes	Use of mangrove roots for medicinal ingredients for the treatment of diabetes
	Barachois	Yes	Yes	Yes	Location and timing for the collection of fish, mollusks, crabs and other marine invertebrates for food and for fishing baits
	Lagoon	Yes	No	No	Fishing ground
Resource management system	Barachois	Currently no	Currently no	Currently no	The Barachois Project is generating local knowledge on the management of barachois ecosystem complex and on crab aquaculture
Social institutions	Barachois	Currently no	Currently no	Currently no	The project is proposing to establish a local cooperative with community members including fishers, women and youth for aquaculture and ecosystem management in barachois

Figure 16. A crab cage prepared for crab aquaculture testing in the barachois and adjacent mangrove ponds. It uses Strawberry Guava (*Psidium cattleyanum*) wood, brought from the Black River Gorge National Park. Strawberry Guava, an invasive plant species, is now rapidly spreading and suppressing native vegetation in humid areas throughout Mauritius. The project team was supported by the National Parks and Conservation Services (NPCS) to collect Guava wood, as a part of an invasive alien species eradication program. Guava wood is durable in water, and can be continuously collected from the NP for free.

3.3.4 Governance

Different governance regimes are in place within respective ecosystem domains (

Table 18). For these basis the influences of the French (1715-1810) and British (1810-1968) rules cannot be ignored, which brought plantation economy, slavery, and power transfer to the Indians upon the nation's independence (Hollup, 2000).

The inshore sea outside barachois is governed under classical top-down and command-and-control regime under the government which is largely dominated by Indian Hindus. This mainly focuses on the issuance of the fishing license, collection of statistics and surveillance of fish catch by licensed fishers, setting closing seasons and restricting fishing gears. Law enforcement operations are carried out by district-level Fisheries Post under the National Fisheries Protection Services. These so far have been proved ineffective, with illegal fishing continuing and fish catch per effort being kept in decline. Fisher folks, mostly Creoles, have never developed community-based resource management systems and institutions for inshore fisheries. They simply have no other means than illegally fishing to make ends meet, in a circumstance where the government can hardly support the issuance of fisheries license.

The Mahebourg barachois belongs to the Ministry of Agro-industry and Food Security (**Figure 17**). The Ministry oversees the developments in barachois through administrative instruments, such as environmental impact assessment (EIA) and permits. The National Ramsar Committee, a cross-ministerial coordination body chaired by the Ministry of Environment and Sustainable Development, is also engaged in the administrative procedures relating to barachois, as barachois is classified into wetlands in the national land use classification.

Table 18. Ecosystem governance structure

	Ecosystem domain			Stakeholder type
	Coastal ecotone (mangrove)	**Inshore sea (lagoon)**	**Settlement /urban**	
Ownership	Ministry of Agroindustry and Food Security (Overseen under the National Ramsar Committee)	Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping	Ministry of Housing and Lands	Government or public
Management right holder	The government holds the right to manage the mangrove area however no management has been applied for more than 40 years.	The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping and the beach authority are in charge of the area but no management is carried out.	The Grand Port District Council hold ultimate management rights however the public are able to manage their local area e.g. gardens in a limited manner.	Government or public
Other stakeholders	Ministry of Agro-Industry and Food Security (Ramsar Committee); Ministry of Environment and Sustainable Development	Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, Ministry of Environment and Sustainable Development, Ministry of Agro-Industry and Food Security, Fisheries Post of Mahebourg, Beach Authority, Fisheries Training and Extension Centre (FiTEC), Competent Authority Seafood.	Social Welfare Centre Committee, Grand Port District Council, National Development Unit (NDU), Ministry of Agro Industry and Food Security.	Government or public
	Local environmental NGOs: Ecosud (Lagon Bleu Project), Mauritian Wildlife Foundation (MWF)	Local environmental NGOs: Ecosud (Lagon Bleu Project), Reef Conservation, Mauritius Marine Conservation Society (MMCS)	Mouvement Aide Agricole (MAA), La Voie de Mahebourg	Non-governmental
	Kolektif ecoguards	Kolektif Ecoguard, La Voie de Mahebourg.	Residences la Chaux 's associations, Ocean Women, Mouvement Bien-Etre Résidences La Chaux, Nu Zenfan Cite, Mahebourg Espoir, Association of elders.	Formal community org.
	The whole community	The whole community including registered and unregistered fishers, Mahebourg fishers	The whole community	Individual
	All businesses	All businesses	All businesses	Local business
	MCB Forward Foundation, sponsors from local and international companies through CSR (Corporate Social Responsibility)	MCB Forward Foundation, sponsors from local and international companies through CSR (Corporate Social Responsibility)	MCB Forward Foundation, sponsors from local and international companies through CSR (Corporate Social Responsibility)	Other private sector
		Mauritius Oceanographic Institute (MOI), Albion Fisheries Research Centre (AFRC),	SMEDA (Small and Medium Enterprises Development Authority, FAO (Food and Agricultural Organisation).	Research institutions
	University of Mauritius (Faculty of Agriculture and Faculty of Ocean Studies)	University of Mauritius, Ocean Study department	Local schools	Schools/ universities
	Indian Ocean Commission (Biodiversity project)	DCP, Indian Ocean Commission (Smartfish Project)	Decentralized Corporation Programme (DCP)	International org.
	Local, national and global	Local, national and global		Other stakeholder

	experts for mangrove restoration and conservation	experts for mariculture and marine biodiversity conservation		

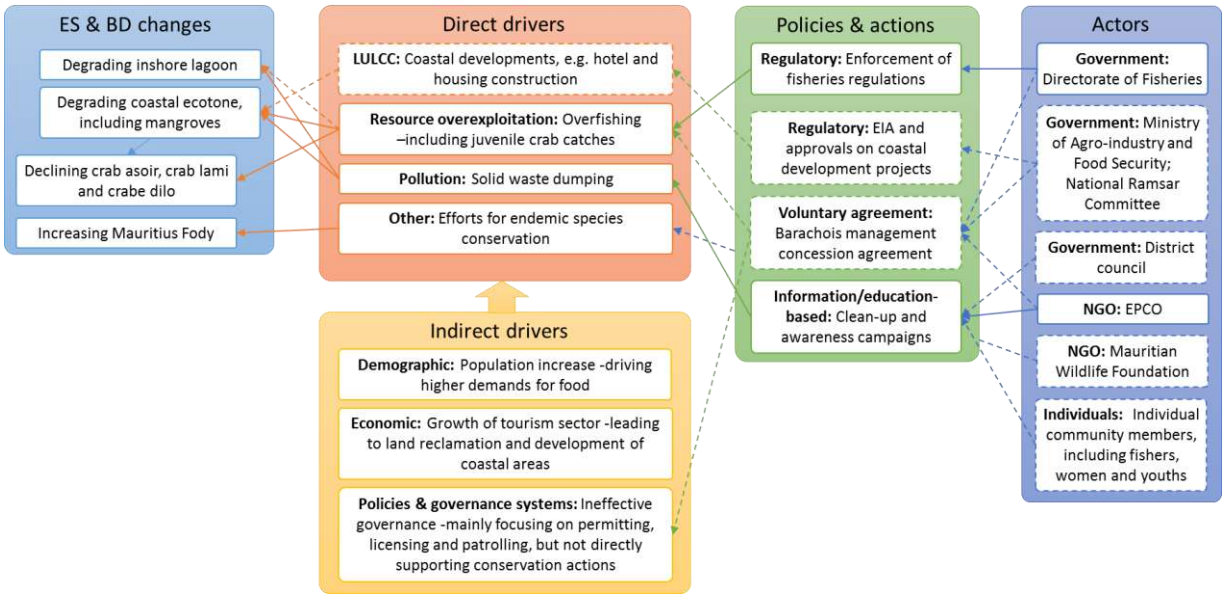


Figure 17. Configuration of the linkages between ecosystem degradation and species decline, direct drivers and the existing policies for abating the drivers

In 2014 the state government passed a decision that promote aquaculture development in the state-owned barachois. This allowed private proponents to lease state-owned barachois for three years under a concession agreement with the government, which is renewable upon successful results in the previous project period. The Mahebourg barachois is the one owned by the state government, and was recently leased out to EPCO for the barachois rehabilitation project. The management right of the barachois is delegated to EPCO under the concession agreement. It is imperative for the Project to closely coordinate with the Fisheries Post for monitoring and law enforcement upon the introduction of the planned crab aquaculture, as poaching is reportedly the major cause of production loss in barachois aquaculture (Coche, 1982).

As EPCO's involvement in the barachois management is project based and time limited, a permanent local institution needs to be established and operationalized with a view to filling the governance vacuum after the project end. A new national legislation on fisheries co-management, said to be enacted in November 2017, is expected to create enabling environment for establishing and operationalizing such a local institutional arrangement.

3.3.5 Value-knowledge-governance interplay in the Barachois seascape

The linkage between the value, knowledge and governance within three ecosystem domains are presented in **Table 19.** Currently the local community attributes the highest economic value to lagoon, amongst out of the three, as fishing grounds and tourist destinations. However, the sustainability of the resources in lagoon is highly contested due to excessive resource appropriation. Fisheries law enforcement cannot solely be effective in the face of the desperate needs of the fishers' community to make ends meet, as well as of the lack of their knowledge and capacity for sustainable resource management. This calls for the need of alternative economic means and filling the knowledge and policy gaps for sustainable resource management.

Barachois –once extensively developed along the Mauritian coastline under French rule before centuries but currently has become increasingly abandoned- is now revisited for its potential to boost aquaculture production and thereby to provide an alternative to the diminishing capture fisheries. To do so the generation and adoption of localized knowledge pertaining to resource management system and institutions holds the key, taking into account rapidly changing circumstances including technologies, market opportunities and stakeholders.

Mangrove and coastal dry scrub vegetation surrounding the barachois continue to play important role for cyclone hazard mitigation, fish reproduction, local food security and recreational uses. The rehabilitation of native vegetation of the coastal lands can attract pro-nature tourists to the barachois area. To do so, institutional setting needs to be carefully designed to bridge the different interest of fisheries and tourism sectors in the community.

Considerations are also needed to look at the value-knowledge-governance interplays across the three ecosystem domains, i.e. mangroves, barachois and lagoon, as these are inseparable component of socio-ecological system in the coastal seascape of the project area.

Table 19. The interplay between the value, traditional knowledge and governance within three major ecosystem domains in the project site.

Ecosystem domain	NCP*	Traditional knowledge	Governance: issues and stakeholders
Mangrove	1, 7, 8, 9, 12, 14, 15, 16, 17	General understanding of the functions of mangrove ecosystems pertinent to the NCP listed in the left column. Knowledge and practices for proactive sustainable management were not found. The project developed an inventory of plants in mangrove and coastal scrub areas, and plans to rehabilitate native vegetation.	The area is owned by the Ministry of Agroindustry and Food Security, and managed by EPCO under concession, overseen by the National Ramsar Committee.
Barachois	12	Currently local people harvest fish, mollusks, crabs and other marine invertebrates in barachois for subsistence food and for fishing baits. Now the project is piloting crab aquaculture and thereby generating knowledge for boosting production in and sustainably managing barachois ecosystem complex.	The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping oversees the barachois area managed by EPCO under concession. The Mahebourg Fisheries Post will assist law enforcement and surveillance once aquaculture has started. The Project established a Local cooperative of 52 community members, including fishers, women and youth to undertake aquaculture and ecosystem management.
Lagoon	12	Fishers own knowledge on fishing grounds, but no collective knowledge, management practice and social institution for the proactive management of fisheries for its sustainability	The Fisheries Directorate of the Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping oversees fisheries management through the enforcement of the Fisheries Law by its district fisheries post in Mahebourg.

* NCP 1 Habitat creation and maintenance; 7 Regulation of freshwater and coastal water quality; 8 Formation, protection and decontamination of soils and sediments; 9 Regulation of hazards and extreme events; 12 Food and feed; 14 Medicinal, biochemical and genetic resources; 15 Learning and inspiration; 16 Physical and psychological experiences; 17 Supporting identities

3.4 Peru: Consolidation of the participatory management of the Alto Huayabamba Conservation Concession – AHCC as a production landscape, and strengthening of partnerships for conservation, production and research in the Peruvian Amazon

3.4.1 Description of landscape project overview

The landscape of the Alto Huayabamba Conservation Concession - AHCC (143,928.09 ha) is located in the Peruvian Yungas and Paramos ecoregions (known locally as Bosques Montanos and Jalca respectively). Both are habitats of priority species and provide different ecosystem services to most of the population that inhabits Huayabamba and Huallaga basins. The buffer zone of the AHCC includes the Bosque Seco del Marañón ecoregion. The total estimated area of the landscape cover both the AHCC (**Figure 18**) and its buffer zone in La Libertad to the west, totaling 249,803.97 ha (Questionnaire survey).

The main ecosystems of the landscape are natural forest and human influenced settlement areas, where both small-scale economic and subsistence agriculture are practiced. Subsistence agriculture is basically for self-consumption, they are developed by people from the settlements of Nuevo Bolívar and El Progreso, who live within the AHCC. Small-scale economic agriculture is practiced in the buffer zone of the AHCC (population of the province of Bolívar, La Libertad), where the Association of Organic Producers produces quinoa and other Andean grains. The forests of the landscape located in the San Martín region have experienced pressure from extensive animal husbandry caused by migrants from the highlands of La Libertad region, a part of which is included in the buffer zone of the AHCC because of its ecosystem services. Many villagers have migrated looking for new productive areas under the misconception that these areas were suitable for agricultural production. As a result, these people are even poorer and have been the main driver behind Yungas deforestation and Paramos degradation. The concession was granted to AMPA by the Peruvian State for its administration for a period of 40 years in 2006 with the objective of preventing the deforestation and degradation of the Yungas by migrants from the highlands of La Libertad. The management of the concession by AMPA has been strengthened by financial support and additional activities under the GEF-Satoyama Project.

Among the species of animals, plants or other organisms considered most important in terms of their threatened species status, endemism or values for local people, AMPA identified the following five: Yellow-tailed woolly monkey (*Oreonax flavicauda*), white-bellied spider monkey (*Ateles belzebuth*), Andean night monkey (*Aotus miconax*), spectacled bear (*Tremarctos ornatus*) and a tree species locally known as *queñual* (*Polylepis multijuga*). All these species depend on the natural forest as their habitat, but the three primate species are also found in the surrounding forests of the settlement areas. All five are included in the IUCN Red List either as vulnerable, endangered (white-bellied spider monkey) or critically endangered (yellow-tailed woolly monkey).

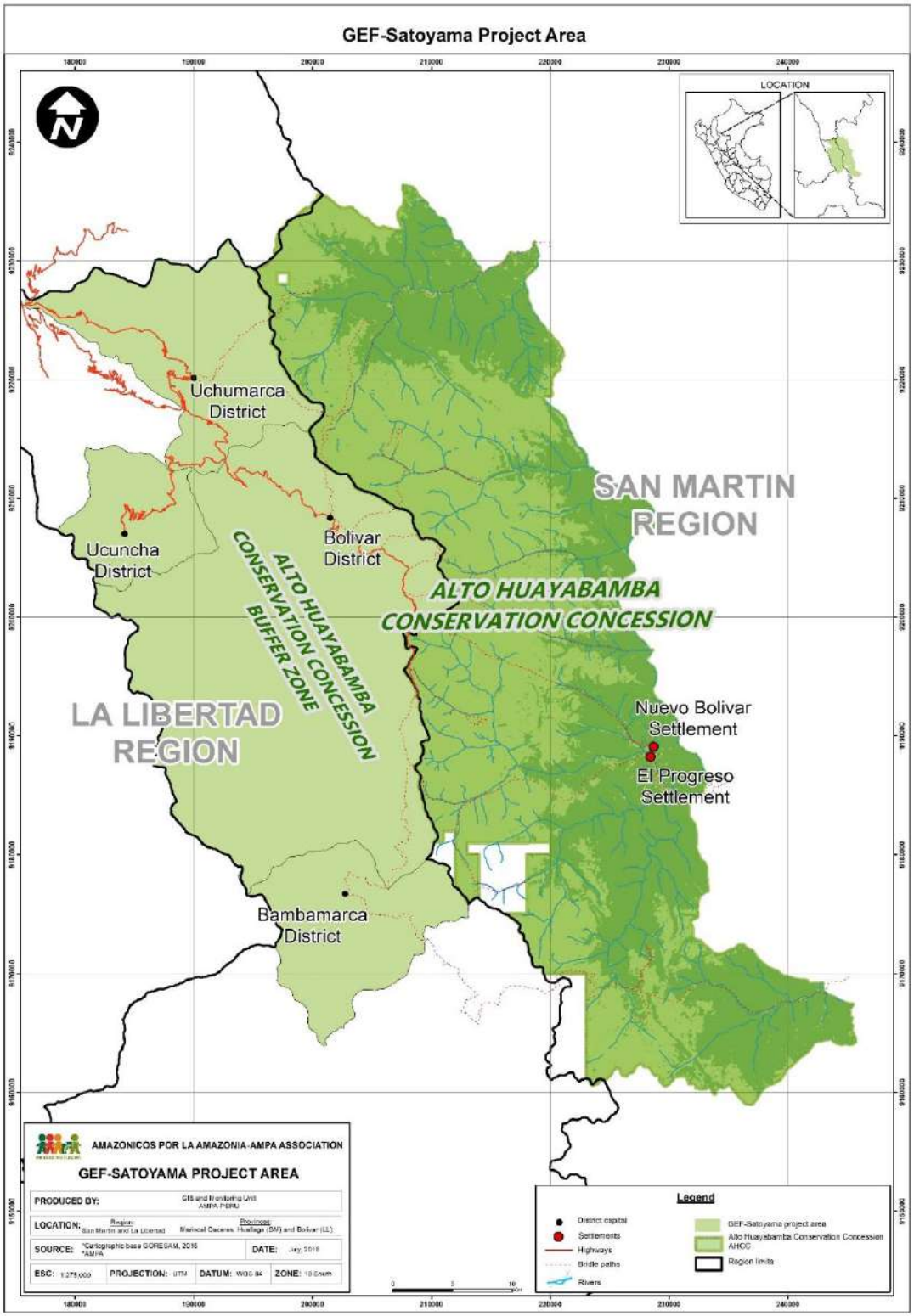


Figure 18. Map of the GEF-Satoyama project area (Buffer zone area to the west) and the AHCC (light and dark grey areas within the boundaries): Forest areas within the AHCC are shown in deep green, while Páramo areas without forest are in light green (Source: AMPA)

Box 6. AMPA project overview

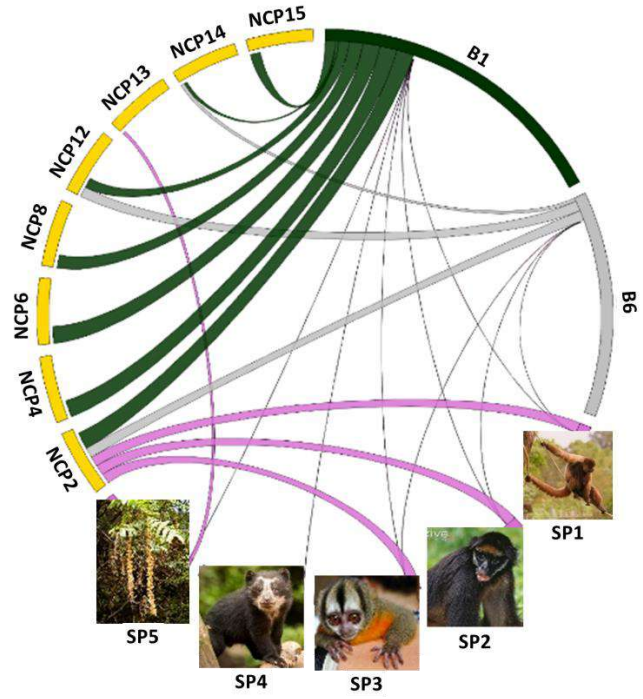
This project, implemented by Amazónicos por la Amazonía (AMPA), is titled "Consolidation of the participatory management of the Alto Huayabamba Conservation Concession – AHCC as a production landscape, and strengthening of partnerships for conservation, production and research in the Peruvian Amazon") and has the objective to guarantee the conservation of the priority areas of Peruvian Yungas and Paramos. AMPA´s goal is to contribute to improve the life quality of people settled in the AHCC and its buffer zone.

The project focuses on the consolidation of wild honey and organic quinoa, like sustainable productive chains. In addition, it develops some capacities of local young people in the research and monitoring habitat of *Oreonax flavicauda*. While AMPA had already achieved a decrease in the deforestation rates since it commenced managing the concession, the activities promoted under the GEF-Satoyama project contribute to further reduce the deforestation and degradation caused by farmer migrants within the AHCC. The AHCC users are current members of associations that signed conservation agreements with AMPA, in which they state their commitment to stop deforestation activities and to support the recovery of logged areas. Involving the communities in forest management contributes to ensure forest conservation.

AMPA´s GEF-Satoyama project has shown that wild honey has a higher efficiency than the traditional crop-coffee, in the role of created more carbon storage and increased the family income. Currently AMPA is seeking to consolidate these initiatives and empower their partners, the communities, to be involved in the conservation of critical endangered and endemic species and the contribution in the production landscapes. The project has 4 components: a) Development of sustainable productive activities; b) Organizational and business reinforcement for associations; c) Promoting sustainable management of ecosystems; d) Participatory monitoring with young people. According to AMPA these are in line with the national development goals of Peru and the Aichi Biodiversity Targets (GEF-Satoyama website).

3.4.2 Values

The project implementer, AMPA, identified eight Nature's contributions to people associated with the three main ecosystem domains (Natural/protected forest, farmland and settlements areas) and species present at the site (Figure 19). Pollination and seed dispersal (NCP1) was the most frequently recorded NCP, being associated with the natural/protected forest, farmland and settlement ecosystems, as well as with the three primate species among the five important species. Food and feed (NCP12), and medicinal, biochemical and genetic resources (NCP14) are also provided by both ecosystems. Quinoa is grown in the buffer zone outside the AHCC (Farmland). The buffer zone is settled by peasant communities and members of the Association of Organic Producers. Geographically they are located in the province of Bolívar, La Libertad. Although they are outside the AHCC these populations have also performed anthropic pressure within the AHCC. NCP1, and the NCPs of ´climate regulation´ and ´freshwater quantity, flow and timing regulation´ were rated as 'critically important' to their beneficiaries, the local community. Soil formation, protection and decontamination is another NCP that is provided by the natural forest and is considered ´important´. A certain proportion of the settlers in Nuevo Bolívar and El Progreso are migrants, who came to the area decades ago. They previously lived on pasturage and subsistence agriculture, with limited knowledge on the regulating contributions of nature (i.e. NCP2, 4, 6, 8), and hence were blamed for causing deforestation. They have now become more interested in the production activities that are compatible with forest conservation (See section 3.4.4 for details).



Ecosystem domain (deep green, grey)
B1: Natural/protected forest
B6: Farmland

Important species (purple)
SP1: Yellow-tailed woolly monkey
SP2: White-bellied spider monkey
SP3: Andean night monkey
SP4: Spectacled bear
SP5: *Queñual* (Polylepis multijuga)

Ecosystem services (NCP) (yellow)
NCP2: Pollination and seed dispersal
NCP4: Climate regulation
NCP6: Freshwater quantity, flow & timing regulation
NCP8: Soil formation, protection & decontamination
NCP12: Food and feed
NCP13: Materials and assistance
NCP14: Medicinal, biochemical and genetic resources
NCP15: Learning and inspiration

Figure 19. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

According to an AMPA representative, the community of the Nuevo Bolívar settlements (within the AHCC) as well as the community in the zone of influence are recently aware of the importance of primates. The monitoring AMPA is conducting involves some people of Nuevo Bolívar and El Progreso and is expected to provide more information about primates. The spectacled bear is also recognized by the communities. The wood of *quiñuales* (*Polylepis multijuga*), which is endemic to montane forests in the Peruvian Northern Andes, has traditionally served as structures in houses as well as material supply for tools used by the local communities (NCP 12).

3.4.3 Traditional knowledge

Quinoa is produced using ancestral knowledge, but adapting it to the principles of organic agriculture and new technologies. As a result of the inputs by AMPA as the concession holder, the previously diminishing traditional knowledge has been identified and secured traditional knowledge of the quinoa producers, is outside the AHCC, in the Farmland (**Table 20**). According to an AMPA representative, the people of the Nuevo Bolívar and El Progreso settlements, who are immigrants from the Sierra de La Libertad who entered the SEPLS more than 50 years ago to cut the forest and develop livestock and subsistence agriculture, also hold traditional knowldge. They are not natives proper, but they know the use of some medicinal plants and fruits of the forest, which they use sporadically in their daily life. This traditional knowldge will be within the AHCC.

Table 20. Traditional knowledge for the use and management of different ecosystem domains and species

Ecosystem	Traditional knowledge		Trend	Knowledge holders
	Domain	Description		Farmers
8.Farmland	2.Mgt. system	Quinoa is being produced under organic principles, adapting ancestral knowledge to new technologies.	↗	○

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

3.4.4 Governance

The governance systems in the landscape differ depending on the type of ecosystem and legal status of the area.

Table 21 shows the different ownership and management rights within the Alto Huayabamba Conservation Concession area in the two main ecosystems identified by the subgrantee.

Table 21. Ecosystem governance structure in the Alto Huayamba landscape

Ecosystem type	Protected/natural forest	Farmland & Urban/Settlement	Stakeholder type
Ownership	Peruvian state		Government or public
		Individual local community members (e.g. farmers)	Individual
Management right holder	Non-governmental organization AMPA: Concession for 40 years from 2006)		Non-governmental
		Individual local community members (e.g. farmers)	Individual
Other stakeholders	Regional Environmental Authority - ARA San Martín	Agriculture Agency of Bolívar	Government or public
		Municipal government of San Martín: urban planning	Government or public
		AMPA	Non-governmental
	Association of Beekeepers (APA) of AHCC		Formal community org.
	Research Institute of the Peruvian Amazon – IIAP		Research institution
	Users of the AHCC (farmers)		Individual

Source: Questionnaire survey

In the AHCC, the management rights are with AMPA as the concession holder. AMPA is responsible for meeting the objectives of forest and biodiversity conservation and reporting its progress to the Peruvian state. According to the Ecological and Economic Zoning, it was determined that the headwaters of the Huayabamba river basin are located on lands with priority for protection and ecological conservation. Based on this, AMPA conserves this area for its biodiversity the diverse ecosystem services that it provides to the local population. Users of the Alto Huayabamba Conservation Concession include the population of the settlements of Nuevo Bolívar and El Progreso, who migrated to the area decades ago and have put pressure on the forest by deforestation for pasture development and subsistence agriculture. They are now changing to productive activities compatible with the conservation of forests.

In the buffer zone of the AHCC it is mainly independent farmers, who own and manage the land. Here AMPA has been promoting the production of organic quinoa and wild bee honey. There are also

three farmer communities in the municipalities of Bambamarca, Bolívar and Uchumarca, who manage their areas collectively and have recognition by the Peruvian state.

Other stakeholders include:

- Regional Environmental Authority - ARA San Martín: It is responsible for environmental conservation of the Regional Government of San Martín and directly supervises the Conservation Concessions located in San Martín region, but lacks capacity to enforce its norms, which generates problems with garbage management.
- Association of beekeepers (APA), formed by users of the Alto Huayabamba Conservation Concession, of the settlements of Nuevo Bolivar and Progreso.
- Research Institute of the Peruvian Amazon - IIAP: This State institution dedicated to scientific research and sustainable development of the Amazon, which has carried out activities in the Alto Huayabamba Conservation Concession.
- Agricultural Agency of Bolívar with a local office of the Regional Management of Agriculture of the Regional Government La Libertad, responsible for promoting agricultural activity in the province of Bolívar.

The survey identified a series of drivers that are responsible for the ecosystem and biodiversity changes in the landscape. The main direct driver, which used to be prevalent in the landscape before AMPA took over the management of the concession and the overall landscape, was deforestation and forest degradation (**Figure 20**). Land use change and the disorderly increase of settlements also compromised the viability of endangered species populations. Under the management of the concession by AMPA regulatory measures such as patrolling by communities, market and incentive-based livelihood promotion activities, voluntary agreements and education activities have largely addressed this driver and the underlying indirect socio-cultural, economic and governance related drivers. The conservation of the environment is linked with the promotion of apiculture in collaboration with APA and organic production of quinoa in partnership the Association of Organic Producers of the Province of Bolivar. AMPA has drawn the attention of the central government to these efforts, seeking recognition at the national level.

In addition, poor waste management in the expanding settlement areas has contributed to an increasingly serious pollution of water streams in the farmland ecosystems in the buffer zone of the AHCC. This contamination can indirectly affect the agricultural crops. The responsibility to lead initiatives to control the contamination of streams is of the Provincial government, having in its regulation the care of water sources. However, it has no capacity to enforce its norms, which generates problems with the management of the garbage.

3.4.5 Interplay between the values, traditional knowledge and governance

The ecosystem domain of the natural protected forest shares three NCPs with the farmland and settlement ecosystems but has additional NCPs, namely habitat creation, climate regulation, regulation of freshwater quantity and timing, as well as learning and inspiration (**Table 22**). The fact that the management rights are with AMPA, which is explicitly committed to biodiversity conservation, can be understand as a governance related indirect driver for the recognition and, more proactively, the enhancement of these additional NCPs. In the settlement/urban areas, AMPA's promotion of existing ILK of quinoa production among the farmers, who hold the ownership and management rights of their land, can be expected to improve the NCP of "food and feed" in the ecosystem domains of urban/settlement areas [and farmland].

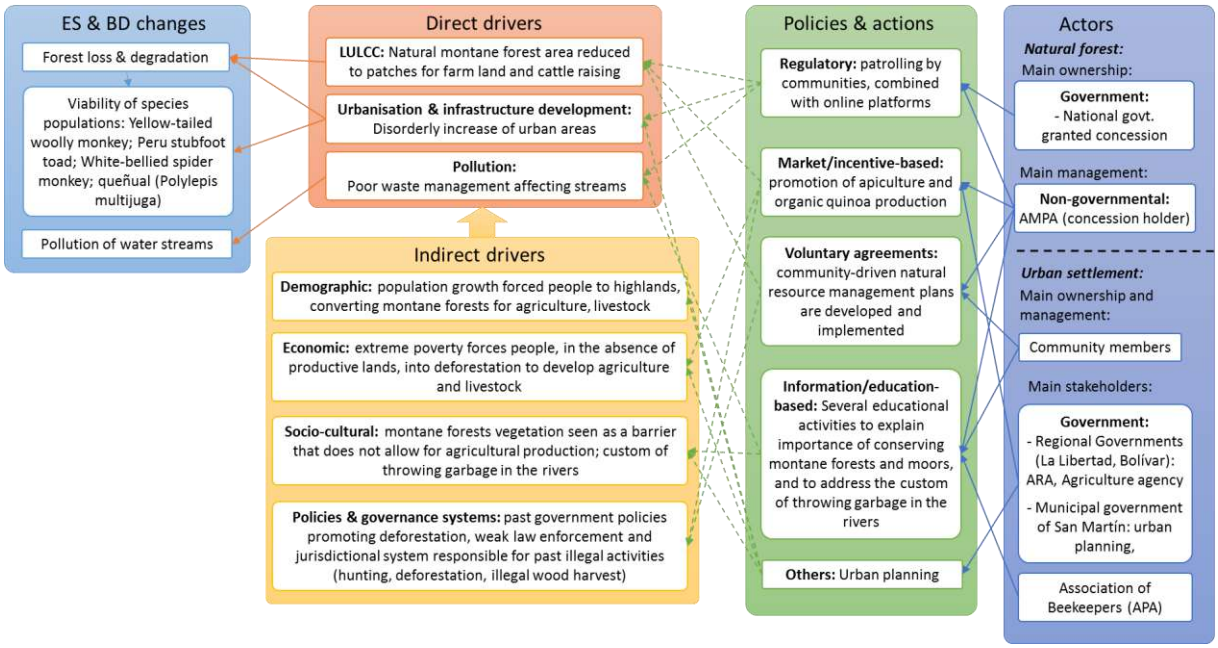


Figure 20. Configuration of the linkages between ecosystem and biodiversity changes, their direct and indirect drivers and corresponding policies and actions

Table 22. Interplay between the value, ILK and governance within the two major ecosystem domains

Ecosystems/species	Value (NCP*)	ILK	Governance: issues and stakeholders
Natural/protected forest	1. Pollination and seed dispersal 3. Climate regulation 5. Freshwater quantity, flow & timing regulation 7. Soil formation, protection & decontamination 11. Food and feed 13.Medicinal, biochemical and genetic resources 14. Learning and inspiration	None recorded on this eco-system	In the AHCC, the management rights are with AMPA as the concession holder. AMPA is responsible for meeting the objectives of forest and biodiversity conservation and report-ing its progress to the Peruvian state.
Farmland	1. Pollination and seed dispersal 7. Soil formation, protection & decontamination 11. Food and feed 13.Medicinal, biochemical and genetic resources	Quinoa is produced using ancestral knowledge, but adapting it to the principles of organic agriculture and new technologies.	In the buffer zone of the AHCC inde-pendent farmers own and manage the land. There are also three farmer communities, which manage their areas collectively.
Settlement/urban	1. Pollination and seed dispersal 11. Food and feed 13.Medicinal, biochemical and genetic resources	Quinoa is produced using ancestral knowledge, but adapting it to the principles of organic agriculture and new technologies.	In the buffer zone of the AHCC inde-pendent farmers own and manage the land. There are also three farmer communities, which manage their areas collectively.

3.5 Myanmar: Conservation and sustainable use of freshwater ecosystems in Myanmar.

3.5.1 Landscape and project overview

Project was implemented in 3 project locations namely Indawgyi Wildlife Sanctuary and Hponganrazi Wildlife Sanctuary situated in the upper Ayeyarwady Basin in Kachin State and Lenyar proposed National Park situated in the Sundaic lowland forest in the Tanintharyi Region (Figure 21). Indawgyi project area includes 117,600 hectares of natural/protected forest and lake area, and a further 16,000 hectares of freshwater wetlands (Figure 22). Protected forest area including rivers and tributaries of Hponganrazi Wildlife Sanctuary is about 270,000 hectares and Lenyar proposed National Park (Figure 23) is about 176,000 hectares. Key objectives of the project are to enhance local knowledge on endemic fish species, sustainability of fisheries resources and to improve fisheries management by co-management approach in collaboration with local communities and relevant government departments. The project aims to integrate community-managed fisheries and conservation zones into the legally-recognized protected area zones and management plans.

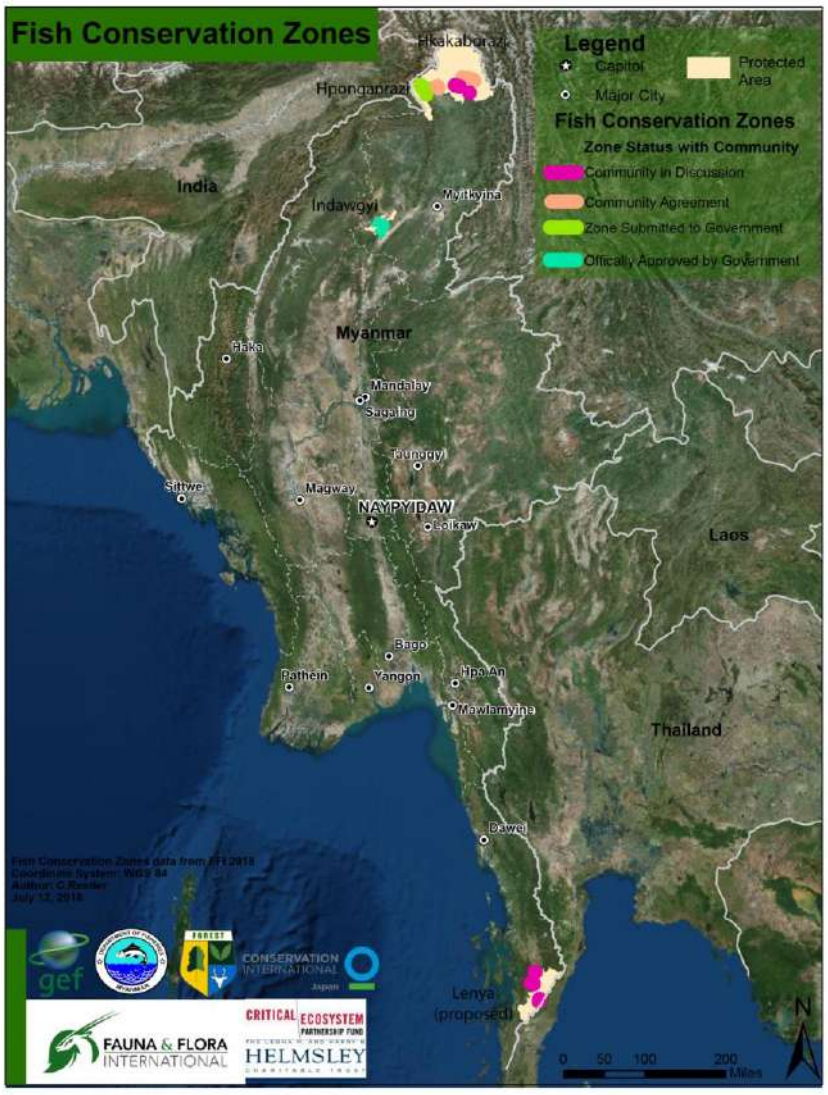


Figure 21. Project areas in Myanmar

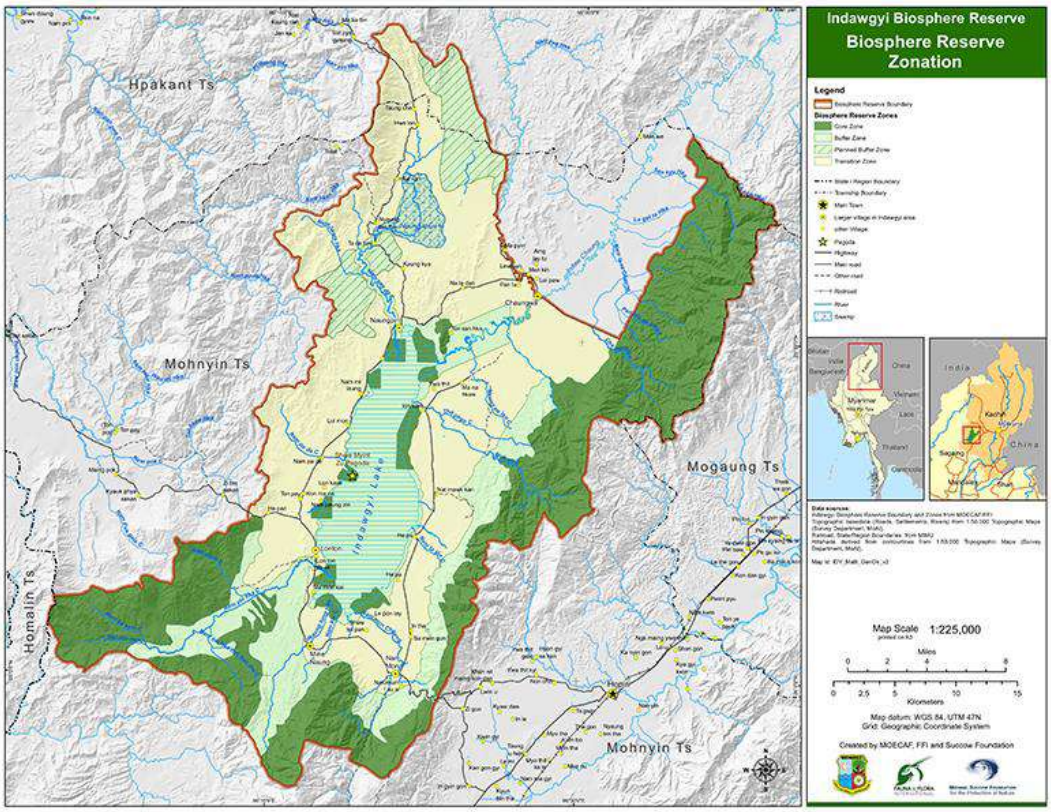


Figure 22. Indawgyi MAB map including FCZs.

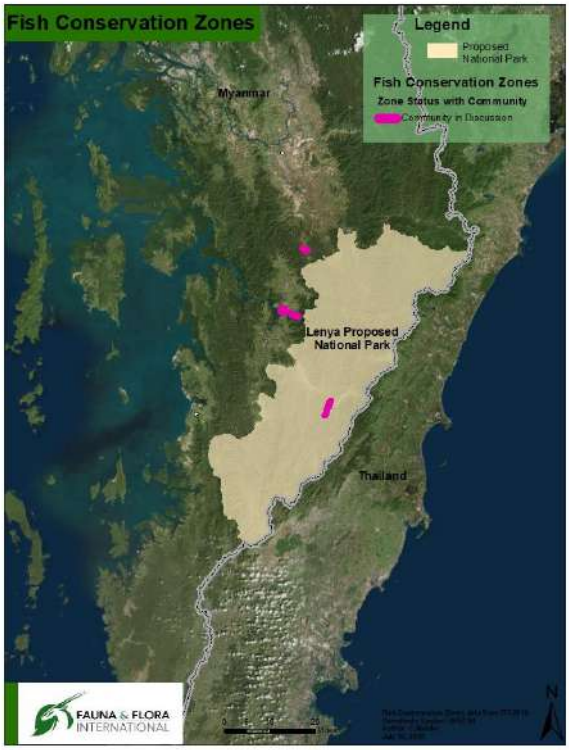


Figure 23. Lenyar (proposed) National Park project area

Box 7. FFI project overview

There was currently little useful data to aid the conservation of freshwater fishes and to assess the threats they faced in Myanmar. A recent IUCN study highlighted the need for extensive new work on freshwater species in the Eastern Himalaya region which includes the Ayeyarwady Basin, where 31% of assessed freshwater species are currently listed as Data Deficient (Allen *et al.* 2010). The last comprehensive assessment of Myanmar freshwater fauna dates back to the late 19th century (Day, 1889). From 2014, FFI, with support from CEPF commissioned Maurice Kottelat, has built local capacity on fish taxonomy and to undertake fish surveys in the Upper Ayeyarwady basin and Tanintharyi/Lenya watershed. These surveys significantly increased the number of known fish species in Myanmar and also discovered1 genus and about 20 new species to the science. Among them, 1 genus namely *Malihkaia* and 4 new species namely *M. aligera*, *Schistura nubigena* and *S. wanlainensis* and *Exostoma sectile* from Hponganrazi Wildlife Sanctuary and 3 new species namely *Schistura indawgyiana*, *Lepidocephalichthys eleios* and *Amplyceps improcerum* from Indawgyi Wildlife Sanctuary were published.

Threats to the Ayeyarwady and Tanintharyi watershed include planned hydropower dams, migrant fishers and unsustainable fishing practices, and pollution from artisanal gold mining. Direct use of freshwater species through unsustainable fishing practices has currently the largest impact on aquatic biodiversity, and overfishing is believed to be the main threat.

While some protected areas including freshwater areas have been established (e.g. Indawgyi and Inle Lake), their coverage is patchy and their placement is sub-optimal for the protection of freshwater biodiversity. None of the protected areas have yet established fish conservation zones (FCZs) or fisheries management regulations. FCZs offer refuges for aquatic species from exploitation, and can improve the resilience of fish populations in the face of other, broader threats.

This project aims to:

- Complete the gap analysis for freshwater key biodiversity areas (KBAs) in the Upper Ayeyarwady and Tanintharyi/Lenya watershed;
- Pilot locally-managed freshwater fisheries areas including fish conservation zones for the protection of freshwater KBAs; and
- Integrate community managed freshwater fisheries areas/fish conservation zones into protected area zonation and management plans to facilitate legal recognition.

3.5.2 Values

The project proponent identified a total of two NCPs associated with the ecosystem domains and species present at the site (Figure 24). Learning and inspiration (NCP15) was the most frequently recorded NCP, being associated with both the natural/protected forest ecosystem and wetland ecosystem, as well with as all five important species. In addition, the endemic pipe fish (*Microphis dunckeri*) supports the identity of the local community and science. In all cases these NCPs were rated as 'critically important' to the local community. Nevertheless, an attention needs to be paid in interpreting this result, which mainly derived from the perspective of the project implementation agency. As noted in the project description, the project clearly recognizes other values of SEPLS for different stakeholders, e.g. freshwater fish for the livelihood and subsistence of local communities, as well as hydropower potential for energy companies, that may come in conflict of the sustainability of SEPLS.

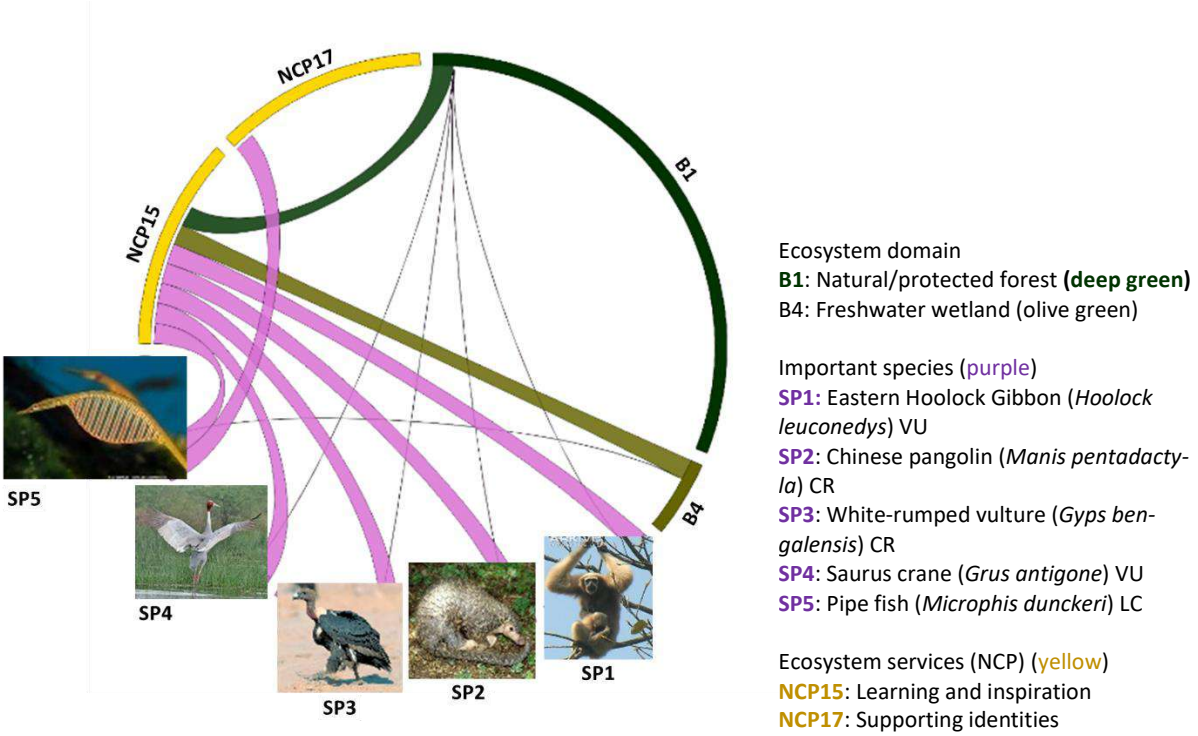


Figure 24. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.5.3 Traditional knowledge

The water surface area of Indawgyi is about 16,000 hectares and local communities depend their fisheries livelihood on this area for their daily income and nutritional source. The communities In Hponganrazi Wildlife Sanctuary and Lenyar proposed National Park have been depending to the fisheries for their subsistence income and also daily nutritional source. The project recognized local communities' traditional knowledge on fish spawning habitats and nursery areas. Therefore, consultation meetings with the communities were conducted and selected priority areas for the establishment of co-managed Fish Conservation Zones based on their traditional knowledge together with the scientific survey results. The project proponents did not identify any particular traditional knowledge at their project site.

Table 23. Traditional knowledge for the use and management of SEPLS

Ecosystem	Traditional knowledge		Trend	Knowledge holders
	Domain	Description		Fishers
5. Freshwater	1. Local and empirical knowledge	fish spawning habitats and nursery areas	NI*	◯

* Not indicated in the survey response

3.5.4 Governance

Both ownership and management rights over the forest and freshwater wetland systems are government or public (Table 24). In addition, the project proponents recognized a large number of other stakeholders in these ecosystems. These include several government departments, two non-governmental and two formal community organizations, as well as two university research institutes, other schools and universities, and five international organizations.

Infrastructure development, pollution from gold mining and invasive species are the direct drivers of decreasing trends in the integrity and area of the forest, lake and wetland ecosystems (**Figure 25**). Indirect driver such as the population increase and migrants caused pressure to the natural environment and resources. Additionally, shifting cultivation, hunting and fishing as local livelihood means had resulted in resource over-exploitation and ultimately caused declines in the populations of the eastern hoolock, Chinese pangolin, white-rumped vulture and saurus crane. The population of these species has now recovering owing to the wildlife sanctuary establishment and community-based conservation efforts. With the exception of infrastructure development, the direct drivers are being addressed through regulatory instruments already in place or currently being negotiated under the project. A school program is implemented to increase awareness of these problems.

The project proponents highlighted the importance of public support of and adherence to regulations, as well as the active participation of both local and international organizations in educational programs, in conjunction with the responsible government departments.

In the Resilience Indicators workshop local people expressed that law enforcement in the area was very weak. Communities in the project areas have started establishing fish conservation zones, and prohibiting unsuitable fishing practices. They also create community fishery group and social services group to manage natural resources, and cooperate with village teams. Local organizers are collaborating with government and local community to integrate community managed fisheries areas and fish conservation zones into protected area zonation and management plans in order to facilitate legal recognition.

Table 24. Ecosystem governance structure

Ecosystem type	Protected/natural forest	Freshwater wetland	Stakeholder type
Ownership	*Government*	*Government*	Government
Management right holder	*Forest Department*	*Forest Department*	Government
Other stakeholders	Department of Fisheries, General Administrative Department, Police Department	Department of Fisheries, General Administrative Department, Police Department	Government
	Fauna & Flora International, Friends of Wildlife	Fauna & Flora International, Friends of Wildlife	Non-governmental org.
	In Chit Thu, Indawgyi Natural Conservation and Development Association	In Chit Thu, Indawgyi Natural Conservation and Development Association	Formal community org.
	All villages around Indawgyi Lake and 7 project villages in Putao District	All villages around Indawgyi Lake and 7 project villages in Putao District	Schools/universities
	Myikyina University, Moenhyin University	Myikyina University, Moenhyin University	Research institution
	CEPF, Helmsley, Norad, ACB-kfw, GEF-Satoyama, BIZ	CEPF, Helmsley, Norad, ACB-kfw, GEF-Satoyama, BIZ	International org.

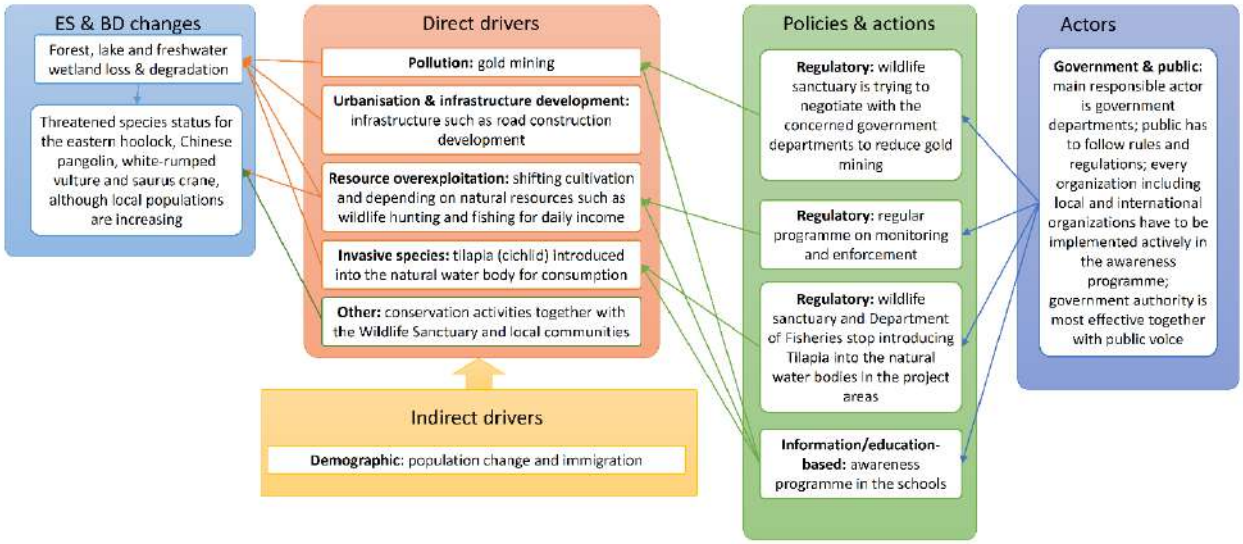


Figure 25. The configuration of the linkages between ecosystem and biodiversity changes, their direct and indirect drivers and corresponding policies and actions

3.5.5 Values–knowledge–governance interplay in the Indawgyi landscape

Table 25 highlights the linkage between the values and governance within the two ecosystem domains and the five species. These ecosystems and species present high value to the local community in their provision of learning opportunities and inspiration. Additionally, the endemic pipe fish *Microphis dunckeri* contributes to both the identity of the local community and to wider science. The current poor state of knowledge on the freshwater fish species in the project area emphasizes the importance of preserving the ecosystems, for the preservation of their learning and inspirational value. However, resource over-exploitation, pollution and invasive species are key threats to the integrity of these ecosystems and need to be addressed for the long-term sustainability of both the ecosystems and their species.

Efforts to protect and maintain these ecosystems and their important species to date primarily include regulatory and educational instruments. The long-term effectiveness of these policies and actions will require continued cooperative efforts between government departments, the public, and other stakeholders including local community groups and international organizations.

Table 25. The interplay between the value, knowledge and governance within the two major ecosystem domains and five species in the project site

Ecosystem domain	NCP	Knowledge	Governance: issues and stakeholders
Natural/protected forest	15. Learning and inspiration	None recorded in online survey	Regulatory instruments and educational programs are the main activities currently addressing pressures on these ecosystems and species. A range of stakeholders are engaged across the project area, including research institutes, domestic and international organizations, and NGOs, including FFI.
Freshwater wetland	15. Learning and inspiration	None recorded in online survey	
Eastern hoolock gibbon, Chinese pangolin, white-rumped vulture, saurus crane	15. Learning and inspiration	None recorded in online survey	
Pipe fish	15. Learning and inspiration 17. Supporting identities	None recorded in online survey	

3.6 Madagascar: Integrated adaptive management to protect ecological integrity in the socio-ecological production landscape of the south-east watershed of Makira Natural Park.

3.6.1 Landscape and project overview

The project aims to address forest loss and degradation in the southeast basin of Makira forest in the Makira Natural Park, located in low and mid-altitude rainforest in eastern Madagascar. The forest in the project area extends to 372,000 hectares, and underpins the livelihoods and security of surrounding communities through the provision of goods and services (Box 8).

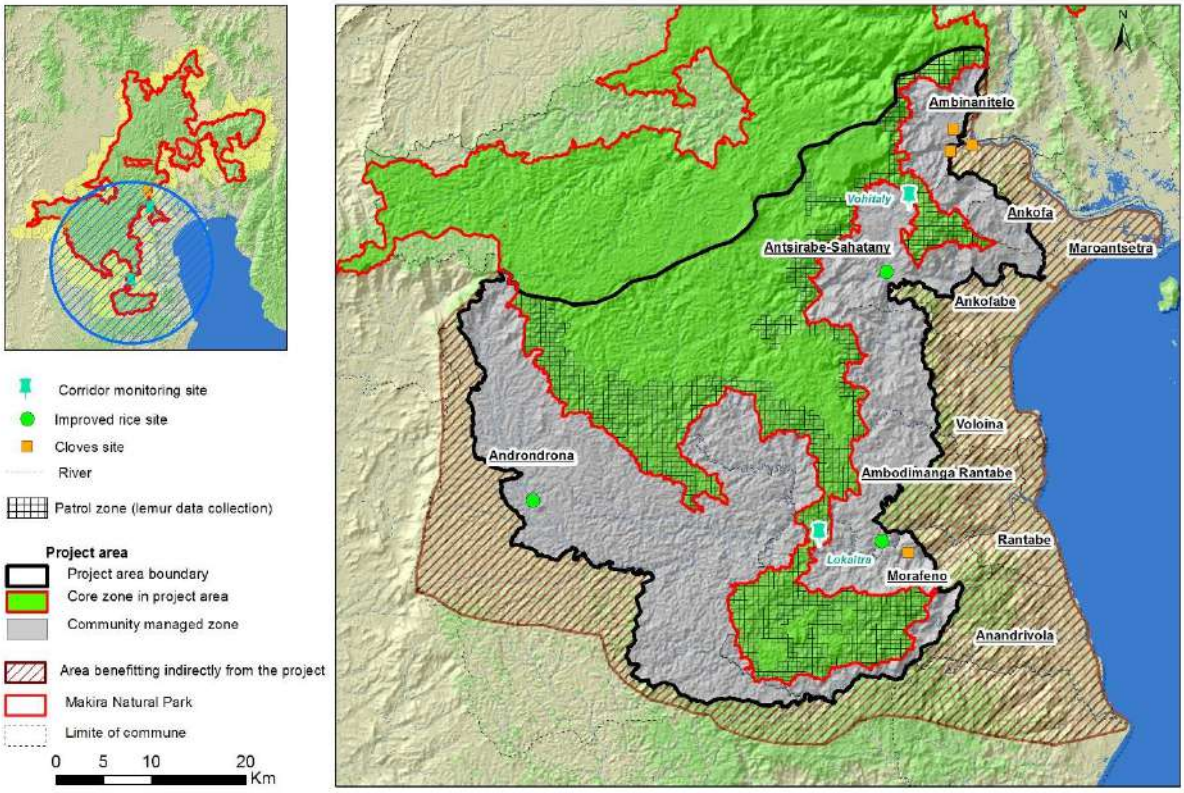


Figure 26. Project area map

Figure 27. Project also works to improve the productivity of rice paddies. (photo by Yoji Natori, Conservation International)

Box 8. WCS project overview

The Makira Natural Park represents the largest remaining contiguous tract of low and mid-altitude rainforest in eastern Madagascar. It constitutes an important genetic corridor between other protected forests across the north of Madagascar, and ensures the ecological integrity of one of the most diverse and intact areas of Madagascar. The Makira forests also support the terrestrial and marine livelihoods of thousands of households and protect their means of subsistence by protecting the watersheds, by preventing flooding of plains, and in reducing the sedimentation of the downstream Antongil bay.

However, the Makira forests are highly threatened by the demands from the 90,000 people living in the Makira landscape, which in turn affect the livelihoods of people that depend on them. The biggest threat is slash and burn agriculture (*tavy*) for rain-fed rice growing to meet subsistence needs, followed by, e.g. bushmeat hunting, non-timber forest products collection, illegal logging and mining. One area of particular ecological and social fragility within Makira is its southeast watershed, which is not only ecologically important and fragile, but also highly exposed to the threats from the surrounding communities, while still pertains the high – yet largely untapped - potential for sustainable natural resource-based livelihood activities.

This project aims to improve the ecological integrity of the southeast basin of Makira forests and the wellbeing of the surrounding local communities through:

- Securing ecological function and enabling adaptive management of natural resources within the landscape through sylvicultural maintenance and community-based monitoring;
- Empowering local communities and enhancing their livelihoods based on a sustainable use of natural resources of the SEPL with private sector partners, including certified clove production; and
- Promoting good governance practices amongst all stakeholders based on traditional knowledge.

3.6.2 Values

The project proponent recognized multiple values deriving primarily from the protected forests to the communities living adjacent to the forest, which fall under as many as 13 NCP categories (Figure 28). Multiple values of the endangered primate species inhabiting in the forests were recognized, encompassing pollination, food, tourist attraction and supporting local identities. It is vital here to recognize the three value types, i.e. regulating, material and non-material contributions, associated with the white fronted brown lemur (*Eulemur albifrons*) that may come in conflict. It also should be noted that the values elicited here does not incorporate those attributing to the areas outside forests, such as paddy fields (Figure 27) that constitute the main livelihoods of the local communities.

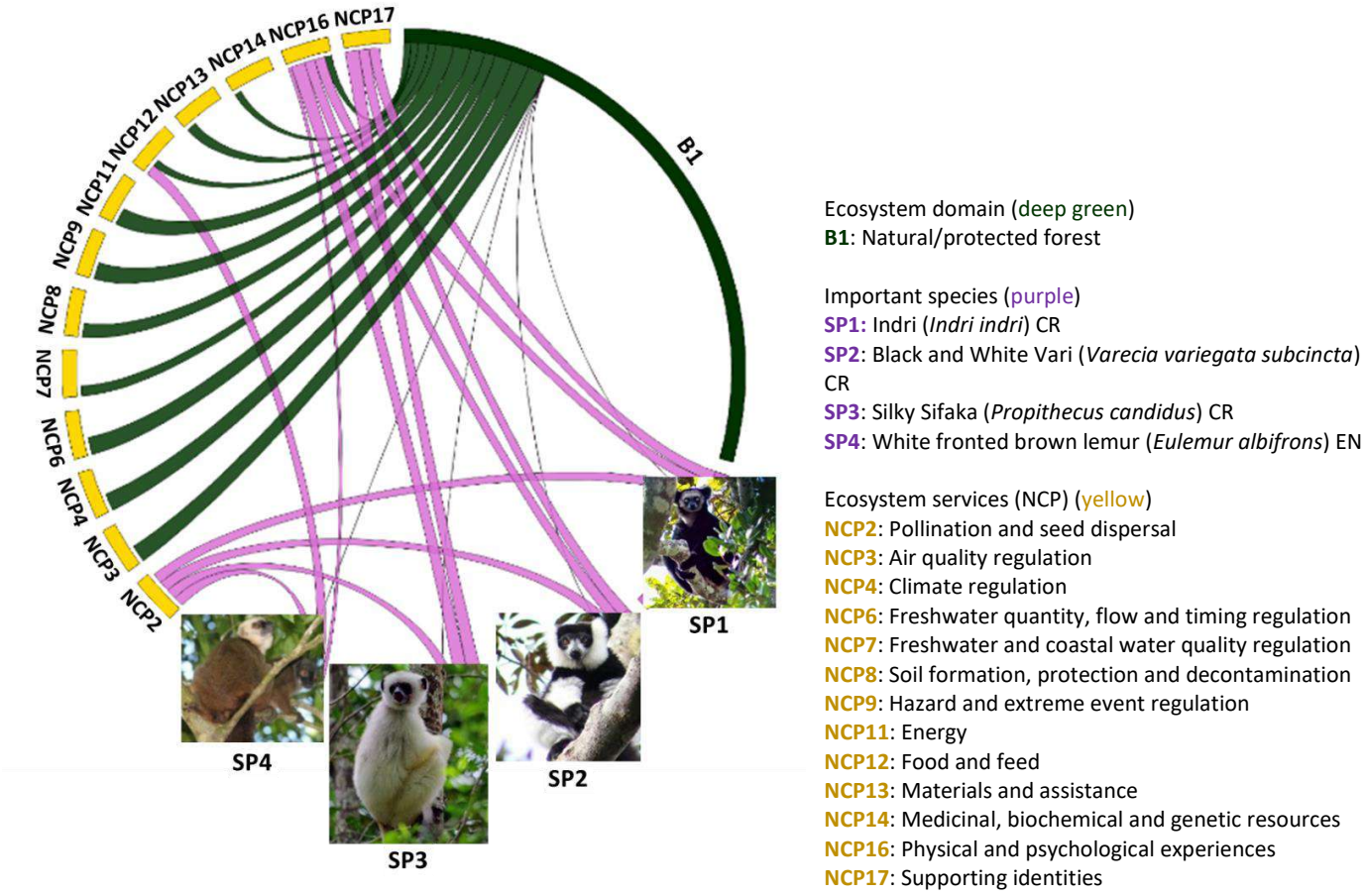


Figure 28. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

These include the provision of the habitats for endangered and critically endangered primate species, which play critical role to maintain the integrity of the forest ecosystem through seed dispersal, and pertain values for local people as tourist attraction (NCP 16) and in their worship (NCP 17). White Fronted Brown Lemur (*Eulemur albifrons*) is exploited for food by local communities. Among the 13 NCP, air quality regulation (NCP 3), climate regulation through carbon sequestration (NCP 4), the regulation of freshwater quantity, flow and timing that benefit local water supply and hydropower

(NCP 6), protection from cyclones (NCP 9), as well as firewood supply (NCP 11) were valued relatively higher than other NCP.

3.6.3 Traditional knowledge

The online survey clarified that, while the local elders well maintain traditional knowledge of plants and animals in forests, the management of non-timber forest products (NTFPs) having been practiced in traditional and sustainable ways has become less practiced. Elders maintain beliefs in the spirits that the three primate species represent, i.e., Black and White Vari, Indri and White Fronted Brown Lemur; and overall the community members share ecological knowledge of Black and White Vari, Indri and Silky Sifaka. Traditional knowledge in these sorts have still been handed down to younger generations only verbally and not in writing. With respect to local knowledge, in the Resilience Indicators Workshop people expressed that they are proactively innovating agriculture and conservation practices, including sustainable rice cultivation, permaculture, agroforestry, as well as sustainable clove and cacao productions that merit controlling soil erosion. Therefore, since the 2016 agricultural seasons, 575 farmers have been supported to adopt the improved rice system. In the south of Makira, 1,500 households received support for the establishment of agroforestry composed mainly of cocoa and cloves

Table 26. Traditional knowledge for the use and management of different ecosystem domains and species

Ecosystem	Traditional knowledge		Trend	Knowledge holders		
Species	Domain	Description		NTFP gatherers	Elders	Local community
1.Natural/ protected forest	1.Knowledge	Knowledge of forest animals and plants	↗		◯	
	2.Mgt. system	Environmental knowledge on sustainable NTFP extraction	↘	◯		
Black and White Vari	1.Knowledge	Species identification and taxonomy, life histories, distributions and behavior	↘			◯
	4.World view	Traditional and natural religious beliefs	↗		◯	
Indri	1.Knowledge	Species identification and taxonomy, life histories, distributions and behavior	↘			◯
	4.World view	Traditional and natural religious beliefs	↗		◯	
Silky Sifaka	1.Knowledge	Species identification and taxonomy, life histories, distributions and behavior	→			◯
	4.World view	Traditional and natural religious beliefs	↗			◯
White fronted brown lemur	4.World view	Traditional and natural religious beliefs	→		◯	

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

3.6.4 Governance

Forests in the project area belongs to the Makira Natural Park and thus owned by the government, i.e. the Ministry of Environment, Water, Forest and Tourism, and are managed by an NGO Wildlife Conservation Society (WCS) under the government's concession. A network of community associations (COBAs) are delegated to manage their adjacent forests under community-driven natural resource management agreement and plans (Table 27).

Forest clearance for farmland expansion, illegal logging, residential area expansion and bushmeat hunting constitute the major direct causes of forest loss and degradation and subsequently threat the viability of the populations of endangered primate species (Figure 29). These are triggered by a number of indirect drivers, such as the pressures from increasing human population, demand for cash crops, NTFPs and bushmeat, overreliance of the poor on forest resources, ICTs supporting illegal

logging and hunting, as well as weak governance. The project tackles these issues by several means, including the introduction of co-management that engages voluntary agreement and collaborative law enforcement, NTFPs certifications and export, environmental education as well as the provision of alternative crops and protein sources. WCS plays a pivotal role in designing and implementing a series of interventions, in which the government and community-based organizations participate under a co-management scheme.

Table 27. Ecosystem governance structure

Ecosystem type	Protected/natural forest	Stakeholder type
Ownership	Ministry of Environment, Water, Forest and Tourism	Government or public
Management right holder	Wildlife Conservation Society	Non-governmental
Other stakeholders	Network of community associations (COBAs)	Formal community org.

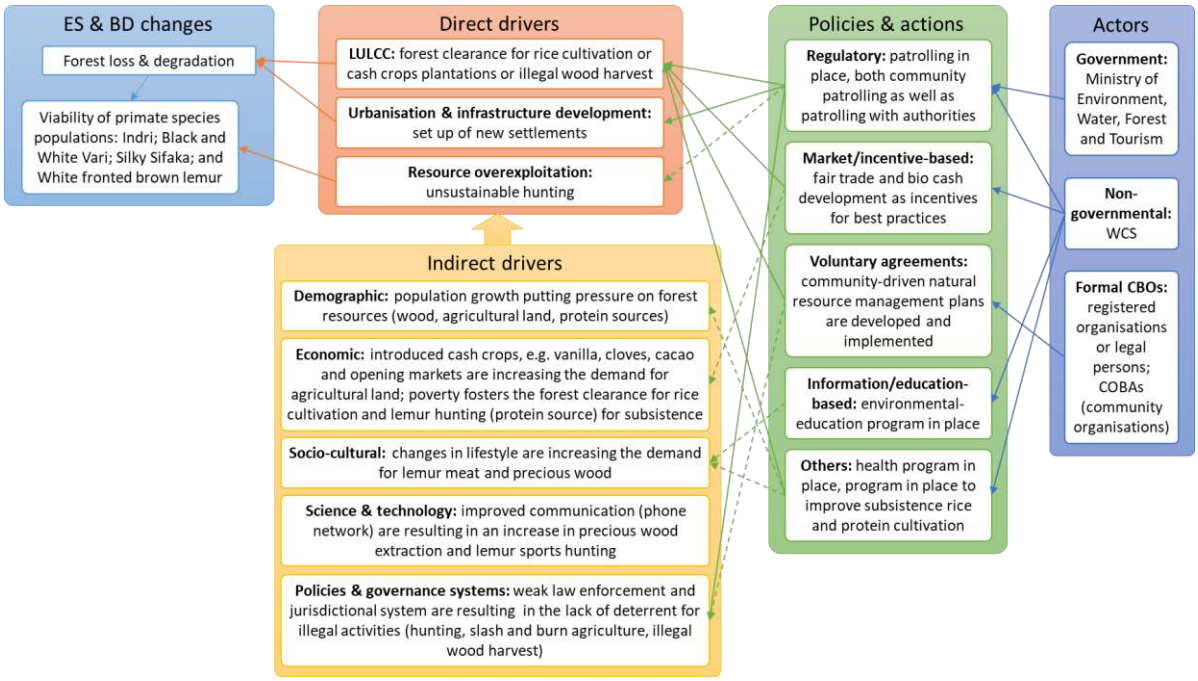


Figure 29. The configuration of the linkages between ecosystem and biodiversity changes, their direct and indirect drivers and corresponding policies and actions

3.6.5 Values–knowledge–governance interplay in the Makira landscape

The interplay between the values, traditional knowledge and governance of the forest ecosystem and residing endangered lemur species are found (**Table 28**). These provide the basis for ensuring the sustainability of the integrity of the forest ecosystem, as well as the viability of lemur populations.

NTFPs harvested in forests constitute important livelihood sources for adjacent communities, but their resource sustainability is now contested due to increasing population pressure and the loss of traditional knowledge on sustainable NTFP harvest. To ensure resource sustainability, NTFP certification has introduced in which traditional and modern knowledge are integrated, and producers are incentivized to implement best sustainable practices.

Lemur species have two conflicting value aspects for local people, i.e. their intrinsic value as the representation of ancestral spirits that support people's identities, vs. utilitarian value for bushmeat. Given that mainly elders appreciate the spiritual value, and that the ecological knowledge of lemurs

held by wider local community members have been disappearing, the latter can override the former in decades. However, the co-management scheme implemented by the project can offer an opportunity where the local traditional beliefs are respected and integrated into the formal reciprocal agreement with the government and natural resource management plans.

Table 28. The interplay between the value, knowledge and governance within three major ecosystem domains in the project site.

Ecosystems and species	Value (NCP*)	Knowledge	Governance: issues and stakeholders
Makira Forest	12. NTFPs such as honey and small mammals	Knowledge on sustainable use of NTFPs held by NTFP gatherers, which is currently in decline	NGO (WCS) is now implementing NTFP certification and product export to incentivize the adoption of best practices
Indri; Black and White Vari; Silky Sifaka; and White footed brown lemur	12. Bushmeat 16. Tourist attraction 17. Traditional beliefs	Traditional beliefs in the spirits dwelling in lemur species maintained mainly by elders. Local communities share ecological knowledge on lemurs, which is currently in moderate decline.	Natural resource management delegated to local communities and collaborative patrols executed under co-management scheme. Alternatives for livelihoods and cash are explored to mitigate anthropogenic pressures.

* NCP 12 Food and feed; 16 Physical and psychological experiences; 17 Supporting identities

3.7 India: Sustainable management of SEPLS and mainstreaming of biodiversity conservation in the State of Nagaland, India.

3.7.1 Landscape and project overview

The project is situated in the Zunheboto district of North-east Indian state of Nagaland and spans over an area of 5794.24 ha, covering three villages, namely Sukhai, Ghukhuyi and Kivikhu (see Figure 30). The primary ecosystem of the project area is dense to very dense forests which are extremely rich in biodiversity and ecosystem services, but areas cleared for 2-year shifting cultivation, as well as areas under renaturation are also characteristic of the landscape. The project surrounding areas include the well-known Ghosu bird sanctuary, which hosts more than 20 endangered bird species. The project areas, including the buffer zone, contain large extent of natural/protected forests (10822.54 ha). The other dominant ecosystems within the project area include (a) managed/ resource forests (2331.62 ha), (b) farmland (2074.1 ha), and (c) rural settlements (127.56 ha) (Questionnaire survey). The project proponents identified that all forested ecosystems including both protected and managed forests decreased since the past 10 to 20 years, while farmland increased considerably, owing to shifting cultivation, predominantly by conversion of forests to farmland.

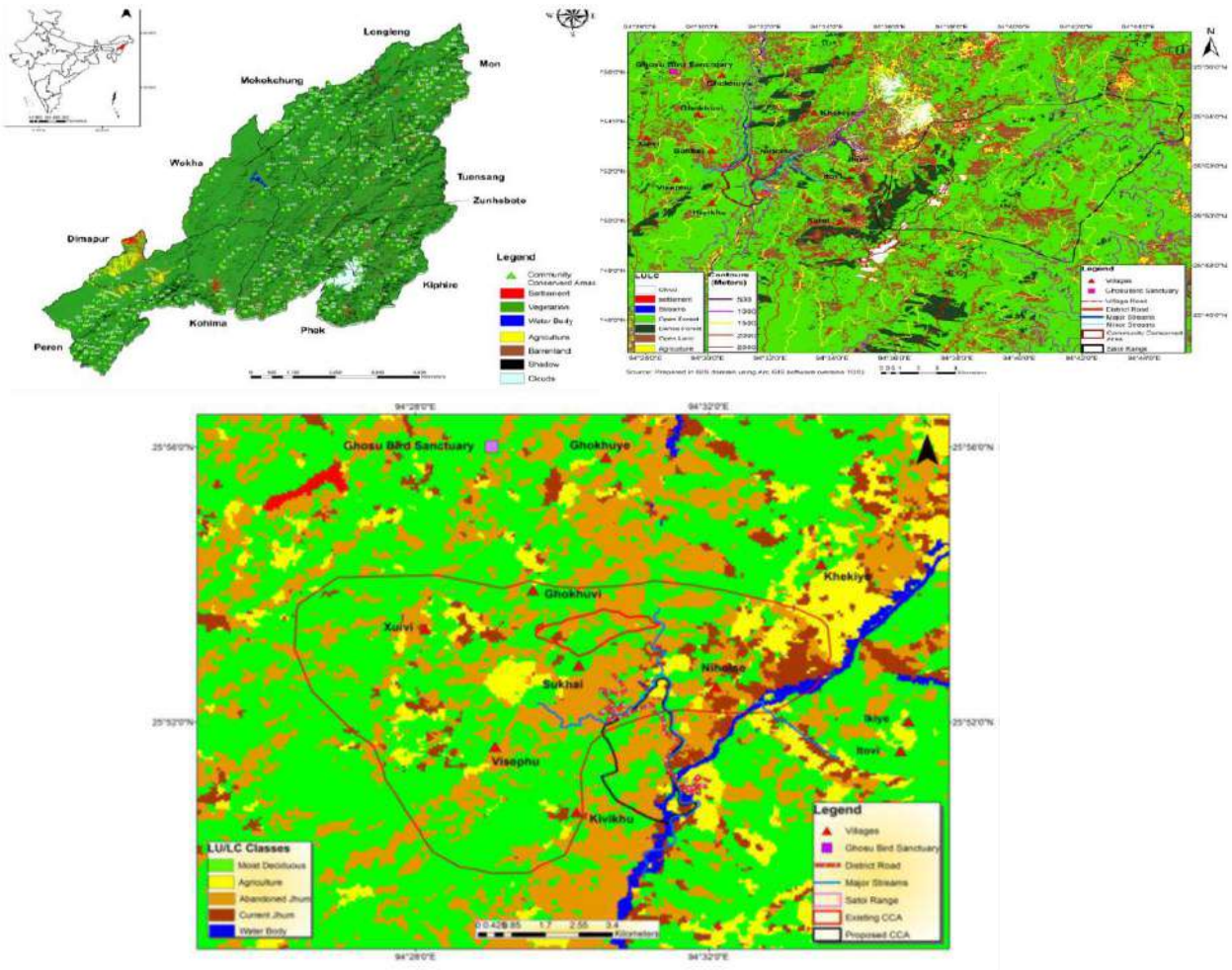


Figure 30. Location and Land-use map of Nagaland and project area (top) and detailed land-use map of the project area, with boundary of the project areas and location of the villages marked in red (bottom).

Despite its rich natural forested landscapes, the local biodiversity is threatened by indiscriminate hunting, tree felling and habitat destruction through reduced fallow shifting cultivation - which is locally known as Jhum cultivation. Indiscriminate hunting, on the other hand, is a significant driver of wildlife loss in the project areas, which led to potentially cascading effects from unraveling ecological interactions with serious consequences for ecosystems and the services. The local community, Sema, traditionally used a variety of traps and snares, which were replaced by guns and destructive fishing practices (e.g. dynamite or electric currents) in modern times. This led to alarming decline in wildlife over the past. In the questionnaire survey, three avian species were identified by the proponents as locally important which require special attention considering their cultural and ecological values. This includes (a) Great Barbet (*Psilopogon virens*) which is socio-culturally important to local communities due to its value as a 'timekeeper', (b) Blyth's Tragopan (*Tragopan blythii*) and (c) Indian cuckoo (*Cuculus micropterus*) (locally called Kasu pa po in the Sema language). These birds belong to 'Least concern' to 'vulnerable' category as per the IUCN classification, however, accordingly to the questionnaire survey the population of Blyth's tragopan is of critical concern as it is seldom encountered recently.

Box 9. TERI project overview

In Nagaland, traditional conservation and wise-use practices have helped protect biodiversity over the centuries. Despite this, rampant hunting, forest degradation and tree felling are greatly threatening the State's biodiversity. The revival of traditional conservation practices through the creation of Community-Conserved Areas, however, offers hope for conservation, as communities set aside parcels of forests within productive, jhum (shifting cultivation) landscapes. Yet, CCAs face numerous challenges- in their creation, effectiveness and sustainability.

To ensure the future of Nagaland's CCAs and thereby its biodiversity, a multi-pronged approach was taken in this project, which includes alternative livelihood opportunities through the development of wildlife tourism, legal recognition, ecological restoration, and ecological monitoring. The objectives of this project were to support community-based conservation, in order to

a) mobilize support for the formation of CCAs including larger networks of contiguous forest patches in Zunheboto district

b) Revive traditional conservation practices (e.g. hunting bans during the breeding season)

c) Carry out ecological assessments of these CCAs including the status of the Vulnerable Blyth's Tragopan and other globally threatened species,

d) develop community-based ecotourism initiatives e) Formalize and mainstream a network of CCAs along with the Nagaland Government and Forest Department. (GEF-Satoyama website).

TERI, the project proponent was able to instigate the above-mentioned changes, through active community participation. This in turn, led to the desired transition towards sustainability, while respecting traditional and customary rights.

3.7.2 Values

The project implementer, TERI, identified seven Nature's contributions to people (NCPs) associated with the ecosystem domains and species present at the site (**Figure 31**). Pollination and seed dispersal (NCP2), freshwater flow regulation (NCP 6), energy production (NCP 11), food and feed (NCP 12) were the most frequently documented value, which were primarily derived from natural/protected areas. The project proponents reported that the protected forests are considered important watersheds and contribute regulating freshwater flow, which is required for sustaining local agriculture

and human habitat. Forests also provide wood which is used as a major fuel source in local households. In addition, the secondary/managed forests also contribute to freshwater flow regulation (NCP 6), energy source (NCP 11) and tourist attraction (NCP 16) respectively. Managed forests further provide traditional medicines; although, these are less utilized now. Of the other landscapes, waterbodies contribute significantly to NCP 16 (supporting identifies). For instance, the proponents reveled that Tizu river is an important place-identify which is shared by all the community members living along its length. Contrarily, apart from providing food and feed (NCP 12), the entire lifestyle of the Sema community revolves around the jhum cycle-hunting, festivals, practices, thus, farmland also begets the cultural identify among the villagers (NCP 17). In terms of species, all the three locally important species contribute to tourism (NCP 16), while Great Barbet (*Psilopogon virens*) particularly contribute to seed dispersal (NCP 2).

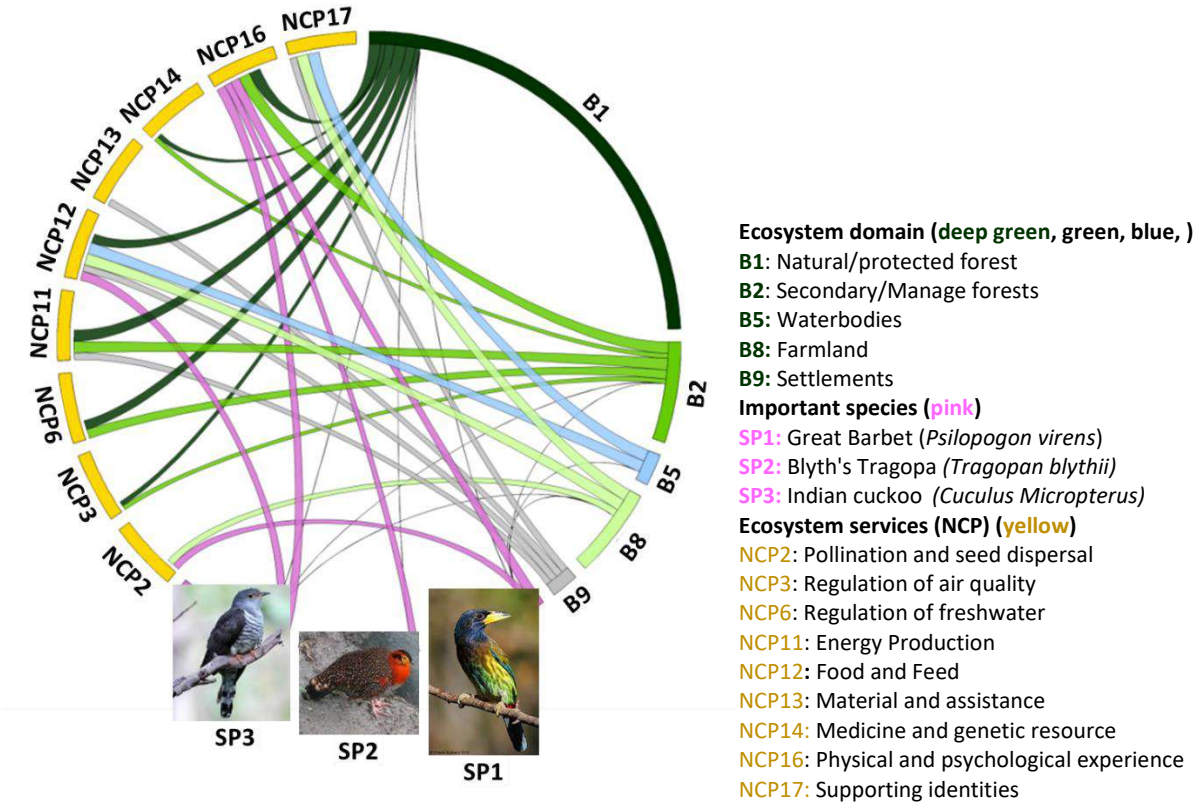


Figure 31. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.7.3 Traditional knowledge

The protected/natural forests have innumerable folkloric stories woven around the plants and animals, for example why some birds and animals look the way they do. The local communities believe in lycanthropy-souls of people enter bodies of tigers or leopards-tigers, which are rarely killed by Naga communities. The Sema Nagas, however had several periodical restrictions (*gennas*) and taboos for the killing of certain game; or example, whoever killed a tiger had to remain chaste for six days. While on the first day he could not eat rice, for the remaining six days he could not eat vegetables except chillies nor any meat except pork and had to sleep away from home on a bed of split bamboo

to prevent sound sleep, lest the spirit of the slain beast attack him. In some tribes such as the Changs this *genna* is observed for thirty days. Various animals were not eaten including several birds for many reasons. In addition, amongst Semas, those who killed a tiger or leopard must abstain from eating plants called *chiiye, ashebaghiye, tsughukutsiye*, or *aghiye*. In case of waterbodies, restriction of fishing or use of poisonous roots and during the spawning season was noted. For, farmland, propitiation of the spirit with rice, and rice beer to beg forgiveness for animals, plants, birds and reptiles inadvertently harmed during clearing of forest land for shifting cultivation (jhum). Moreover, agricultural calendar attuned to nature-sowing of paddy only when Orion (Phogwosiilesipfemi) at zenith or after Kasupapo (Indian cuckoo, *Cuculus micropterus*) is heard calling. There are also number of stories linking humans in villages and wild nature.

Table 29. Traditional knowledge for the use and management of different ecosystems

Ecosystem	Traditional knowledge	
	Domain	Description
1. Natural/ protected forest	2. Mgt. system	Periodical restrictions (gennas) and taboos for the killing of certain game
	4. Worldview	Folkloric stories woven around the plants and animals, e.g. why some birds and animals look the way they do; lycanthropy
5. Freshwater	2. Mgt. system	Restriction of fishing or use of poisonous roots during fish spawning season
8. Farmland	2. Mgt. system	Agricultural calendar attuned to nature-sowing of paddy
	4. Worldview	Propitiation of the spirit with rice and rice beer to beg forgiveness for sacrificing living organisms during clearing of forest land for shifting cultivation

3.7.4 Governance

The governance systems in the landscape differ depending on the type of ecosystem and legal status of the area. Technically, the all protected/natural forests are conserved under the federal forest conservation act, which comes under the jurisdiction of the state forest department. However, the project area being tribal-dominated and isolated, it is often difficult to restrict overexploitation of forests and other biological resources by the local communities. Therefore, governance of forests is largely communal in nature in Nagaland and driven by customary practices. At present, local communities are setting up community conserved areas (CCA), but these have not yet received any legal sanctity within the conservation framework. The main purpose of CCA is to regulate illegal hunting and logging in protected areas, such as banning hunting during the breeding session and to create patches of sustainably managed forests within the Jhum landscapes. Amongst the Semas, Konyaks and Changs, ownership of land vests with the village chief (Akukao). The chief controls the land and hence all power and privileges lie with him to control farmland. The chief decides who gets a piece of land (forest) to farm based on the needs of each member of the village community. The proponents mentioned, that although govt. is supposed to implement the Wildlife (Protection) Act, it does not do so since the customary rights are protected under Article 371 A of the Indian Constitution, but few people are aware that such a law is applicable in Nagaland. **Table 30** shows the different ownership and management rights within the project area, with four major ecosystems.

The survey identified two important local drivers responsible for ecosystem and biodiversity changes in the local landscape (**Figure 32**). Nonetheless, the two direct drivers are magnified with number of indirect drivers. The main direct drivers for the project sites are (1) shifting cultivation (locally known *as Jhum cultivation*) and (2) illegal and indiscriminate hunting of wildlife. Jhum cultivation is a practice involving the slash-and-burn of felled trees within a densely forested patch, generally on the mountain slope. Although shifting cultivation has traditionally been practiced in the area, the proponent informed that that the original cultivation cycles was thirty years, however due to increasing population, it is now turned to 7 years or even less. Hunting, on the other hand, is direct conse-

quence of population growth and changes in socio-cultural values, which is also fueled by week law enforcement. The village council is the main formal decision-making body at the local level, which holds a comparatively strong autonomy given both the traditional village-level governance in Nagaland and the above constitutional recognition of the Naga people's customary rights. In the project area, decision-making on jhum cultivation, particularly the next jhum cycle, traditionally on the sidelines of a harvest festival, and involves the village council traditional chieftains and the wider community.

Table 30. Ecosystem governance structure in the Zunheboto landscape

Ecosystem type	Protected/natural forest	Managed Forests	Waterbodies	Farmland	Stakeholder type
Ownership	Informal/traditional community organization				Community
		Informal/traditional community organization			Community
			Informal/traditional community organization		Community
				Informal/traditional community organization, also village chief (Akukao)	Community Individual
Management right holder	Informal/traditional community organization				Community
		Informal/traditional community organization (e.g. group of forest users or farmers who meet regularly but are not registered)		Village-chief (Akukao)	Individual
Other stakeholders	Illegal timber operations				Individual
		Forest community organizations			Non-governmental
		Village council			Government

Source: Questionnaire survey

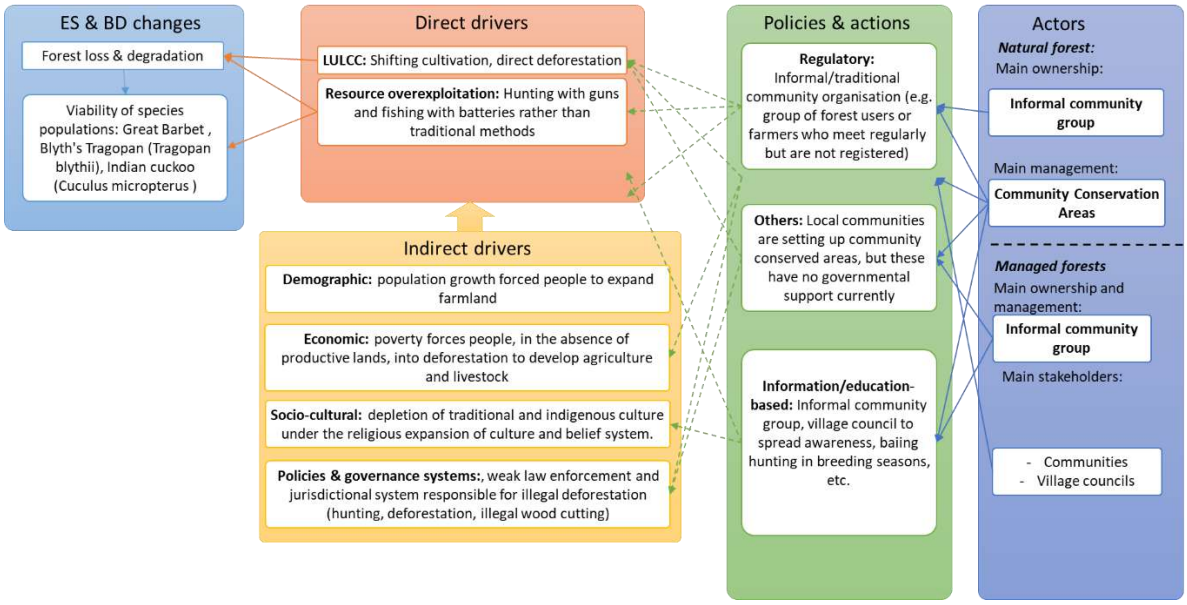


Figure 32. Configuration of the linkages between ecosystem and biodiversity changes, their direct and indirect drivers and corresponding policies and actions

3.7.5 Interplay between values, traditional knowledge and governance

As could be expected, there are significant overlap of NCPs derived from the three major ecosystems, i.e. protected forests, managed forests and farmland. These include (a) NCP-2: Regulation of air quality (b) NCP-11: Food and Feed as well as NCP-15 (Physical and psychological experience). Also, all the three ecosystems are rich with traditional and customary knowledge. Communities, in general, play a pivotal role for the governance of all the three ecosystems, although technical, the local government is responsible. Additionally, village chiefs play a very important role in resource allocation, particularly for farmland, which also showcase the strong community bonding and respect for traditional and customary rights. **Table 31** summarizes the interplay between the value, traditional knowledge and governance within the three major ecosystem domains.

Table 31. Interplay between the value, traditional knowledge and governance within the three major ecosystem domains

Ecosystems/species	Value (NCP*)	Traditional knowledge	Governance: issues and stakeholders
Natural/protected forest	2. Regulation of air quality 5. Regulation of freshwater 10. Energy Production 11. Food and Feed 13. Medicine 15. Physical and psychological experience	1: Local knowledge of land, animals, plants 3: Social institutions	Although forest is concerned technically by the state, in Nagaland, community play a significant role in forest governance, as well as, communities are the most important stakeholder.
Managed forests	2. Regulation of air quality 5. Regulation of freshwater 10. Energy Production 15. Physical and psychological experience	1: Local knowledge of land, animals, plants 3: Social institutions	Community conserved area, managed by informal groups is the main agency responsible for governance, such as restriction of hunting and illegal logging. The main stakeholder is the local community.
Farmland	1: Pollination 11: Food and Feed 16. Supporting identities	2: Land and resource management system 3: Social institutions	Although individual farmers are responsible for farming, the village chief (Akukao) allocate the land to community members.

3.8 Comoros: A landscape management model for conserving biodiversity in the Comoro Islands.

3.8.1 Landscape and project overview

Despite forming part of one of the world's hottest hotspots for biodiversity conservation, the Comoro Islands lack any terrestrial conservation measures. The country lost 24% of its forest between 1990 and 2015 (FAO, 2015), a consequence of high poverty rates, extremely high population pressure, and a high dependence on agriculture for livelihoods - amongst other factors. The main threats to natural forest cover are the extension of the agricultural frontier and the cutting of old-growth trees for timber. Charcoal, wood for cooking and for ylang ylang distillation come mainly from agroforestry areas.

The heavy deforestation threatens the livelihoods of both the local population – through loss of water resources and soil fertility – and endemic biodiversity, with over 20 terrestrial species listed as vulnerable or worse on the IUCN's Red List. The situation is particularly critical on Anjouan where population pressure at over 600 people/km^2 is one of the highest in the world. The Moya forest in the south of the island is a managed resource forest, largely secondary forest, on an estimated area of 5,992 ha (questionnaire survey), which is used for agroforestry, and the provision of wood and water. Apart from the key ecosystem services the Moya forest provides for 34,000 beneficiaries it was identified by CEPF identified as a Key Biodiversity Area (KBA).

Box 10. Dahari project overview

This project, titled "A landscape management model for conserving biodiversity in the Comoro Islands", seeks to consolidate a community-led model for landscape management for the Comoros, combining forest and biodiversity protection with agricultural and agroforestry development in 10 villages surrounding the Moya forest KBA in Anjouan. The project, implemented by the NGO Dahari, will support over 2000 farmers and thus 10,000 direct beneficiaries to improve their revenues from agriculture and agroforestry.

The project will map traditional knowledge regarding the advantages and disadvantages of different trees for different purposes, and combine this with scientific understanding to propose improved agroforestry regimes. At the same time at least 400 hectares of forest conserving key ecosystem services, notably water provisioning, will be put under management by communities supported by local authorities, and at least 40 hectares conserving biodiversity hotspots. A fourth component will look to integrate the model into national policy and legislation. Lessons learnt will be recorded in peer-reviewed articles and be applicable to Small Island Developing States (SIDS) and any seascapes and landscapes with high agriculture and natural resource dependency.

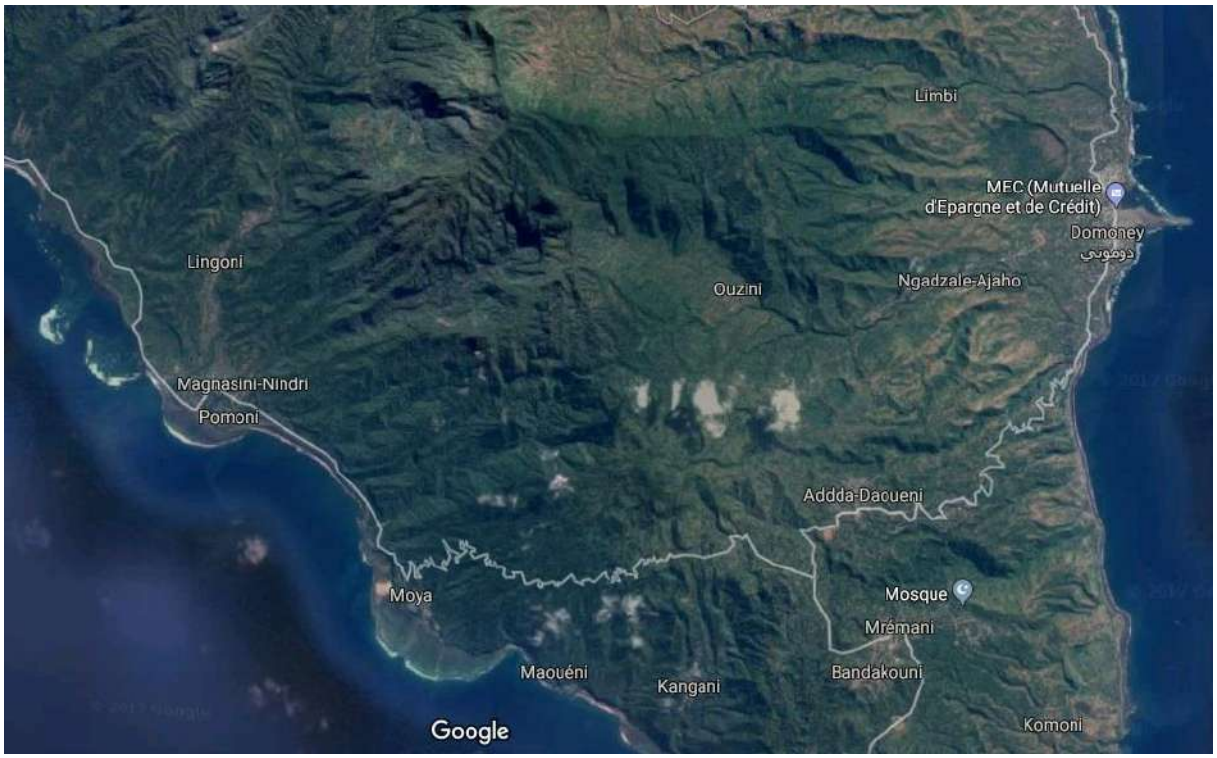


Figure 33. Maps showing the Dahari's GEF-Satoyama project area. (Source: Dahari and Google map)

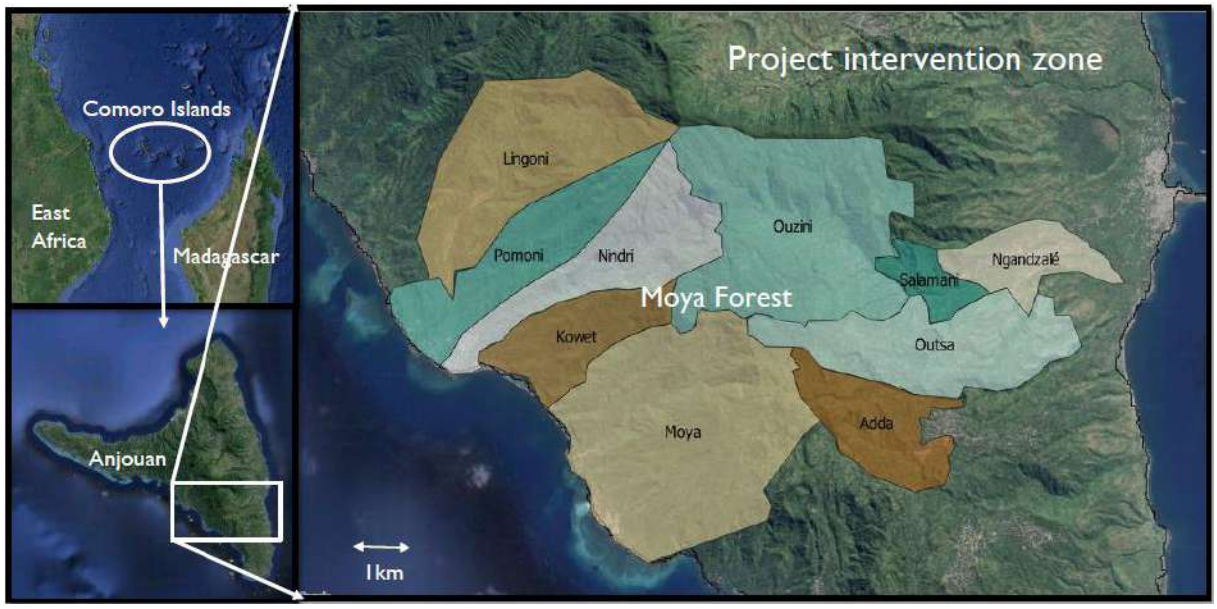


Figure 34. The areal details of the Moya forest landscape (below). Source: Dahari and Google map

Among the species of animals, plants or other organisms considered most important in terms of their threatened species status, endemism or values for local people, Dahari identified the following five: the Anjouan scop's owl (*Otus capnodes*), the Comoro ground gecko (*Paroedura sanctijohannis*), the Livingstone's fruit bat (*Pteropus Livingstonii*), the mongoose lemur (*Eulemur mongoz*) and the butterfly *Papilio aristophantes*. The IUCN lists the Livingstone's fruit bat as Critically Endangered, and the other four as Endangered.

3.8.2 Values

The project implementer, Dahari, identified six NCPs associated with the ecosystem domains and species present at the site (Figure 35). Pollination and seed dispersal (NCP 2) were the most frequently recorded NCP, being associated with both the resource forest ecosystem and two of the five important species (the Livingstone fruit bat and the mongoose lemur). Climate regulation (NCP 4), freshwater flow regulation (NCP 6) as well as food and feed (NCP 12) were rated as 'critically important' to the local community. The importance of freshwater supply is increasing as deforestation has led to a decrease in the number of rivers of 40-50%. The provision of 'energy' is another NCP that is provided by the resource forest and is considered ´important', as the main wood use is for cooking. The Anjouan scop's owl also plays a moderately important role in the regulation of detrimental organisms eating rodents in the field. Overall, the local communities and authorities, which primarily own and manage the landscape for production purposes, have relatively homogenous perception of the value of SEPLS which centers on the functions of SEPLS that support their productions.

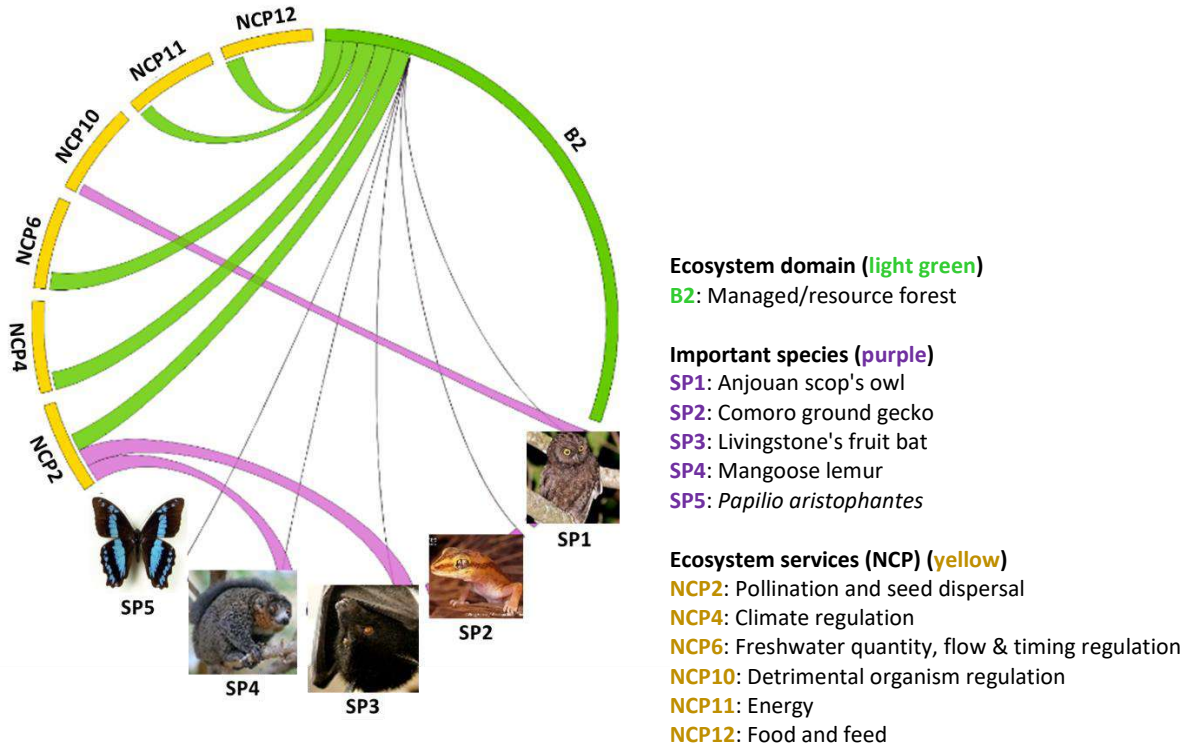


Figure 35. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.8.3 Traditional knowledge

The transmission of information is mainly oral between the generations of farmers in the communities. This is the main factor why IKLP is increasingly being lost, particularly on the tree species in the resource forest that help protect the water sources (Table 32). Therefore, Dahari's project intervention seeks to harness traditional knowledge about indigenous and commonly-used introduced tree species in the Comoros – their advantages and disadvantages for different purposes – and combining

this with expert support from international partners. The integration of these two knowledge systems will allow identifying a variety of tree and crop regimes depending on what goals are prioritized for different areas (water preservation, biodiversity conservation, revenue generation and/or fertilization).

Knowledge also exists on the role of species in rodent control, and the contribution to seed dispersal and forest regeneration. However, the authorities do not take into account the IKLP and local initiatives in their decisions on natural resource management. The absence of public authorities in integrated resource management and challenges to assume their responsibilities explain the existing gap between the national law and the local rules. Science based in-depth research on local biodiversity is also lacking (questionnaire survey).

Table 32. Traditional knowledge for the use and management of different ecosystem domains and species

Ecosystem	Traditional knowledge		Trend	Knowledge holders
Species	Domain	Description		Farmers
2.Managed/resource forest	1.Knowledge	Knowledge about species being able to protect the water resource	↘	◯
Anjouan scop's owl	1.Knowledge	Rodent control	NK	◯
Livingstone's fruit bat	1.Knowledge	Contribute to seed dispersal and forest regeneration	NK	◯
Mangoose lemur	1.Knowledge	Contribute to seed dispersal and forest regeneration	NK	◯

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

NK: not known

3.8.4 Governance

Informal community-based *natural resources management committees* in the villages of the Moya Forest hold both the main ownership and management of the resource forests in the landscape (**Table 33**). They are part of the traditional village governance structures that exist in the Comoros and particularly Anjouan but generally informal and not structured. However, governance of natural resources forest ecosystems is usually weak at all levels, including the local authorities, with low levels of capacity and community cohesion. This complicates achieving effective community management within and between villages. In the Moya Forest, there are plans to create a terrestrial protected area (online questionnaire survey).

Table 33. Ecosystem governance structure in the landscape

Ecosystem type	**Managed/resource forest**	Stakeholder type
Main ownership	Natural resources management committees	Informal community org.
Management right holder	Natural resources management committees	Informal community org.
Other stakeholders	Local authorities, UNDP	Government or public
	Dahari	Non-governmental
	Farmers	Individual
	ICRAF,	Distant end users
	CEPF, EU, Bangor University (UK)	International organisations

Some meeting regularly realized with majors (Moya, Adda, Ngandzalé), the Director of the environment in Anjouan, the representing of the UNDP. The objectives were to exchange about the field activities to promote the participation and with the Director it was to organize a workshop to reflecting about the tree cut rules.

The resource forest ecosystem has experienced deforestation and forest degradation due to a number of direct drivers including extension of the agricultural frontier, and an overexploitation of natural resources, particularly wood for charcoal, cooking and ylang ylang distillation (**Figure 36**). Underlying indirect drivers include a high population growth and density, a high dependency on agriculture for livelihoods, lack of employment in industry and tourism, poor social cohesion and weak governance. While the community-based natural resource management committees don't have really the right to manage but they support the farmer for their natural resources management and use the forests they lack capacity. Insufficient local governance institutions and the absence of the State negatively affect the management of natural resources & biodiversity conservation. But currently the UNDP support the Comorian government to create some protected areas whole the islands.

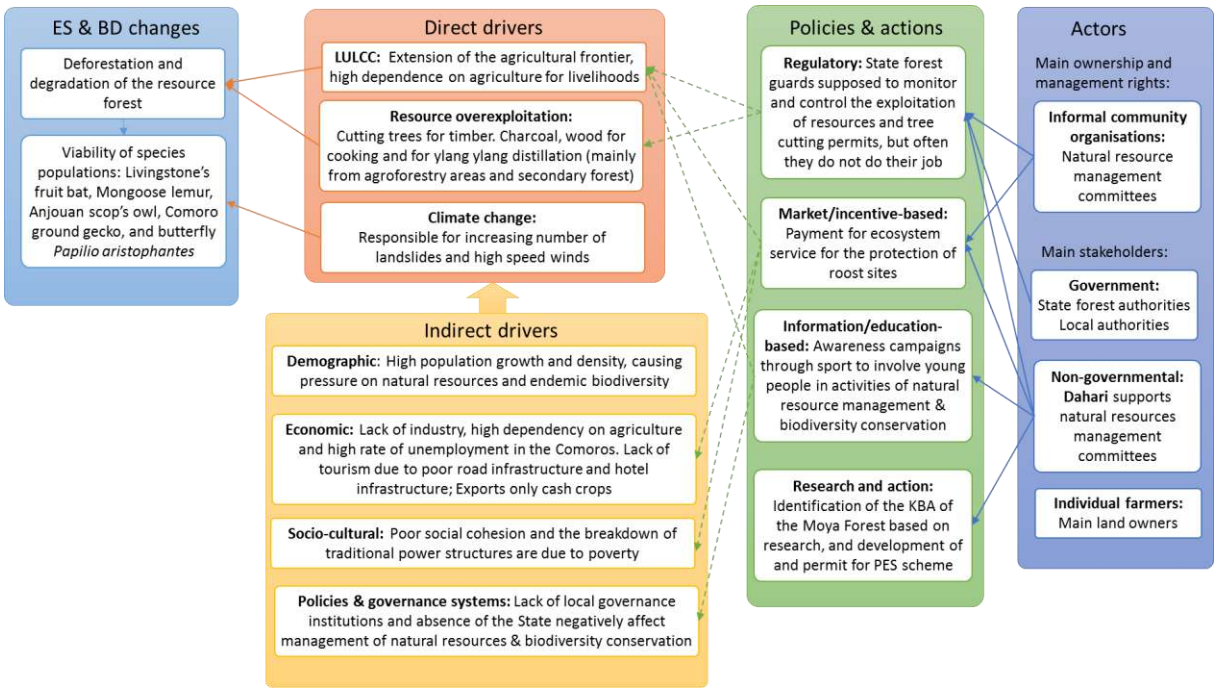


Figure 36. Configuration of the linkages between ecosystem and biodiversity changes, their direct and indirect drivers and corresponding policies and actions

Combining forest and biodiversity protection with agricultural and agroforestry development in ten villages surrounding the Moya forest KBA in Anjouan. In the Comoro Islands, the community members find that community rules exist and certain areas of the landscape are protected, however these rules are not documented. They also find that in the areas, awareness-raising on sustainable management of natural resources is carried out, but resource management and use remains unsustainable. Water management committees that work on management of natural resources are also recognized during the workshop, and these committees are supported by Dahari, but they manage only some portions of the forest. Thus, the participants of the workshop came up with the action plans to develop the written rules for forest management and biodiversity conservation practices, organize village meetings inviting community members, water management committees and local authorities to discuss rules for tree cutting, promote the role of committees in water management in the villages including forest management, and conduct awareness-raising meetings for management of tree cutting in the area.

3.8.5 Interplay between values, traditional knowledge and governance

Table 34 summarizes the interplay between the value, traditional knowledge and governance within the two main ecosystems. Traditional knowledge of local communities and their natural resource management committees related to tree species and their role and water resources conservation has been important to ensure NCPs such as pollination and seed dispersal as well as regulation of freshwater quantity and flow. The involvement of the local community in the management of the resource forests through the committees has been a key governance factor for the conservation of this ecosystem domain. However, the lack of capacity for appropriate management, insufficient local institutions and the absence of the State in the management of the forests have contributed to their degradation.

Through the project intervention, Dahari has provided support to the natural-resource management committees empowering them to monitor and control their natural resources and has sought to involve local authorities in this process. Dahari has also concluded a protection agreement of a Livingstone fruit bat roost site with the landholder as one of four agreements. The aim is to preserve the environment of the Livingstone fruit bats, by protecting its roost sites and by supporting the regeneration of the natural forest surrounding its habitat. Dahari will in turn support the landholder to improve his agricultural income and to promote his environmental protection efforts. The landholder committed himself not to cut any trees on the roost site, and to replant it with newly grown natural forest trees.

Table 34. The interplay between the value, traditional knowledge and governance within three major ecosystem domains

Ecosystems/species	Value (NCP*)	Traditional knowledge	Governance: issues and stakeholders
Managed / resource forest	1. Pollination & seed dispersal 3. Climate regulation 5. Freshwater quantity, flow & timing regulation 9. Detrimental organism regulation 10.Energy 11.Food and feed	Knowledge of tree species that help protect the water sources and species important for rodent control, and the contribution to seed dispersal and forest regeneration	Community-based natural resource management committees have the right to manage and use the forests but lack capacity. Insufficient local governance institutions and the absence of the State in the management of natural resources & biodiversity conservation.
Farmland	1. Pollination & seed dispersal 5. Freshwater quantity, flow & timing regulation 11.Food and feed	Knowledge of traditional agricultural practices	Insufficient local governance institutions and the absence of the State in agriculture management

3.9 Ecuador: Improvement of the livelihoods of the communities through the sustainable management of productive landscapes and biodiversity conservation in mangrove (Estuaries Chone and Portoviejo), the dry forest (Cordillera del Balsamo) and rainforest (Commune Playa de Oro).

3.9.1 Landscape/seascape and project overview

The project area encompasses three ecosystem domains, i.e. mangrove, coastal dry forest and rainforest, which represent the Ecuadorian coastal landscapes and seascapes with rich biodiversity and vital ecosystem services that underpin the livelihood and security of rural communities (**Figure 37, Box 11**).

Figure 37. FIDES's project site locations

Box 11. FIDES project overview

Mangroves provide a number of important ecological functions, especially the support for the reproduction of marine vertebrates and invertebrates that constitute major protein sources and economic gains for local communities. However, mangroves have cleared by 60% in Ecuador and 80% in Manabi province for developing shrimp aquaculture ponds, which led to the sharp decline of fish, mollusks and crabs in few decades. To secure the remnant mangroves and recover the lost functions, mangrove areas in Chone River Estuary were gazetted as a protected area in 2004, and those in Portoviejo became a community protected area in 2011. Since then a series of restoration efforts have been undertaken, including mangrove replanting and integrated river basin management.

Coastal dry forest in Ecuador entails high endemism and biodiversity, but has lost by 90% for timber extraction, farmland expansion and urbanization. Against this backdrop, ten private landowners in Cordillera del Balsamo are voluntarily protecting the dry forest, and currently processing the registration of their lands as Provincial Protected Areas under the Ecuadorian protected areas system.

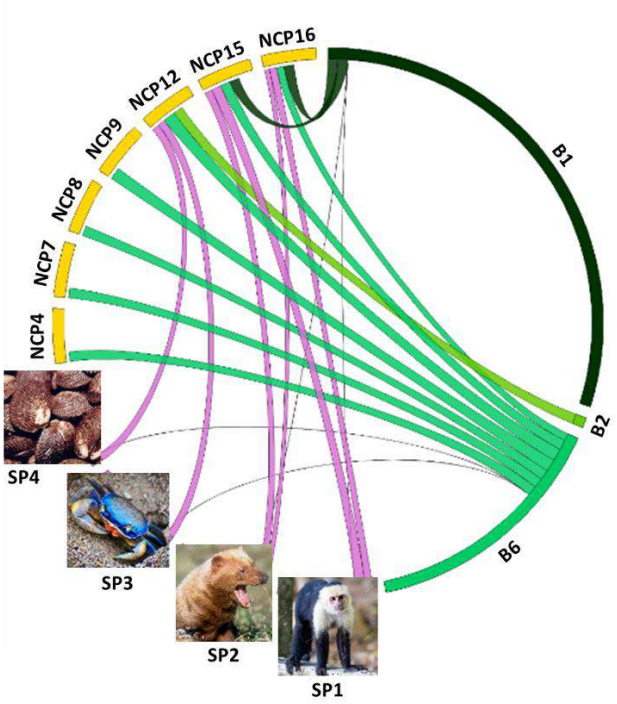
The lowland rainforests on the Santiago river banks, extending to 10,000 hectares and covered largely by pristine vegetation, are protected by the Playa de Oro, an afro-descendant community under their customary ownership and management. Cocoa growing in a mixed agro-ecosystem is their main income sources, and currently community tourism is on rise.

The project aims to strengthen biodiversity conservation and restoration in these three ecosystem domains to ensure the livelihoods and security of local people by:

- Restoration of ecosystems and the goods and services they provide to local communities through community-based diagnosis, management and restoration activities;
- Livelihood support through the improvement of artisanal salt production, community tourism and organic cocoa production and marketing;
- School education and community leadership programmes; and
- Advocacy for the policy uptake of the Chone River Estuary recovery plan and the Portoviejo river basin management plan.

3.9.2 Values

The project proponent recognized different values that local communities associate with different ecosystem domains and inhabiting species (Figure 38). Among these, food supply (NCP 12) was valued the highest, including cocoa from agroforests by the Playa de Oro people; and fish, crabs and mollusks reproducing or caught in mangroves for coastal communities. Tourism, including science tourism (NCP 15, 16), takes place in all ecosystem domains, where rare animals such as the Ecuadorian Capuchin (*Cebus albifrons aequatorialis*), categorized as critically endangered (CR) by the IUCN Red List, attract visitors' attention. The diagram also highlights the multiple value aspects of mangroves, encompassing carbon capture (NCP 4), mitigating groundwater salinization (NCP 7), water and sediment filtration (NCP 8), protection from storm and hurricane hazards (NCP 9) in addition to NCP 12, 15 and 16 mentioned above.



Ecosystem domain (deep green, yellow green, light green)
B1: Natural/protected forest
B2: Managed/resource forest
B6: Coastal ecotone

Important species (purple)
SP1: Ecuadorian Capuchin (*Cebus albifrons aequatorialis*) (CR)
SP2: Perro de monte (*Speothos venaticus*) (VU)
SP3: Blue crab (*Cangrejo azul*)
SP4: Black shell (*Concha prieta*)

Ecosystem services (NCP) (yellow)
NCP4: Climate regulation
NCP7: Freshwater and coastal water quality regulation
NCP8: Soil formation, protection and decontamination
NCP9: Hazard and extreme event regulation
NCP12: Food and feed
NCP15: Learning and inspiration
NCP16: Physical and psychological experiences

Figure 38. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.9.3 Traditional knowledge

The Playa de Oro people, residing in the lowland rainforest, own knowledge on the medicinal properties from wild plants, and practice traditional agroforestry relying on lunar calendar especially for pruning. The coastal communities living adjacent to mangrove forests practice customary resource management systems linked to their mythological beliefs, such as Community Vedas (meaning closed season). They also have the knowledge on the identification of Black shell (*Cancha prieta*) and Blue crab (*Cangrejo azul*). These knowledge and management practices are all in decline, while critical for local communities to secure the functioning of each ecosystem domain and thus for supporting their livelihood (**Table 35**).

Table 35. Traditional knowledge for the use and management of different ecosystem domains and species

Ecosystem domain	Traditional knowledge		Trend	Knowledge holders
Species	Domain	Description		Local community
1.Natural/protected forest	1.Knowledge	Medicinal properties of the parts of some plants (roots, seeds, flowers, bark)	↘	○
2.Managed/resource forest	2.Mgt. system	Lunar calendar for agricultural activities, especially pruning.	↘	○
6.Coastal ecotone, e.g. mangrove	2.Mgt. system	Community Vedas (closed season) based on the intervention of mythological beings (La Tunda and El Riviel)	↘	○
Black shell (*Concha prieta*)	1.Knowledge	Information on identification and taxonomy	↘	○
Blue crab (*Cangrejo azul*)	1.Knowledge	Information on identification and taxonomy	↘	○

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

3.9.4 Governance

The four project sites under three different ecosystem domains, i.e. mangroves (Chone River and Portoviejo River Estuaries), coastal dry forest and lowland rainforest, are spatially disconnected and under completely different governance regimes (**Table 36**). Among the two mangrove sites, the Chone River Estuary mangrove is owned and managed by the state under its protected area system with limited local participation. The small mangrove fragments in the Portoviejo River Estuary are currently managed by the community and in process towards registration as a community protected area under the national protected area system. The coastal dry forests are privately owned and managed, to which FIDES provide support for the preparation and implementation of management plans. The lowland rainforests on the Santiago riverbanks are owned and managed by the Playa de Oro commune in collaboration with the Ministry of Environment under its Social-Forest Programme.

The survey identified downward trend of ecosystem integrity or the population of important species in mangroves and lowland rainforests, among the three ecosystem domains.

Mangrove loss and degradation are caused by the expansion of shrimp farms, house and hotel constructions, overfishing, water pollution and waste dumping, which subsequently resulted in the reduction of fish, crab and mollusk stocks (**Figure 39.a**). Behind these are increasing urban and rural populations, expanding shrimp farms for cash gains, socio-cultural shift away from artisanal fisheries, as well as the limited linkage between statutory law and customary local governance. Regulatory measures are in place to abate the direct causes, such as the protected areas designation by the state, the size and seasonal limits by state for crab catch, as well as the regulations on waste and sewage management by the local government. The mangrove fragments in the Portoviejo Estuary are now under communal management, and in process for the co-management agreement under the National Protected Area System (SNAP).

The integrity of the lowland rainforests is relatively well maintained under the Playa de Oro's communal tenure, but few inhabiting mammalian species that move across wilder landscapes, such as Bush Dog (*Speothos venaticus*), are in decline due to habitat loss and hunting in neighboring areas (**Figure 39.b**). Although limited within the areas owned by the Playa de Oro commune, effective governance is in place that employed financial conservation incentive and a co-management scheme.

Table 36. Ecosystem governance structure

Ecosystem type	Mangrove	Coastal dry forest	Lowland rainforest	Stakeholder type
Ownership	The Chone River Estuary: State The Portoviejo River Estuary: Community	Private landowners (private)	Playa de Oro community (formal community organization)	
Management right holder	Primarily managed under the national protected area system. Some remnants are under community concession for custody and sustainable use (formal community organizations)	Private landowners (private)	Playa de Oro community (formal community organization) has communal management right of forests in general, except for the cocoa farms which are managed by individual community members	
Other stakeholders	Ministry of the Environment, Local governments.	Provincial government of Manabí	Ministry of the Environment (socio-forest program) in Playa de Oro Community.	Government or public
	FIDES	FIDES Foundation	FIDES	NGO
		Cerro Seco Foundation Private Owners Network National (Nodo El Bálsamo)	Playa de Oro community	Formal community org.

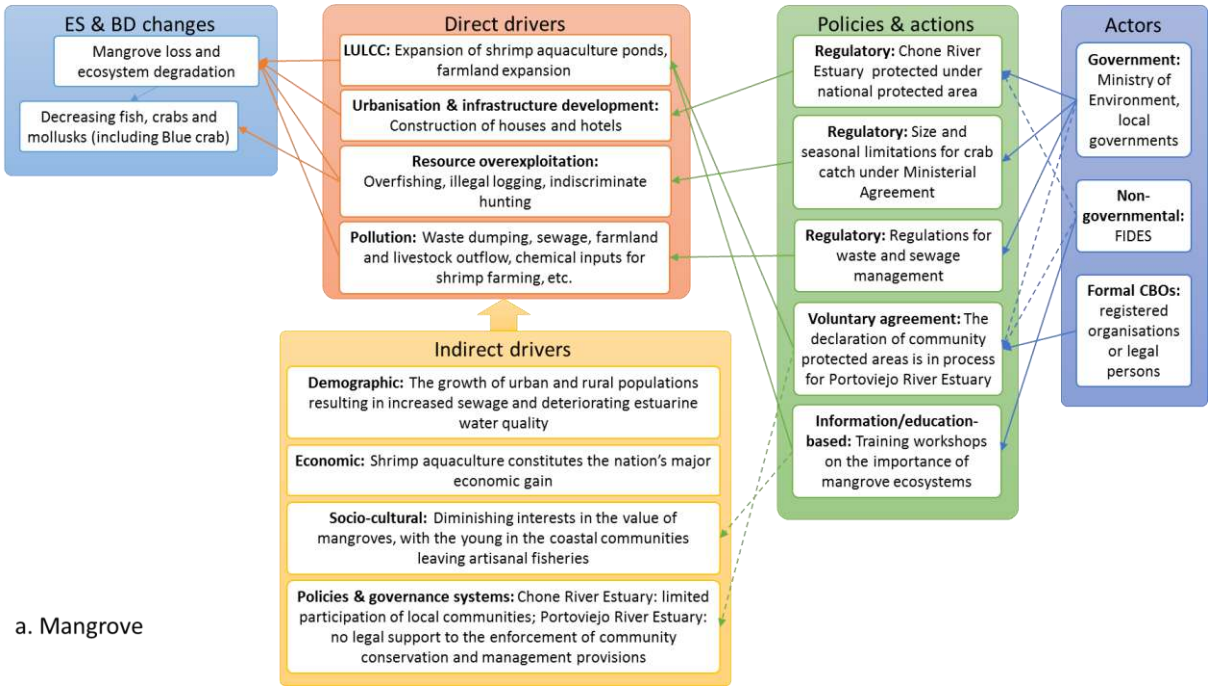


Figure 39. Configuration of the linkages between ecosystem degradation and species decline, direct drivers and the existing policies for abating the drivers in mangrove (a); lowland rainforests (b) and dry forests (c)

3.9.5 Value–knowledge–governance interplay in Ecuadorian coastal landscapes and seascapes

Interlinkage between value, traditional knowledge and governance in lowland rainforests and in mangroves was inferred from the online survey results (**Table 37**). In lowland rainforest, cocoa production in mixed agroecosystem is a main income source for Playa de Oro people, in which they maintain traditional agricultural practices, such as pruning, based on lunar calendar. They also have knowledge on the use of plant roots, seeds, flowers and barks for medication, implying that these resources falling under NCP 14, while not elicited by the values question, are valuable for them. Playa de Oro people can take advantage of their tenure and management rights under co-management scheme to maintain these traditional knowledge and customary practices that pertain to valuable rainforest goods.

Coastal communities have the ecological knowledge on Black Shell and Blue Crab that they harvest for food and for cash. They also have customary fisheries management system based on their mythological beliefs, such as closing seasons, which can complement the national regulations on seasonal and size limits for crab catch. Currently the two mangrove sites are in contrary governance regimes: The Chone River Estuary mangrove is protected under the state's protected area system with limited community participation; while the Portoviejo River Estuary mangrove is protected by the community with limited legal support. Here the linkage between the government's and community's roles in an integrated governance scheme would be the key, so that traditional knowledge and customary management practices support the resource sustainability.

Table 37. The interplay between the value, knowledge and governance within three major ecosystem domains

Ecosystems/species	Value (NCP*)	Traditional knowledge	Governance: issues and stakeholders
Lowland rainforest	12. Cocoa 14. Medicinal	Knowledge on the medicinal properties of the parts of some plants (roots, seeds, flowers, bark); Lunar calendar for agricultural activities, especially pruning.	Co-management scheme in place where the Playa de Oro commune has customary ownership and management rights and collaborate with the government under its social forestry programme.
Mangrove	12. Fish, crabs and mollusks for food and for cash	Knowledge on Black shell and Blue crab; Community Vedas (closed season) based on mythological beings (La Tunda and El Riviel)	Chone River Estuary is protected under the state's protected area system, where local community's participation is limited; Portoviejo River Estuary is protected under community protected area currently with limited legal support. National regulations on season/size limits for crab harvest is in place

* NCP 12 Food and feed; 14 Medicinal, biochemical and genetic resources

3.10 Seychelles: The development of a co-management plan, designed by fishers, to minimize the impact of the Seychelles artisanal fishery on threatened species.

3.10.1 Seascape and project overview

The project aims to assess and mitigate artisanal fishers' impacts on threatened fish species in Seychelles through artisanal catch surveys, the development of fisher-led measures to reduce impacts on threatened species, and elaborating these measures into fisheries co-management plan (**Box 12**). While the project interventions take place mainly in the coastal areas of Mahé Island where 90% of artisanal catch is landed, it aims to benefit the marine biodiversity widely in the Mahé Plateau that extends to 3,900,000 hectares (**Figure 40**).

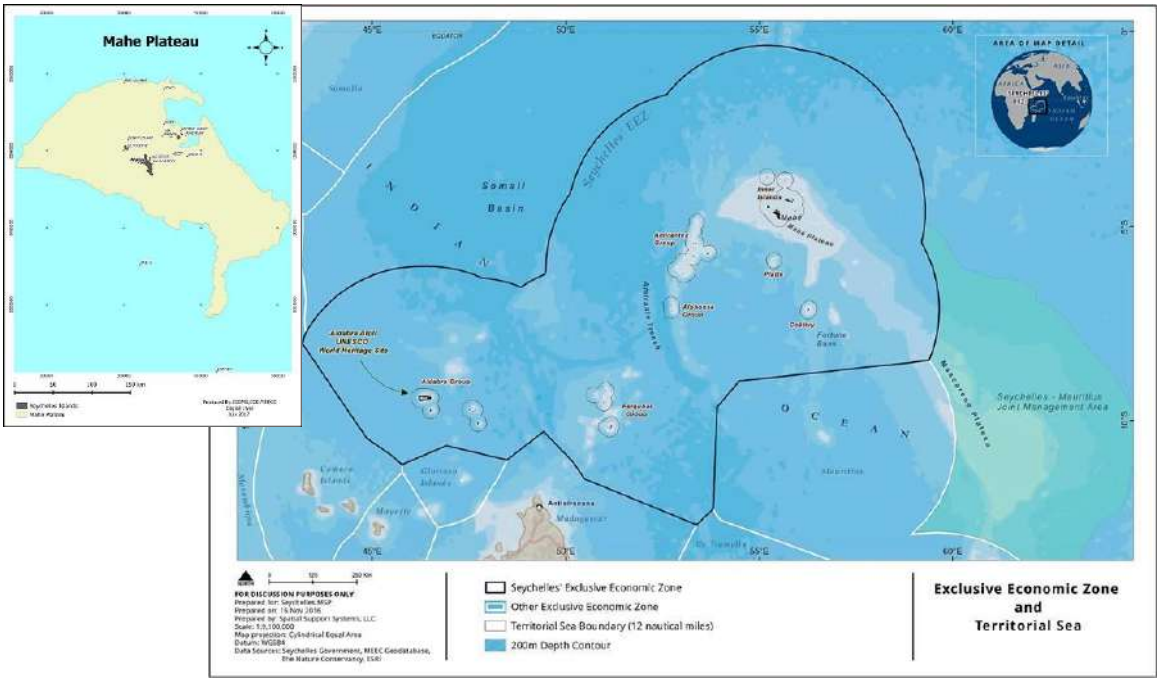


Figure 40. Project area map

Box 12. GIF project overview

Fishing is a vital economic sector for Seychelles and central to national food security. In 2012 the fisheries sector employed approximately 5,500 people, including from 1,300 to 1,400 artisanal fishers, and constituted 12% of total formal employment. However, many species have become rare or even disappeared from the catch and there is historical evidence of extinctions in the past. Seeing that the conventional fisheries management through the top-down imposition of regulations has proven unsuccessful, in 2014 the government passed the new Fisheries Act that prescribes the enabling mechanisms for co-management approaches.

The project assesses a baseline of threatened species occurrence in the artisanal fishery, in the main island of Mahé where 90% of artisanal catch is landed, through fisher consultation, literature review and an intensive 12-month survey of artisanal catch. The project also will facilitate artisanal fishers to develop a pragmatic, fisher-led measure to reduce artisanal fishing pressure on threatened species. These measures will be developed into an artisanal fishery co-management plan for threatened species to be implemented under the 2014 Fisheries Act.

3.10.2 Values

The Seychelles' coastal seascape is represented by inshore sea, where the bottom is mainly covered by coral reefs and seagrass. Among the six NCP identified by the survey, food provision (NCP 12) from reef flats and seagrass beds in coastal ecosystem, and five threatened fish species were valued the highest (**Figure 41**). The two ecosystems are also important as learning grounds for school kids and scientists, as well as for inspiring local arts (NCP 15). Shallow sea habitats especially reef flats and sea grass beds host fish species that could serve as an attraction to tourists for snorkeling and diving (NCP 16). Local people obtain multiple values from coastal ecotone e.g. coral reefs, such as the regulation of coastal waters and sedimentation in coastal lagoons (NCP 7), protection of coastal infrastructure from extreme weather events (NCP 9) and the use of coastal spaces for social gatherings (NCP 17). These values were not uniformly perceived by local people in different occupations. The five threatened species listed in **Figure 41** were important for food for fisheries sector. In contrast, they were important tourist attraction and hence provide vital non-material value to the tourism sector.

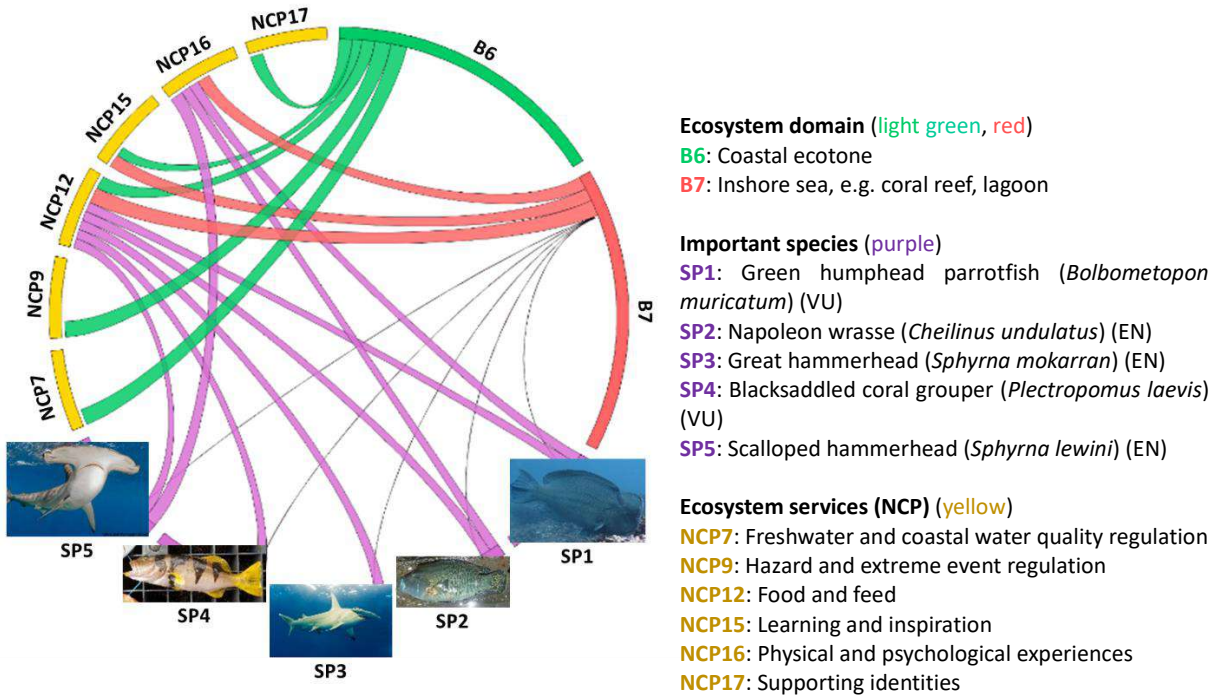


Figure 41. Connection between ecosystem domains, species and ecosystem services (NCP). The diagram illustrates the area of major ecosystems that constitute the SEPLS in proportions (top-right arcs), the species inhabiting in these ecosystems that were recognized as important either for biodiversity conservation or for local people (bottom arcs in purple, connected to their habitat ecosystem domains by thin lines), and the value of these ecosystems and species for local people falling under each NCP category (top-left arcs in yellow, connected to the ecosystem domains and species from which these values derive).

3.10.3 Traditional knowledge

Local community, including fishers, the youths and elders, share a common understanding of ecosystems such as coral reefs and sea grass beds as important habitats for Threatened fish species (**Table 38**). However, there is, in general, limited knowledge on the ecology of these species. Species-specific knowledge may increase with promulgation of results on data and projects targeting these species.

Table 38. Knowledge for the use and management of different ecosystem domains and species

Ecosystem	Traditional knowledge		Trend	Knowledge holders			
Species	Domain	Description		Fishers	Youth /kids	Elders	Local community
7.Coastal and near shore sea	1.Knowledge	Coral reef and sea grass bed are important ecosystem for fish species	↗	◯	◯		◯
		Important foraging grounds for juvenile sharks	↗	◯	◯		◯
Blacksaddled coralgrouper	1.Knowledge	Varying colourations and patterns at different life stages and as per the sex of the fish	→	◯			
Scalloped hammerhead shark	2.Mgt. system	The species is targeted and caught during the Southeast season	↓	◯			
Green humphead parrotfish	1.Knowledge	Reef-dwelling fish	→	◯			◯
Napolean wrasse	2.Mgt. system	All specimen caught of this species in trap fishery are juveniles	↓	◯			
Great hammerhead shark	1.Knowledge	This species is becoming very scarce in artisanal catch	↓	◯			

↓ rapidly decreasing; ↘ decreasing; → not changed; ↗ increasing; ↑ rapidly increasing

3.10.4 Governance

The state government manages Seychelles' coastal seascape, where different ecosystem domains and sectoral issues fall under the jurisdictions of different ministries (**Table 39**). Coastal ecotones are managed by a number of government entities namely the Ministry of Environment, Energy and Climate Change, Ministry of Habitat, Infrastructure and Land Transport, the Seychelles Fishing Authority, the Ministry of Fisheries and Agriculture, The Ministry of Tourism, Civil Aviation, Ports and Marine. The involvement of each entity depends on the location and management aspect. In some cases, wetland management at district level is taken up by local community groups under co-management schemes. There are several other stakeholders engaging in the management or use of Seychelles' coastal zones as listed in **Table 39**.

The Ministry of Environment, Energy and Climate Change oversees the management of biodiversity and habitats, and the Seychelles Fishing Authority is responsible for all fisheries management-related activities in Seychelles. The Seychelles Maritime Safety Administration of the Ministry of Tourism, Civil Aviation, Ports and Marine has the general responsibility for all leisure-related activities (commercial or private) that take place within inshore waters. Several other governmental and non-governmental organizations and individuals listed in **Table 39** are involved in the use and management of the inshore sea resources.

Near-shore habitats; coral reef and sea grass bed habitats, and inshore sea ecosystems have become degraded due to numerous direct drivers, which subsequently affect all twenty-two Threatened species monitored under this project. These include, but are not limited to green humphead parrotfish (*Bolbometopon muricatum*), Napoleon wrasse (*Cheilinus undulatus*), blacksaddled coralgrouper (*Plectropomus laevis*), great hammerhead (*Sphyrna mokarran*) and scalloped hammerhead (*Sphyrna lewini*). (**Figure 42**). Direct drivers include land reclamation, which can result in loss of near-shore habitats, overfishing, and climate change, which can result in escalating storm hazards and rising sea temperatures. These direct drivers are triggered by a number of indirect drivers including population increase, demand for fish export, enhanced living standards leading to coastal developments and advanced fishing techniques.

Table 39. Ecosystem governance structure

Ecosystem type	Near-shore ecotone (coral reef/ sea grass beds)	Inshore sea (lagoon)	Stakeholder type
Ownership	No entities legally own near-shore ecotones in Seychelles. However, many agencies are responsible for the management of different aspects depending on the area and types of use of these sites.	No entities legally own inshore lagoon habitats in Seychelles.	Government or public
Management right holder	State government: A number of government entities, depending on the management area and site are responsible for the management of near-shore ecotones namely: The Ministry of Environment, Energy and Climate Change, Ministry of Habitat, Infrastructure and Land Transport, the Seychelles Fishing Authority, the Ministry of Fisheries and Agriculture, The Ministry of Tourism, Civil Aviation, Ports and Marine	State government: likewise, many government entities are responsible for for the management of inshore sea areas in Seychelles, depending on the management area and site namely: The Ministry of Environment, Energy and Climate Change, Ministry of Habitat, Infrastructure and Land Transport, the Seychelles Fishing Authority, the Ministry of Fisheries and Agriculture, The Ministry of Tourism, Civil Aviation, Ports and Marine.	Government or public
Other stakeholders	Seychelles Conservation and Climate Adaptation Trust (SeyCCAT), a recently established fund, supports projects geared towards conservation and management of near-shore ecotones.	The Seychelles National Parks Authority play a role in the management of inshore waters, and the Seychelles Fishing Authority for the management of fisheries Seychelles Conservation and Climate Adaptation Trust (SeyCCAT), a recently established fund, supports projects geared towards conservation and management of inshore sea zones.	Government or public
	A number of non-governmental organization may also get involved in projects geared towards management, conservation and enhancement of coastal ecosystems namely Sustainability for Seychelles, Marine Conservation Society of Seychelles.	The Marine Conservation Society of Seychelles, Global Vision International, Green Islands Foundation carry out projects and research in inshore waters	Non-governmental
	Local registered community groups, such as the Port Glaud Action Group, are delegated by the government to manage wetland ecosystems in their districts under an agreement with the government.	Several fishermen association across Mahe island	Formal community org.
	Artisanal fishers use coastal zones to moor their boats and shelter from stormy weather	Fishers and local communities use inshore reef and lagoons for fishing with traps, nets and line and hooks	Individual
		Tour/Boat charter operators offer excursions, diving and snorkeling to tourists in inshore waters	Local business
	Schools and the university of Seychelles utilise coastal ecotones for outdoor learning and research	Schools offer snorkeling, outings in lagoon around the islands for students as learning experiences	Schools/ universities
	Several international organizations and donors fund projects related to integrated coastal zone management and mangrove protection e.g. the Mangrove For the Future Initiative by IUCN, GEF SGP.		International org.

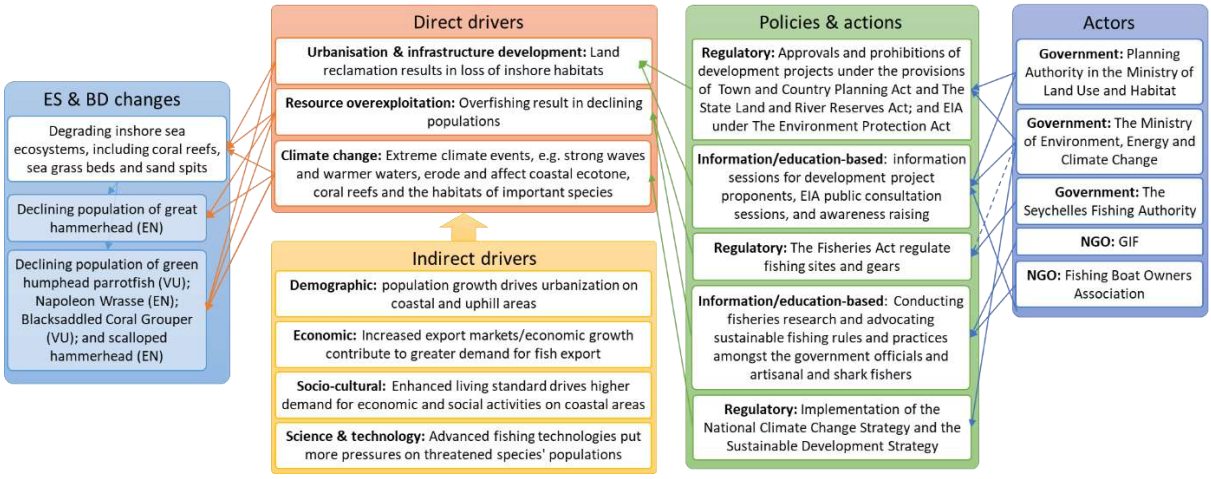


Figure 42. Configuration of the linkages between ecosystem degradation and species decline, direct drivers and the existing policies for abating the drivers

A number of legislations, policies and actions are in place to address these direct drivers (**Figure 42**). Land and coastal developments are regulated under the provisions of the Town and Country Planning Act, the State Land and River Reserves Act as well as the Environmental Protection Act, which are overseen by the Ministry of Habitat, Infrastructure and Land Transport and the Ministry of Environment, Energy and Climate Change respectively. These laws ensure the implementation of public information and consultation processes, such as information sessions for the development project proponents and public consultations in the environmental impact assessment procedures, which are often supported by local expert NGOs.

To prevent overfishing, the Seychelles Fishing Authority enforces fishing regulations, e.g. sites and gears restrictions, under the provisions of the Fisheries Act. GIF conducts artisanal catch survey and advocates, in collaboration with the Fishers' Associations, for sustainable fishing rules and practices. It should be noted that GIF's project proposal indicated the ineffectiveness of the conventional top-down imposition of the fisheries regulations by the government authority and envisages its support to the establishment of a bottom-up fisheries management under a co-management scheme in line with the provisions of the 2014 Fisheries Act. Upon the fulfilment of this goal, the project will reinforce the institutional setting for regulating overfishing.

The application of the National Climate Strategy and the Sustainable Development Strategy seek to mitigate local climate change-related issues, which fall under the jurisdiction of the Ministry of Environment, Energy and Climate Change.

3.10.5 Value–knowledge–governance interplay in Seychelles' seascape

Interplay between value, knowledge and governance in Seychelles' near-shore habitats and inshore sea was inferred from the online survey results (**Table 40**). Coral reefs and sea grass beds support fish reproduction and proliferation and are of a primary importance for Threatened species. This knowledge needs to be understood by fishers and local actors. This would strengthen the community-based involvement in advocating for protection of these habitats. Research activities in the coastal areas by local expert NGOs and universities may play a vital role to reinforce the local knowledge on reef and seagrass habitats. With better ecological knowledge, local communities can enhance their participation and position in public consultation sessions when coastal development projects are proposed.

Local community, especially fishers and elders, have rich knowledge on the appropriation of fishery resources in the Seychelles' inshore sea on which they rely for food and livelihood. A number of in-

stitutions in Seychelles are involved in and support sustainable fisheries management; namely the Seychelles Fishing Authority, the Blue Economy Department and the Ministry of Environment, Energy and Climate change. GIF's project proposal indicated declining fish catch due to the failure of the conventional top-down imposition of the fisheries regulations by the state authority. In this backdrop, and with a view to the implementation of the co-management scheme under the provisions of the 2014 Fisheries Act, GIF is expected to make substantial contributions to filling the knowledge, technological and institutional gaps through the collaboration with artisanal fishers and their local institutions. The investigation of the impacts of artisanal fisheries will inform the design of sustainable fishing practices and management plans. This knowledge will in turn contribute to the proposal of pragmatic measures, to be enforced by fishers themselves, which can significantly decrease fishers' impacts on Threatened species in artisanal catch.

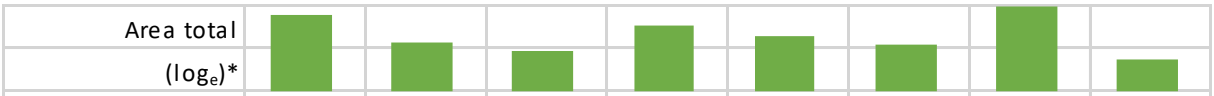
Table 40. The interplay between the value, knowledge and governance within three major ecosystem domains in the project site.

Ecosystems/species	Value (NCP)	Knowledge	Governance: issues and stakeholders
Near-shore ecotone (reef flats/sea grass beds)	1. Habitat creation and maintenance	Coral reef and sea grass beds serve as an important feeding, reproduction and foraging grounds for fish	Primarily managed by a number of entities while coastal developments are overseen by the Planning Authority of the Ministry of Land Use and Habitat. Local expert NGOs and universities use near-shore ecotone for outdoor learning and research.
Inshore sea	1. Habitat creation and maintenance	Inshore sea is an important habitat for all fish species under monitoring and serves as a foraging ground for juvenile sharks	The Seychelles Fishing Authority enforces fishing regulations, e.g. sites and gears restrictions, under the provisions of the Fisheries Act. The new Fisheries Act 2014 provides the mechanisms for enabling co-management approaches. In this line, GIF conducts artisanal catch survey, and advocates for sustainable fishing practices and practices.
Green humphead parrotfish, Napoleon wrasse, great hammerhead blacksaddled coral grouper and scalloped hammerhead	12. Food; 16. Tourist attraction	Fishers and elders lack specific ecological knowledge on most e.g. color variations of blacksaddled coral grouper.	

4 Synthesis

This chapter answers to the three questions set out in the research objectives, i.e. ways to recognize the values of SEPLS; the relevance of traditional knowledge for managing and sustainably using SEPLS; and the ways to strengthen the governance of SEPLS, by a synthesis of the findings from the ten project case studies. The contents presented here derive from a contents analysis of the ten individual project case studies, as well as a meta-analysis of the dataset generated by an online survey of the ten projects.

To start with, **Figure 43** illustrates the difference of the SEPLS across the ten project sites in terms of the area of different ecosystem types constituting each SEPLS. Natural or protected forest is the main constituent of the SEPLS in three projects (FFI, WCS and TERI). SEPLS in five projects (IMPECT, UIS, AMPA, Dahari and FIDES) are more complex, being composed of a mix of forest and agricultural ecosystems. Three projects (EPCO, FIDES and GIF) deals with seascapes, encompassing mangroves, coral reefs and inshore sea. Overall, sea, natural forest and farmland are relatively highly represented among the ten project sites.



Area total (log_e)*								
# Projects	7	5	1	4	3	3	2	4
Project proponent**	**NAF**	**MAF**	**GRL**	**FAL**	**FRW**	**COE**	**SEA**	**URB**
01.IMPECT	666	1,153		285	416			12
02.UIS	2,200	1,000	1,000	2,600	16			140
03.EPCO						7	30	18
04.AMPA	143,928			105,876				
05.FFI	117,598				16,118			
06.WCS	372,470							
07.TERI	10,823	2,332		2,074				128
08.Dahari		1,002						
09.FIDES	7,348	150				3,622		
10.GIF						1	3,900,000	

Figure 43. Area of the nine ecosystem domains represented in each project site

*Natural logarithm scale is applied to the vertical axis of the bar chart to accommodate exponential difference in the area of each ecosystem domain represented in a set of ten projects.
NAF: natural/protected forest; MAF: managed/resource forest; GRL: grassland/rangeland; FAL: farmland; FRW: freshwater wetland and waterbodies; COE: coastal ecotone (including mangroves); SEA: inshore sea; and URB: settlement/urban.

4.1 How to get the values of SEPLS recognized among stakeholders?

Drawing from the ten case studies, we identified three key elements that can help various stakeholders better understand multiple values of SEPLS. These are: recognizing SEPLS as vital habitats for globally threatened species; clarifying multiple goods and services that derive from SEPLS and that underpin livelihoods and security of local communities; and integrating biodiversity in production activities. This section describes these four elements with the facts from the ten demonstration projects.

SEPLS constitute vital component of global biodiversity through the provision of habitats for several globally threatened species.

Table 41 lists threatened species, as well as the species with notable local value, that were found in the SEPLS in the ten project sites. Several endangered mammals, birds, reptiles and vascular plants were found in natural/protected forests and managed/resource forests. Inshore sea provides vital habitats for threatened fish species. Some species provide high value for local people for food, medicine, tourist attraction and support to their identity, as well as for their functions to disperse plant seeds. These utilitarian and intrinsic values of species constitute biocultural diversity that is unique to each SEPLS.

SEPLS underpin human livelihood, security and development of local communities through the provision of numerous ecosystem goods and services, particularly food, learning and inspiration, freshwater, soil and hazard regulation. **Figure 44** presents the relative importance of diverse nature's contributions to people (NCP) attributing to the seven ecosystem types represented in SEPLS across the ten projects. Food, among others, was the most important goods deriving mainly from grasslands, managed forests, seas and farmlands. Learning and inspiration was ranked the second, highlighting the importance of intrinsic value of nature for people in SEPLS. More concretely, such value of SEPLS included local knowledge generation, a venue for youth education, as well as providing inspirations for folk songs. The regulating functions of forest and mangrove ecosystems were also highly recognized, e.g., freshwater flow regulation, soil formation and protection, climate regulation and disaster risk reduction, that collectively contribute to human security in these landscapes and seascapes. Among the seven ecosystem types, the importance of natural or protected forests was appreciated the highest for its various goods and services, followed by coastal ecotone and managed forests.

Each SEPLS has a unique configuration of ecosystems and their contributions to people (Figure 45). This implies the importance of locally optimized management of SEPLS to ensure their sustainability. The configurations, however, can be characterized by the major ecosystem types that constitute SEPLS. In natural forest-dominated SEPL, such as those in AMPA (Peru), FFI (Myanmar) and WCS (Madagascar) projects, forest contributes to human security through providing food, regulating climate, freshwater flow and soils. Mammals and birds dwelling in forest play vital role to maintain forest ecosystems, including by seed dispersal. They also provide humans with inspiration and learning opportunities. Agroforests, rotational farms or permanent farms dominate agro-ecological SEPL in the Dahari (Comoros), UIS (Colombia) and IMPECT (Thailand) project sites. In these SEPLS people harvest food from both forests and farmlands, and also attribute high value to the functions of natural and managed forests to regulate freshwater flow. In coastal seascapes in the FIDES (Ecuador), EPCO (Mauritius) and GIF (Seychelles) project sites, local people unanimously placed the highest value on fish and mollusk harvested in mangrove and inshore seas. They also recognize the function of mangroves to mitigate coastal hazards. In addition, diving, leisure fishing, boat trips and other types of ecotourism enterprises bring economic opportunities to local communities. Overall, there is no one-size-fits-all measure to manage SEPLS sustainably, considering such a wide variety of configurations of ecosystems and their contributions to people in SEPLS.

Table 41. Important species identified by the online survey.

Class	English/ local name	Scientific name	RL*	NAF	MAF	GRL	FAL	FRW	COE	SEA	URB	High value NCP
Mammal	Indri	*Indri Indri*	CR									
	Black and White Vari	*Varecia variegata subcincta*	CR									
	Silky Sifaka	*Propithecus candidus*	CR									Seed dispersal; local identity
	Yellow-tailed woolly monkey	*Oreonax flavicauda*	CR									
	Chinese pangolin	*Manis pentadactyla*	CR									
	Livingstone's fruit bat	*Pteropus Livingstonii*	CR									Seed dispersal
	Yo Hhaw (Pangolin)	*Manis pentadactyla*	CR									Medicine
	Ecuadorian White-fronted Capuchin	*Cebus aequatorialis*	CR									
	White fronted brown lemur	*Eulemur albifrons*	EN									
	White-bellied spider monkey	*Ateles belzebuth*	EN									
	Eastern Hoolock Gibbon	*Hoolock leuconedys*	VU									
	Mangoose lemur	*Eeulemur mongoz*	EN									Seed dispersal
	Gray-bellied night monkey	*Aotus lemurinus*	VU									
	Andean night monkey	*Aotus miconax*	VU									
	Spectacled bear	*Tremarctos ornatus*	VU									
	Bush dog /perro de monte	*Speothos venaticus*	NT									
Bird	White-rumped vulture	*Gyps bengalensis*	CR									
	Mauritius Fody	*Foudia rubra*	EN									
	Perdiz santandereana	*Odontophorus strophium*	EN									
	Anjouan scop's owl	*Otus capnodes*	EN									
	Saurus crane	*Grus antigone*	VU									
	Great Barbet	*Psilopogon virens*	LC									Time keeper
	Blyth's Tragopa	*Tragopan blythii*	VU									State bird
	Indian cuckoo	*Cuculus Micropterus*	LC									Agri. indicator
Reptile	Comoro ground gecko	*Paroedura sanctijohannis*	EN									
Amphibian	Dei bu (Jub Frog)	not identified	NI									Food
Fish	Napoleon wrasse	*Cheilinus undulatus*	EN									
	Green humphead parrotfish	*Bolbometopon muricatum*	VU									
	Great hammerhead	*Sphyrna mokarran*	EN									
	Blacksaddled coralgrouper	*Plectropomus laevis*	VU									
	Scalloped hammerhead	*Sphyrna lewini*	EN									Tourism
	Pipe fish	*Microphis dunckeri*	LC									Support identity
	Do P' Loo (Root Banana Fish)	not identified	NI									Food
Invertebrate		*Papilio aristophantes*	EN									
	Hswai bau dei (Yellow leg Crab)	*Globonautes macropus*	NI									Food
Vascular plant	Nogal	*Juglans neotropica*	EN									
	Queñual	*Polylepis multijuga*	VU									
	Teen Hm Doi (White Turmeric)	*Curcuma zedoaria*	NI									Medicine

* RL: IUCN Red List category –CR: critically endangered; EN: endangered; VU: vulnerable; NT: near threatened; LC: least concern; NI: no information. Green cells indicate the ecosystem domain in which each species is found. Grey cells indicate the ecosystem domains represented in the project site but in which the species listed in the left column is not found.

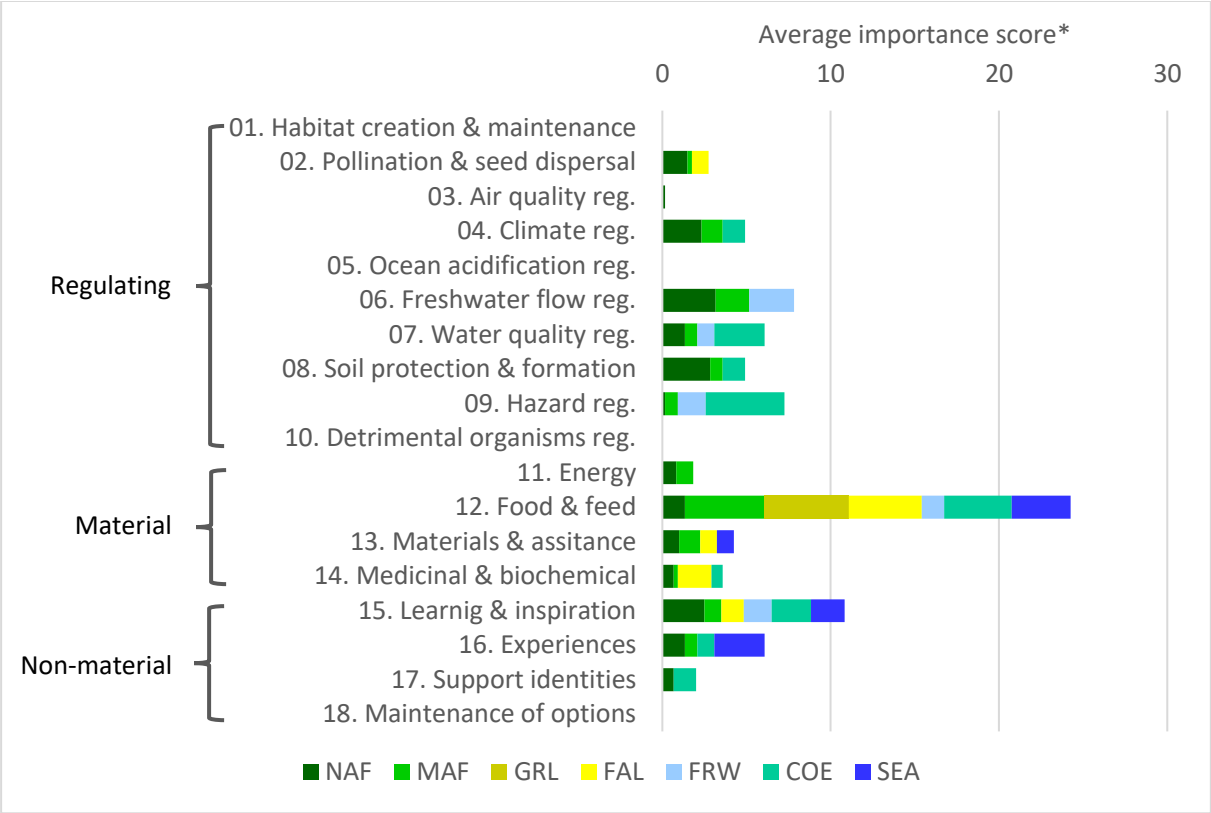


Figure 44. Aggregated scores of the relative value of nature's contributions to people from different ecosystem domains. Numbers in the NCP-Ecosystem domain matrix indicates the average importance scores of the ecosystem goods and services falling under each NCP category among the project sites in which each ecosystem domain is represented. Thus the numbers are within a range from zero (0) (nonexistent) to five (5) (very important).

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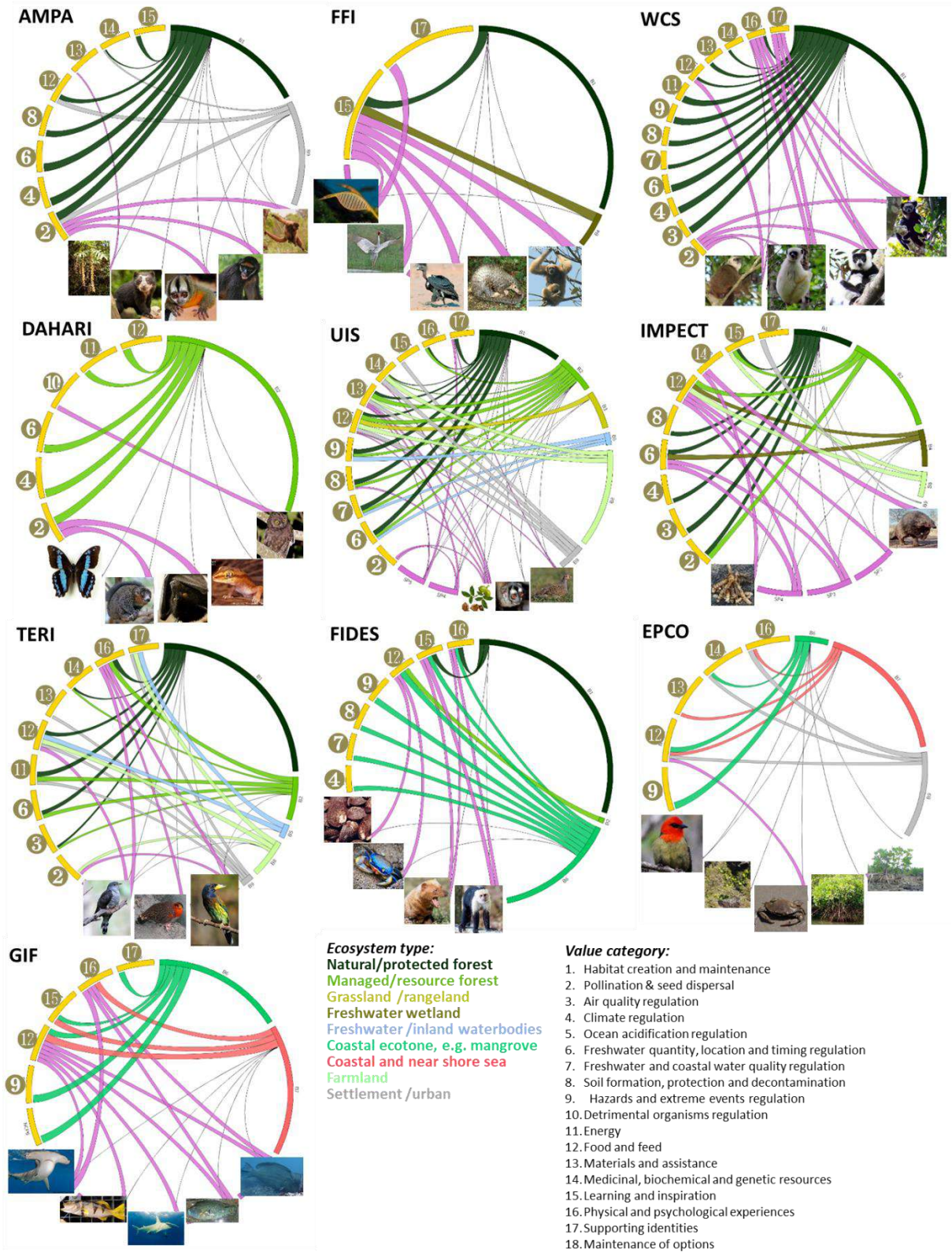

Figure 45. Configurations of the web of interlinkages between ecosystems and people in respective projects

Biodiversity conservation can be integrated into production activities in SEPLS, as demonstrated by the projects in four major ways.
One way is to involve local communities in a scientific assessment of threatened species. FFI (Myanmar) and GIF (Seychelles) collaborated with fishers to identify threatened species in their fish catch, and to understand habitats and reproduction behavior of these species. This process built the capacity of fishers to identify threatened species. Moreover, the results provided the basis for the development of rules and regulations for fisheries co-management. TERI (India), WCS (Madagascar), FIDES (Ecuador) and AMPA (Peru) also conducted participatory biodiversity registry and monitoring.

Another way is to promote ecological production building on indigenous, local and scientific knowledge. In Thailand, IMPECT facilitated revitalizing traditional ecological agriculture and cooking methods and used them to produce and market value-added products. Similarly, in Peru, AMPA revisited traditional wild honey and organic quinoa production, and strengthened their supply chain. Dahari (Comoros), UIS (Colombia) and FIDES (Ecuador) were also making efforts to encourage farmers to produce high-quality products with reduced ecological impacts.

SEPLS, when degraded, need to be restored to make them fully functional. EPCO collaborated with a local community to restore mangrove and blackish water system in a Barachois seascape in Mauritius, which once had been abandoned and turned into a waste dumping site. Clean space and water after the rehabilitation efforts enabled the development of crab aquaculture in Barachois, which was likely to contribute to local livelihoods and thus encouraging the local community to participate in the rehabilitation activities. WCS (Madagascar) and Dahari (Comoros) also made efforts to restore forests for their vital services, particularly for water provision.

Alternative economic opportunities can convince local communities to stay in conservation efforts, especially when such efforts regulate their access to land, sea and their resources in SEPLS. TERI facilitated the development of community-based ecotourism enterprise in Nagaland, India, while they were reinforcing regulations and their enforcement on hunting, logging and fishing under a new community conservation area (CCA) regime. EPCO developed crab aquaculture in Barachois in Mauritius, as described above. WCS introduced advanced agricultural techniques to increase paddy rice production in Madagascar. FIDES revitalized artisanal salt making in the communities adjacent to protected mangroves in Ecuador.

4.2 How to maintain and use traditional knowledge of SEPLS?

We documented traditional knowledge that the ten projects used to manage SEPLS. In that course, we identified their declining trend and the factors that underlie the decline. We went further to identify the policies and measures to revitalize and to effectively use indigenous and local knowledge to manage SEPLS sustainably, drawing on the efforts by the projects and their initial outcomes.

Rich traditional knowledge, encompassing its four nested dimensions, is an integral part of socio-ecological systems in SEPLS (Table 42). As for the first dimension, local people have detailed knowledge of taxonomy, ecology, harvest and the uses of valuable wild species and crop varieties, particularly those directly used for food and medicine. They also knew how ecosystems were regulated, e.g., plant seed dispersal by primates, pest rodent control by owls, as well as the biological and physical signs of freshwater flow and quality, from what they inherited from their elders and from their direct observations. These underlie the second dimension –resource management systems-, such as sustainable harvest of non-timber forest products (NTFPs), nursery and propagation of useful flora species, organic agriculture and pest management as well as species-specific fishing methods. Cases of the third dimension –social institutions- include customary law on forest management and taboos on land and resource uses in and around sacred forests and water springs. These are embedded in the fourth dimension –world view- collectively held by local communities, such as traditional

religious belief in spirits in Madagascar, the Thai Karen's integrated spirituality, knowledge and practices in rotational farming, as well as the Andean peasant culture and societal, and religious traditions. A holistic body of traditional knowledge encompassing the four nested dimensions enables local communities to effectively access, utilize and sustainably manage various ecosystem goods and services derived from SEPLS. However, traditional knowledge on biodiversity was not found or fairly limited in few areas due to historical socioeconomic hindrances, such as migration, limited resource access and fragmented social structure deriving from past colonial history.

Traditional knowledge is declining overall due, among others, to changing values and lifestyles, modern education, lost opportunities for knowledge transmission, rapid population shift from rural to urban areas, land transformation and the limited recognition of traditional knowledge by governments (Table 43). Importantly, these factors are inseparably connected to one another and thus require a systematic remedy. For example, better paid jobs in cities motivate rural residents to move to cities. Higher education requirements for city-type jobs encourage the youth to study hard for higher education achievement along the nation's mainstream curriculum. This takes the time that they previously had been spending to learn from their elders, and thus reduces the opportunities for the elders to transmit traditional knowledge to younger generations. Mass land transformation for monocrop plantations is often caused by the ignorance of the government of the rights of indigenous peoples on lands and resources.

Some policies and measures are available to maintain, evolve and even generate traditional knowledge that contribute to both production and biodiversity conservation in SEPLS (**Table 43**). IMPECT (Thailand), UIS (Colombia), WCS (Madagascar) and Dahari (Comoros) were facilitating reciprocal knowledge exchange among generations and stakeholders to ensure transmission and to evolve traditional knowledge. They were also making efforts to integrate traditional knowledge and modern knowledge and technologies for their advanced applications in changing social, economic and ecological contexts. AMPA (Peru), WCS (Madagascar) and IMPECT (Thailand) envisage to revitalize traditional agricultural systems against expanding commercial mono-cropping. Such measures include integrating traditional and modern knowledge and techniques to create added value to their products. This can enhance the community's economic self-reliance. As the basis for such measures, IMPECT (Thailand) produced a map of customary land uses by participatory GIS mapping, and used it to help local government recognize their customary land uses. In case people do not have traditional knowledge to manage SEPLS, they can generate locally optimal knowledge and techniques by pilot testing new practices and brokering best practice knowledge from outside their SEPLS.

Table 42. Dimensions and description of traditional knowledge found in different ecosystem domains

Ecosystem domain	Dimension and description of traditional knowledge			
	Knowledge	Management systems	Social institutions	World view
Natural forest	↗Knowledge of forest animals and plants (WCS, UIS) ↘Identification and use of high value species including medicinal plants (FIDES, IMPECT, UIS); primate species taxonomy and ecology (WCS);	→ Periodical restrictions (gennas) and taboos on killing animals (TERI) ↘Sustainable extraction of non-timber forest products (NTFPs) (WCS)	↘Customary law to take care of forests, taboos in sacred forests, use of forests for youths learning center (IMPECT);	↗Traditional and religious belief in taboo practices on primates (WCS) →Folkloric stories woven around the plants and animals, lycanthropy (TERI)
Managed forest	↘Identification and use of high value species including medicinal plants (Dahari, IMPCET), timber trees and hunting prey animals (UIS); role of Anjouan Scop's owl in pest rodent control (Dahari); ecological role of fruit bat and lemur in seed dispersal and forest regeneration (Dahari)	↘Nursery, propagation and use of high value tree species such as Nogal, Molinillo and Panela quemada (UIS); Lunar calendar for farm management, e.g. pruning (FIDES);	(NI)	(NI)
Grassland	(NI)	→ Grazing land use and management (UIS)	(NI)	(NI)
Freshwater	→ Predict stream water dynamics (UIS) ↘Clean water indicator animals, e.g. *Jub* frog and yellow leg crab (IMPECT); assessment of physical and chemical properties of water (UIS);	→ Restriction of fishing or use of poisonous roots during fish spawning season (TERI)	↘Taboo practices in sacred water sources (IMPECT)	→ Myths and legends related to unusual increase of stream flow and flush floods (UIS)
Mangrove	↘Identification of high value species such as black shell and blue crab (FIDES); mangrove's function to provide fish spawning and nursing grounds (GIF, EPCO)	↘Closed season for catches embedded in mythological beliefs called '*Vedas*' (FIDES)	(NI)	(NI)
Inshore	↘Fish taxonomy, habitat and movements (GIF)	→ Species-specific fishing methods (GIF)	(NI)	(NI)
Farmland	→ crop soil and climatic requirements (UIS); ↘Local crop varieties (IMPECT);	↗organic crop (quinoa) production based on integrated ancestral and modern knowledge (AMPA); → Traditional pest management methods embedded in peasant culture (UIS); Agricultural calendar attuned to nature-sowing of paddy (TERI) ↘ Rotational farming (IMPECT)	(NI)	→Holistic body of interlinked spirituality, knowledge and practices on rotational farming (IMPECT); Peasant culture and societal and religious traditions that underlie agricultural and food practices and environmental perceptions (UIS); propitiation of the spirit to beg forgiveness for sacrificing living organisms during clearing of forest land for shifting cultivation (TERI)

↗Increasing; ↘Declining; → No significant change

Table 43. Cause of the loss of traditional knowledge and policies and measures proposed by the project proponents

Cause of ILK decline	Proposed policies and measures
Changing values and lifestyles: People increasingly appreciate modern lifestyles, including preference for modern medicine to traditional ones (UIS, WCS).	• NI
Modern education: Formal elementary education with national language and with nation-wide standard curriculum reached indigenous communities (IMPECT).	• Informal community schools to complement mainstream curriculum (IMPECT)
Challenges in knowledge transmission: Transmission of oral and tacit form of knowledge from elders to the youth became increasingly difficult partly due to reduced opportunities to do so (UIS, WCS, Dahari).	• Co-produce new knowledge through facilitating reciprocal knowledge exchange between elders and youths, where youths learn customary laws and practices, and elders learn modern technologies (IMPECT) • Integrate indigenous tacit knowledge on agroecosystems management into expert knowledge (UIS) • Document traditional knowledge and develop its database (WCS) • Integrated indigenous and scientific knowledge on the use and habitat conditions of commonly used tree species (Dahari)
Urbanization and rural depopulation: Rural population is decreasing as more rural youth seek higher education and better paid jobs in cities (IMPECT, UIS).	• Enhance community self-reliance through increasing productivity by synergizing traditional knowledge and innovative agroforestry techniques (IMPECT)
Land transformation: Native crops and production systems, such as rotational upland rice cropping (IMPECT) and quinoa (AMPA), were replaced by modern monoculture of export crops.	• Boost organic quinoa production and supply chain by revisiting ancestral knowledge and integrating them with modern technologies (AMPA) • Introduce innovative integrated agriculture and production practices, e.g. permaculture and agroforestry (WCS)
Limited recognition of ILK by governments: The government policies and legislations do not appropriately recognize, or are sometimes against, ILK or the IPLC's rights on lands and resources (IMPECT, Dahari)	• Engage in policy and legal reform to support community-based sustainable socio-ecological production systems from local to international levels (IMPECT) • Community-based GIS mapping of customary land uses (IMPECT)
No ILK: In some areas ILK on biodiversity and ecosystem services have not been accumulated due to historical socioeconomic hindrances (EPCO)	• Generate knowledge and techniques for ecological aquaculture production by pilot testing and brokering best practice knowledge from outside (EPCO)

4.3 How to improve the governance of SEPLS?

Governance in SEPLS refers to the whole of public and private interactions to solve problems affecting the SEPLS, to create opportunities through the formulation and implementation of innovative policies and measures. Landscape management is a multi-stakeholder undertaking. In many countries the institutional framework to manage the natural resources in the SEPLS has been designed to work in a sectorial vision (agriculture, forests, mining, conservation, etc.), or in silos, without an integrated landscape management approach. This can generate contradicting policies, plans and investments, as will be discussed subsequently.

This section aggregates the data information compiled regarding the governance systems in the diverse SEPLS of the ten grant projects, experts of which participated in the online survey. It also con-

ducts comparative analysis to the possible extent considering the distinct geographical, ecological and socio-cultural contexts in which the projects have been implemented.

Across the diverse SEPLS a range of different direct and indirect drivers threaten the main ecosystems domains and animal and plant species that are endangered and/or important to the local communities, but these drivers can be systematically identified and addressed through inclusive local governance schemes and decision-making processes which raise existing awareness and engagement levels and promote collaborative ecosystem management forms in SEPLS. While a few positive drivers are also reported, the following section discusses the negative direct and indirect drivers affecting biodiversity in the different SEPLS, identifying and highlighting commonalities and differences between the SEPLS.

Figure 46 shows the ***direct*** and ***indirect drivers*** affecting the key species and ecosystem domains in the eight SEPLS of the grant projects. The two main direct drivers affecting the key species of animals and plants identified for the communities in each of the SEPLS are *resource overexploitation* (affecting 15 species of a total of 40 species – 5 for each SEPLS) and land use and land cover changes (LULCC, affecting 14). The ecosystems with the highest number of species affected by direct drivers is natural and/or protected forests and the near shore sea.

The main drivers affecting almost all of the ecosystem domains are land use and land cover changes and resource overexploitation, followed by pollution:

- *LULCC* have affected almost all ecosystem domains of the eight SEPLS – both crops (e.g. AMPA and Dahari) and livestock (AMPA) –, deforestation (WCS and AMPA), shifting cultivation (FFI) and mangrove destruction (FIDES). However, there are also complex cases where the decrease of one ecosystem domain (such as grasslands) can be due to socio-economic factors (conversion to cocoa and coffee as more viable options than cattle rearing, or farm abandonment and consequent natural reforestation) or reforestation as part of conservation efforts in a newly declared protected area (UIS). Reforestation has led to an increase in habitat areas for endangered species in specific cases (UIS). However, a more general trend is habitat loss due to deforestation in other SEPLS (WCS and AMPA).
- *Resource overexploitation* comprises two main types of activities:
  - Unsustainable wildlife hunting (FFI, WCS, UIS) and overfishing (FFI, FIDES, GIF, EPCO): The former impacts species in inland forest ecosystems, while the latter affects both freshwater and marine/coastal ecosystems, including the devastating effects on coral reefs/ sea grass meadows and sand spits in nearshore waters reported in GIF's SEPLS.
  - Over-harvesting of timber and wood affecting endangered species: Unsustainable timber harvesting is reported in natural forest ecosystems (Dahari, UIS), while an excessive use of wood for cooking, ylang ylang distillation and charcoal production also affects resource forests (Dahari). In the case of UIS, the selected logging of high-value timber species has led to a lack of seeds for the recovery of endangered tree species. However, there are cases where the overexploitation of wood from mangroves for energy purposes has significantly decreased as gas and electricity are increasingly important alternatives as in the case of EPCO's SEPLS.
- A third important driver, less frequent in comparison to the drivers discussed above is *pollution* from diverse sources: solid waste dumping (EPCO, FIDES), agrochemicals (FIDES), sewage (FIDES) and garbage from settlements, siltation, gold mining (FFI). It has affected primarily coastal ecotones (EPCO, FIDES) and the near shore sea ecosystem (GIF).

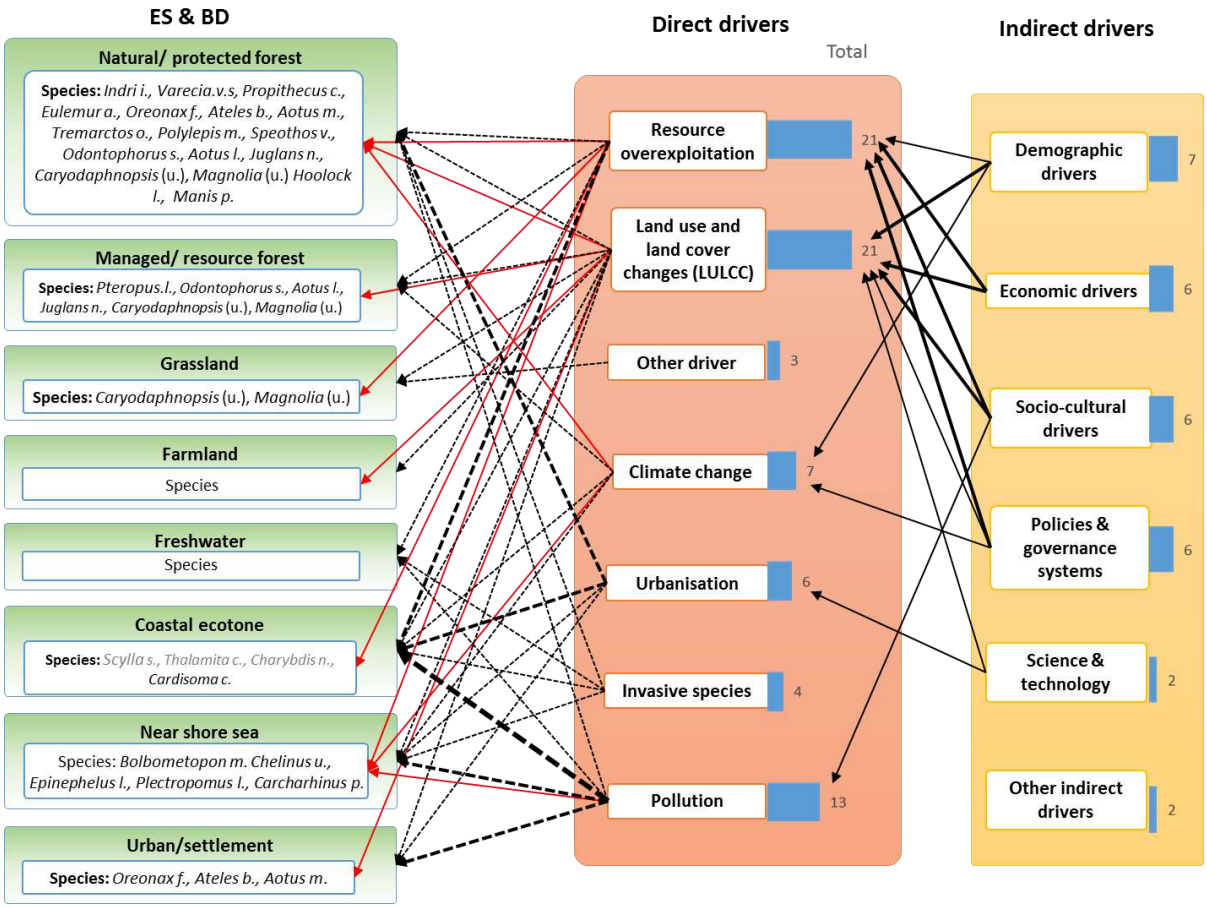

Figure 46. Direct and indirect drivers affecting the key species (red) and ecosystem domains (black), as identified by the eight demonstration projects in their SEPLS

Although relevant, others less frequent direct drivers are *urbanization*, *climate change*, and spread of i*nvasive species*. *Urbanization* affects mainly coastal ecosystems through tourism and related new residential infrastructure (FIDES, GIF), and also natural forest ecosystems through the development of new settlements or road infrastructure (WCS, FFI). *Climate change* impacts have been identified as a driver affecting the coastal and marine SEPLS, e.g. in the form of stronger waves or warmer waters eroding the coastal ecotone, causing coral bleaching and affecting species' habitat (GIF). It has also been reported as a factor for an increasing number of landslides in resource forests (Dahari). Invasive species are reported to have impacts on coastal ecotones and near shore sea but also freshwater ecosystems and natural forests. The category of *other drivers* refers to the positive results of conservation and reintroduction efforts, which have led to the expansion of biodiverse ecosystem domains at the expense of grassland for cattle rearing (UIS).

The ***indirect drivers*** of changes in biodiversity and ecosystems in the eight SEPLS emphasized by the online survey were primarily of demographic, economic and socio-cultural nature, or related to policies and governance systems (Figure 46 and Table 44). The growth of *human population* in seven of eight SELPS (with the exception of UIS) has increased the pressure of direct drivers such as, pollution both in landscapes and seascapes (FIDES, EPCO), resource overexploitation (WCS, Dahari), and land use changes (AMPA). *Economic* drivers include growth of tourism sector leading to land reclamation & development of coastal areas (EPCO, GIF), cash crop production (e.g. vanilla, cloves, cacao) (WCS, Dahari), extreme poverty, high unemployment rate, negative incentive policies (for shrimp industry for export despite of this driving mangroves destruction) and increasing export markets in general (WCS, Dahari, FIDES, GIF).

Table 44. Indirect drivers as identified by the eight demonstration projects in their SEPLS

Demo. Projects	Demographic	Economic	Socio-cultural	Science & technology	Policies & governance systems	Other indirect drivers
EPCO (Mauritius)	Population increase driving higher demands for food	Growth of tourism sector leading to land reclamation & development of coastal areas			Ineffective governance - focus on permits and patrols; little support for conservation actions	
WCS (Madagascar)	Population growth putting pressure on forest resources, agricultural land, protein sources	Introduced cash crops, e.g. vanilla, cloves, cacao and opening markets are increasing the demand for agricultural land (cloves, etc.)	Changes in lifestyle are increasing the demand for lemur meat and precious wood	Improved communication (phone network) increasing precious wood extraction & lemur sports hunting	Weak law enforcement & jurisdictional system, resulting in the lack of deterrent for illegal activities (hunting, etc.)	Poverty fosters forest clearance for rice cultivation and lemur hunting for subsistence
Dahari (Comoros)	High population growth causing strong pressure on the natural resources and the endemic biodiversity	Economic situation is critical, with high unemployment rate. 90% of the population depends on agriculture. Exports only cash crops (cloves etc.)	Lack of social cohesion and the breakdown of traditional power structures due to poverty	Improved road infrastructures increasing human pressures (wood and river sand extraction)	Lack of governance institutions in the villages and absence of state	
AMPA (Peru)	High population increase causing families forcing people to develop agriculture and livestock in the montane forests	Extreme poverty of the highland in the absence of productive lands, driving deforestation and land conversion of montane forests (agriculture and livestock)	People see entering the vegetation of montane forests as a barrier that does not allow to cultivate the land		Govt. policies encouraged deforestation to develop agriculture & cattle raising leading to degradation of Peruvian Amazon region	
FIDES (Ecuador)	Increasing contamination of the rivers that flow into the estuarine areas and the sea due to population growth lack of prior treatment of wastewater	Economic interests prevail at the expense of conservation interests: Incentive policies for shrimp industry for export despite the fact that is a main cause of mangroves destruction	Most young people leaving artisanal fishing activities and losing therefore their interest in mangrove conservation		Community based governance system; lacking support to enforce conservation/management; participation low and limited to information	Economic & political power of the shrimp industry putting economic interests first
UIS (Colombia)			Increasing awareness of the importance of conservation		Creation of the national park and its related policy	
GIF (Seychelles)	Increased urbanisation contributing to degradation of coastal habitat in near-shore waters	Increasing export markets and economic growth contribute to greater demand for fish export hence depletion of fish stocks	Increased in standard of living; higher demand for economic and social activities on coastal lowland	Advancement in fishery technology contributing to higher catches; more pressure on threatened species' populations		
FFI (Myanmar)	Population change & immigration	Limited livelihood options, poverty of the local communities, depending on rapidly declining natural resources, and conversion of the natural forest to agricultural lands	Young generations of remote communities migrating to towns for job opportunities, causing labor shortage in agriculture	Telecommunication and construction of new road networks leading to illegal wood extraction. Electric fishing due to introduction of solar panels	Limited staff in gov. departments, weak law enforcement and little collaboration between gov. departments and within the local communities. Local or indigenous communities' roles and rights not included in the rules and regulations	Weak understanding of the rules and regulations regarding to the fisheries, forestry and wildlife by the local communities; limited awareness programs

Socio-cultural drivers comprise of unsustainable changes in lifestyle, lack of social cohesion and the breakdown of traditional power structures, as well as increasing numbers of young people quitting artisanal fishing activities and losing their interest in conservation. However, cases of i*ncreasing awareness of the importance of conservation* (UIS) and increasing standard of living (GIF) – although not necessarily sustainable in the long term – are also reported.

Indirect drivers related to *policies & governance systems* comprise ineffective management of permits, licenses and patrols (EPCO), lack of institutions (Dahari), weak law enforcement and jurisdictional systems (WCS, AMPA), lack of support of conservation/management (EPCO, FIDES) and low participation (FIDES). One case demonstrates that the creation of a national park and its related policy can possibly result in positive ecological outcomes, while excluding local communities from any form of access to the PA (UIS). *Science and technology* are considerably less frequent, however are important in the case of facilitating hunting (WCS) and fisheries (GIF).

SEPLS are not designed to be what they are, but rather have emerged to be what they are as a result of synergies and trade-offs among multiple interests and objectives. Therefore, a complex, sometimes contradicting, mix of policies and measures rule SEPLS as the result of diverse governance structures and processes in different sectors and at different scales (local, sub-national and/or national). The existing policies needs to be further streamlined and redesigned or fine-tuned, particularly at the local level, to effectively address the drivers affecting the main ecosystem domains and promote local livelihoods in a comprehensive and consistent manner with the active engagement of the multiple stakeholders representing diverse interests.

Regulatory instruments constitute the main type of policies or measures to address the direct drivers in the SEPLS. These are in place targeting all the categories of direct drivers, except for climate change (**Figure 47**). These comprise law enforcement measures (WCS, FFI, GIF), including patrolling by state forest guards (Dahari) or by communities (WCS) to prevent resources overexploitation but also land use changes such as the loss of primary forests (AMPA). They also include regulations to control pollution (FIDES). In fact, in the studied SEPLS, no policy or measure has been reported addressing climate change impacts.

The second most important type of instrument is awareness-raising through *information and education* targeting all drivers except for climate change. This type of measures includes environmental education programs (WCS, AMPA, FIDES) and public information on changes in land use plans (GIF). *Market-based instruments* and *voluntary agreements* are also important to specifically address the drivers of land use changes and resource exploitation in some of the studied SEPLS. The market-based instruments comprise fair trade and bio cash development as incentives for best practices (WCS), the promotion of apiculture (AMPA) and financial incentives for forest conservation (FIDES). Voluntary agreements include a payment for ecosystem services (PES) scheme on upstream-downstream water services (UIS) and community-driven natural resource management plans (WCS).

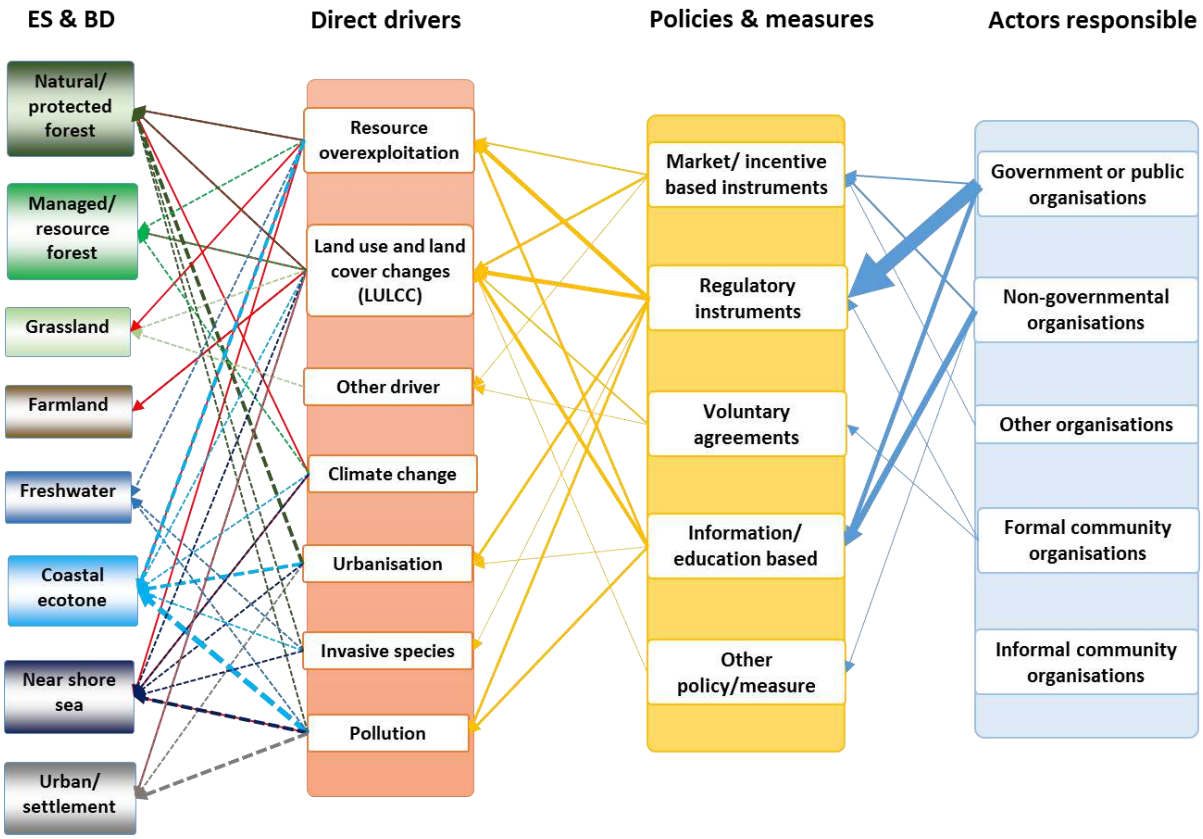

Figure 47. Policies and measures addressing each of the drivers, and actors responsible for these policies and measures.

The main actors in charge of policy-making and programs that affect SEPLS continue to be public or government entities, but other key stakeholders, representing diverse interests at different levels, including local community organizations and social and environmental NGOs, are increasingly engaged at the landscape/seascape level and beyond, and often responsible for implementing specific instruments that aim to address the negative drivers affecting the SEPLS and their biodiversity. While protected areas are managed by a single entity, or set of well-defined entities, this is not the case in many SEPLS. Public and government organizations play a key role in the management of SEPLS as they are the main actor implementing regulatory instruments. In fact, they were the only reported actors in this study that implemented regulatory instruments to curb resource overexploitation. Depending on the SEPLS, it was either public/government organizations or NGOs which implemented regulatory instruments addressing the drivers of land cover and land use changes and pollution. NGOs, in turn, were the main actors using information and education-based and market-based instruments (**Figure 47**), which seek awareness-raising and provision of incentives. To a lesser degree, NGOs were also the main actors responsible for voluntary agreements and other types of measures, including some of the GEF-Satoyama Project grantees. In at least one of the studied SEPLS it was a formal community organization implementing a voluntary agreement and a regulatory instrument. The types of actors, forms of interaction and networking vary from site to site, but this study found a common need for collaborative forms of ecosystem management in the SEPLS as building blocks of participatory and effective governance systems at the landscape or seascape level. Given these factors, a multi-stakeholder platform is needed to facilitate effective governance.

With a few exceptions, the main ownership right holders of the different ecosystem domains found in the eight studied SEPLS coincide with the management right holders, while there are other additional important stakeholder groups involved in the management of most of the ecosystem domains (**Figure 48**). The main right-holders in most ecosystem domains (including coastal ecotone, near shore sea, freshwater and natural and/or protected forest) are governmental or other public entities. These include the agencies in charge of protected area management but also of public ecosystem domains such as freshwater (FFI, UIS), ecotones (EPCO, GIF, FIDES) or near shore sea (EPCO, GIF). Jointly, formal and/or informal community organizations are an important right holder group in the forest ecosystem domains, with informal organizations having the management rights in the SEPLS of IMPECT's project (Thailand) and DAHARI's project (Comoros). The FIDES project (Ecuador) includes a formal community organization holding both ownership and management rights in the SEPLS.). Individual community members are the main tenure holders of grassland, land in settlement areas, farmland and resource forests, particularly in the SEPLS of the Tropical Andes (UIS, FIDES, and partly AMPA [buffer zone]). NGOs play a leading role in the management of natural protected forests in only two SEPLS (WCS, AMPA).

Many stakeholder groups are also involved in – or affected by – the management of all ecosystem domains in the nine SEPLS. In terms of key stakeholder groups, governmental and other public entities and NGOs share a comparable relevance in all ecosystem domains. As a third joint category, formal and/or informal community organizations also play an important role as key stakeholder groups in terrestrial ecosystem domains (forest ecosystems, grassland, farmland, freshwater ecosystems and settlement areas), with a less clearly stated relevance, particularly of informal organizations, in coastal ecotones and near shore sea. There is some relevance of international organizations as a stakeholder category, particularly in the management of natural forests, grasslands and coastal ecotones. The fourth relevant stakeholder group in general is individual community members. Although was not specifically stated as stakeholders in the online questionnaire survey, individual community members are perceived as key actors in the management of most ecosystems across all SELPS.

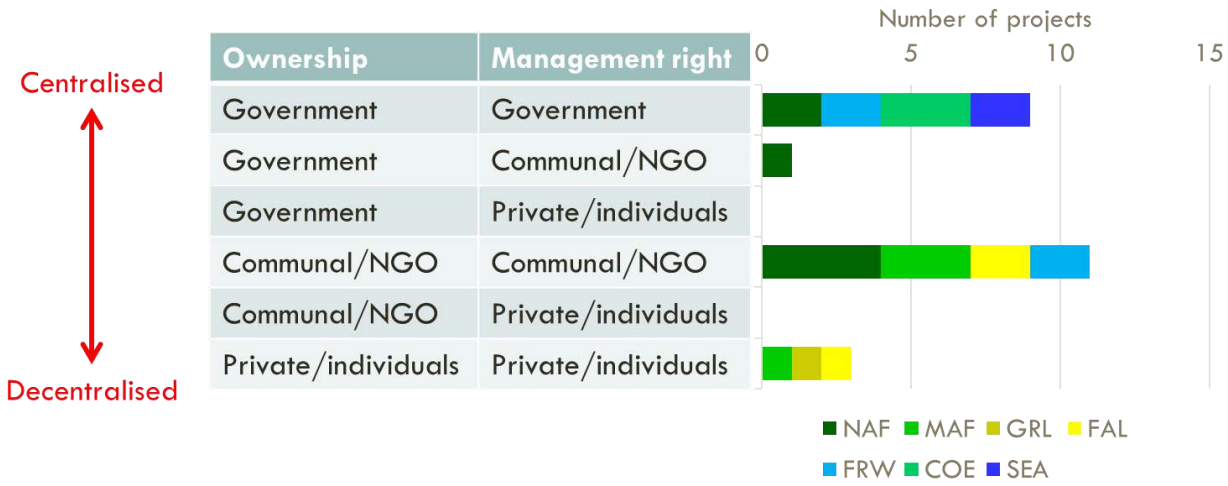

Figure 48. Main ownership and management right holder as well as stakeholder types in each ecosystem domain, as identified by the eight demonstration projects in their SEPLS

NAF: natural/protected forest; MAF: managed/resource forest; GRL: grassland/rangeland; FAL: farmland; FRW: freshwater wetland and waterbodies; COE: coastal ecotone (including mangroves); SEA: inshore sea; and URB: settlement/urban.

Note: The quantitative analysis in this diagram takes into account the number of projects in which each ecosystem domain is present by taking the average, in order to remove the bias caused by the different extent to which each ecosystem domain is present in the nine project sites.

While many SEPLS governance schemes involve several right holders and stakeholders including government, NGOs and community organizations, there is a need to strengthen the existing structures and processes. Many current governance schemes are not fully inclusive, with a weak role of community organizations. Governments at all levels need to actively involve community organizations, transferring management rights so that community organizations can undertake the management more effectively, and allocating sufficient public resources for these organizations to work efficiently.

It is also important to promote equal representation of both genders and different social (and if applicable ethnic) groups at the community level. All actors responsible for the public or communal management of ecosystems need to be accountable and transparent to their constituencies. The related decision-making processes benefit from consensus building, agreements and democratic decisions between the different interests within and among the different organizations. It is key to develop and implement policies and programs that contribute to change environmentally harmful practices, and to address the existing problems.

5 Conclusion

The review and analysis of the 10 GEF-Satoyama demonstration projects showed that the recognition of the diversity of ecosystem values (and services) of SEPLS, the existence of robust traditional knowledge and the functioning of participatory and effective governance schemes is key to the sustainability of SEPLS. Where these three pillars of sustainable ecosystem management mutually reinforce one another, this not only effectively addresses the negative drivers affecting biodiversity (particularly resource overexploitation, land use and land cover changes, climate change and pollution) but strengthens institutional efforts to promote biodiversity conservation and sustainable forms of production in SEPLS.

The recognition of many terrestrial ecosystem values (and services) by local communities is typically linked with extensive traditional knowledge held by communities, not only on their geo-ecological features (e.g. lemur ecology in the case of the Makira Forest, Madagascar or landslide prone areas in the case of Nagaland, India), but also on their management and use (e.g. shifting cultivation in the three landscapes of the projects in the Indo-Burma target geography), and their role in traditional beliefs (such as worship of the ancestral spirits of lemur species in the Makira Forest or conservation of sacred groves for performing rituals and ancestral sanctuary in the case of the Karen people). These values and uses are recognized and often integrated into governance schemes with specific roles in co-management schemes (e.g. joint patrols with rangers such as in the case of Makira Forest or village councils with decision made by traditional institutions such as tribal chief men in the case of Nagaland). The creation of community conserved areas (CCAs) are also important and effective outcomes of local governance schemes that have the strength of building on local level consensus.

However, there are cases where the knowledge held by local communities is not sufficiently recognized and exchanged with government agencies. The lack of recognition of local knowledge is often reflected by an underrepresentation or even exclusion of local communities in the governance structures and decision-making processes affecting their SEPLS, particularly in the case of protected areas. In such cases, creating opportunities for an exchange of knowledge held by communities and scientists or government officials is a first step towards overcoming possible mutual mistrust and institutionalizing platforms for continued dialogue, initially, and future collaboration. Providing venues for capacity building of community organizations is another possible intervention that can be effective in enhancing the recognition of ecosystem values, complementing local/traditional and scientific knowledge, and creating the basis for co-management governance schemes.

Seascapes, encompassing various ecosystems including coral reef lagoons, sea grass beds, mangroves and sometimes a hybrid of nature and built structure such as Barachois in Mauritius, constitute a vital component of global biodiversity, and provide multiple benefits to coastal communities. Coastal communities place primary importance on fisheries resources for livelihoods, and hold rich local or traditional knowledge of fish reproduction, movements and harvest. They also recognize regulating functions of coastal ecosystems, such as the contribution of mangrove to regulating coastal hazards. However, ongoing global changes beyond their control, such as changing climate and depleting resource, increasingly threaten their livelihoods. The projects in Seychelles and Mauritius demonstrated the opportunities to overcome these challenges. One vital step was to integrate scientific and traditional knowledge. In Seychelles, the project investigated threatened species in artisanal fish catch using scientific methods, and suggested the way to reduce fishing pressure on these species. In Mauritius, the project developed crab aquaculture techniques based on a practice of Barachois aquaculture developed centuries ago. Both projects made a substantial step forward towards incorporating these practices as a part of co-management scheme under official fisheries rules and regulations.

For policy-makers and land managers, the existence of interlinkages between values, traditional knowledge and governance means that the development and implementation of polices for SEPLS need to systematically take into account the values of the different ecosystems that are relevant to the affected communities, draw from both scientific and traditional knowledge and be inclusive of and coherent between the different sectors and levels of governance. For this, effective communication and consensus-building between all the stakeholders is key.

A few projects under the GEF-Satoyama Project have also demonstrated that local leaders and resource persons play a crucial role in mobilizing the communities, as they constitute the window of communication to and from the communities, and sustaining the initiatives after the project terms.

References

Alcaldía de San Vicente de Chucurí, S. (2017). Información general.

Andrade-C., M. G. (2011). Estado del conocimiento de la biodiversidad en Colombia y sus amenazas. Consideraciones para fortalecer la interacción ciencia–política. *Revista de La Academia Colombiana de Ciencias Exactas, Físicas Y Naturales*, *35*(137), 491–507.

Atkinson, G. (2017). *The Barachois Project – A Baseline Study – Native and Endemic Species – Terrestrial Plants*. Mahebourg, Mauritius.

Berkes, F. (2008). *Sacred Ecology* (2nd ed.). Routledge.

CAS, C. A. R. de S. (2017). Parque Nacional Natural Serranía de Los Yariguíes - Fauna.

Castellanos-Morales, C. A., Marino-Zamudio, L. L., Guerrero-V., L., & Maldonado-Ocampo, J. A. (2011). Peces del departamento de Santander, Colombia. *La Revista de La Academia Colombiana de Ciencias Exactas, Físicas Y Naturales*, *35*(135), 189–212.

Coche, A. G. (1982). *Coastal aquaculture : development perspectives in Africa and case studies from other regions = Aquaculture côtière : perspectives de développement en Afrique et exemples d'autres régions*. Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/008/ad794b/AD794B00.htm#TOC

DANE, D. A. N. de E. C. (2015). Estimación y proyección de población nacional, departamental y municipal total por área 1985-2020.

Deja, E. (2016). *Feasibility study: developing community-based mariculture in the Barachois of Residences la Chaux, Mahebourg. Final Report*. Mahebourg, Mauritius.

Deja, E. (2017). *The Barachois Project Household Survey Report*. Mahebourg, Mauritius.

Donegan, T., Huertas, B., Arias, J. J., Briceño, E., & Donegan, M. (2005). *Colombian EBA Project Report Series 5: Threatened Species of Serranía de los Yariguíes*. *October*. https://doi.org/ISSN 1811-1246

Donegan, T. M., Avendaño, J. E., Briceño-L., E. R., Luna, J. C., Roa, C., Parra, R., … Huertas, M. (2010). Aves de la Serranía de los Yariguíes y tierras bajas circundantes, Santander, Colombia. *Cotinga*, *32*, OL 72–89.

Fagoonee, I. (1990). Coastal marine ecosystems of Mauritius. *Hydrobiologia*, *208*(1–2), 55–62. https://doi.org/10.1007/BF00008443

Hollup, O. (2000). Structural and sociocultural constraints for user-group participation in fisheries management in Mauritius. *Marine Policy*, *24*(5), 407–421. https://doi.org/10.1016/S0308-597X(00)00016-6

IPBES. (2017). Update on the classification of nature's contributions to people by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Germany.

IUCN, I. U. for the C. of N. (2017). IUCN Red List of Threatened Species.

Lopez-Casero, F., Cadman, T., & Maraseni, T. (2016). *Quality-of-governance standards for forest management and emissions reduction. Developing community forestry and REDD+ governance through a multi-stage, multi-level and multi-stakeholder approach. 2016 Update*. Retrieved from https://pub.iges.or.jp/pub/quality-governance-standards-forest-management

Mantilla Blanco, J., Argüello Angulo, A. L., & Méndez Aldana, H. (2000). *Caracterización y Tipificación de los Productores de Cacao del Departamento de Santander*. Bucaramanga.

Montañez Monsalve, X. (2013, December). Con su permiso, don Pedro Hernández. *Vanguardia.com*.

Olaya, E., Velosa, R., Rodriguez, A., Bueno-Castellanos, J., Holguín, L. (UAESPNN-T. (2010). *Zonificación ambiental del Parque Nacional Natural Serranía de Los Yariguíes*.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Retrieved from http://books.google.co.jp/books?hl=ja&lr=&id=4xg6oUobMz4C&oi=fnd&pg=PR11&dq=governing+the+commons+著者:ostrom&ots=aN5xyMjCVn&sig=Xh-Il0ePbPIkTyuWLOeCsiMLJxw

Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., … Yagi, N. (2017). Valuing nature's contributions to people: the IPBES approach. *Current Opinion in Environmental Sustainability*, *26*, 7–16. https://doi.org/10.1016/j.cosust.2016.12.006

Paul, E. C., & Balkema, A. A. (1987). *Fisheries development and the food needs of Mauritius*. Rotterdam, the Netherlands: CRC Press.

Rawson, G. C. (1988). Future strategies for the fisheries of Mauritius. *Food Policy*, *13*(4), 409–411. https://doi.org/10.1016/0306-9192(88)90096-6

Rodríguez-Moreno, R. A. Ortega-Chinchilla, J. E. Ramírez-Pinilla, M. P., & Serrano-Cardozo, V. H. (2014). *Anfibios, Reptiles y Mamíferos del Área de influencia, Proyecto Hidroeléctrico Sogamoso, Guía Ilustrada.* Bucaramanga.

Rosado, L. (2006). Lista preliminar de escarabajos coprófagos. In T. Huertas, B. & Donegan (Ed.), *Investigación y Evaluación de las Especies Amenazadas de la Serranía de los Yariguíes, Santander, Colombia. (Serranía de los Yariguíes Assessment and Research of Endangered species). Informe Final 2005-2006*.

UIS (Universidad Industrial de Santander). (2017). *Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes. Assessment Workshop Reporting Form*. Bucaramanga.

Yarumo, P. (1991, November). El Compadre Pedro Hernández. *El Tiempo*.