SATOYAMA INITIATIVE

# Satoyama Initiative Thematic Review

## vol. 3

## Sustainable livelihoods in socio-ecological production landscapes and seascapes

2017

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**Satoyama Initiative**
The Satoyama Initiative is a global effort, first proposed jointly by the United Nations University and the Ministry of the Environment of Japan (MOEJ), to realize "societies in harmony with nature" and contribute to biodiversity conservation through the revitalization and sustainable management of "socio-ecological production landscapes and seascapes" (SEPLS). The United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) serves as the Secretariat of the International Partnership for the Satoyama Initiative (IPSI). The activities of the IPSI Secretariat are made possible through the financial contribution of the Ministry of the Environment, Japan.

**UNU-IAS**
The United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) is a leading research and teaching institute based in Tokyo, Japan. Its mission is to advance efforts towards a more sustainable future, through policy-relevant research and capacity development focused on sustainability and its social, economic and environmental dimensions. UNU-IAS serves the international community, making valuable and innovative contributions to high-level policymaking and debates within the UN system. The activities of the institute are in three thematic areas: sustainable societies, natural capital and biodiversity, and global change and resilience.

**IGES**
The Institute for Global Environmental Strategies (IGES) was established in March 1998 under an initiative of the Japanese government and with the support of Kanagawa Prefecture. The aim of the Institute is to achieve a new paradigm for civilization and conduct innovative policy development and strategic research for environmental measures, reflecting the results of research into political decisions for realising sustainable development both in the Asia-Pacific region and globally. The Institute will tackle fundamental challenges to human society, and to redefine the values and value systems of our present societies that have resulted in the global environmental crisis, in order to create new ways of conducting activities and a new paradigm for civilization.

# Table of contents

# Foreword

When we talk about "sustainability" in rural or sub-urban areas the first thing that comes to mind for some people is environmental sustainability, in particular related to conservation of natural ecosystems. It has become increasingly recognized in recent years, however, that the activities humans engage in to secure their livelihoods, or economic and social sustainability, are integral elements to maintain ecosystems all over the world.

The vision of the Satoyama Initiative is to achieve "societies in harmony with nature". In such societies, environmental, economic, and social sustainability are realized through sustainable use of natural resources by local communities, to both secure human livelihoods and conserve biodiversity. The United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS) has worked closely with the Ministry of the Environment of Japan in the development of the Satoyama Initiative, and we have hosted the Secretariat of the International Partnership for the Satoyama Initiative (IPSI) since its establishment at the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP 10) in Aichi-Nagoya, Japan in 2010. IPSI promotes the revitalization and sustainable management of "socio-ecological production landscapes and seascapes" (SEPLS) to support biodiversity while, importantly, ensuring the provision of diverse ecosystem services that contribute to human livelihoods and well-being.

As IPSI's membership has grown to 220 organizations, it has accumulated a wide range of knowledge and experience, which members apply in various ways through their collaborative work toward the better management of production landscapes and seascapes. This third volume of the Satoyama Initiative Thematic Review represents a distillation of this knowledge, focusing on the theme of "sustainable livelihoods in socio-ecological production landscapes and seascapes". While the concept of sustainable livelihoods is quite broad, the focus in this volume is on production activities that provide subsistence and income generation for the well-being of local people based on natural resources in SEPLS, while contributing to biodiversity conservation.

I am confident that the cases presented in this volume will provide inspiration and useful knowledge for practitioners, policymakers, and scientists, and that the activities described herein will make broader contributions to the knowledge base of the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES), as well as toward the CBD Strategic Plan for Biodiversity 2011–2020 including its Aichi Biodiversity Targets, the global Sustainable Development Goals (SDGs), and other ongoing policymaking processes.

Prof. Kazuhiko Takemoto

Director, United Nations University Institute for the Advanced Study of Sustainability

# Preface

The Satoyama Initiative is "a global effort to realise societies in harmony with nature", started through a joint collaboration between the United Nations University (UNU) and the Ministry of the Environment of Japan. The initiative focuses on the revitalisation and sustainable management of "socio-ecological production landscapes and seascapes" (SEPLS), areas where production activities help maintain biodiversity and ecosystem services in various forms while sustainably supporting the livelihoods and well-being of local communities. In 2010, the International Partnership for the Satoyama Initiative (IPSI) was established to implement the concept of the Satoyama Initiative and promote various activities by enhancing awareness and creating synergies among those working with SEPLS. IPSI provides a unique platform for organisations to exchange views and experiences and to find partners for collaboration. At the time of writing, 220 members have joined the partnership, including governmental, intergovernmental, nongovernmental, private-sector, academic and indigenous peoples' organisations.

The Satoyama Initiative promotes the concept of SEPLS (through a three-fold approach that argues for connection of land- and seascapes holistically for management of SEPLS (Figure 1). This often means involvement of several sectors at the landscape scale, under which it seeks to: 1. consolidate wisdom in securing diverse ecosystem service and values, 2. integrate traditional ecosystem knowledge and modern science and 3. explore new forms of co-management systems. Furthermore, activities for SEPLS conservation cover multiple dimensions, such as equity, addressing poverty and deforestation, and incorporation of traditional knowledge for sustainable management practices in primary production processes such as agriculture, fisheries and forestry. (UNU-IAS & IGES 2015)

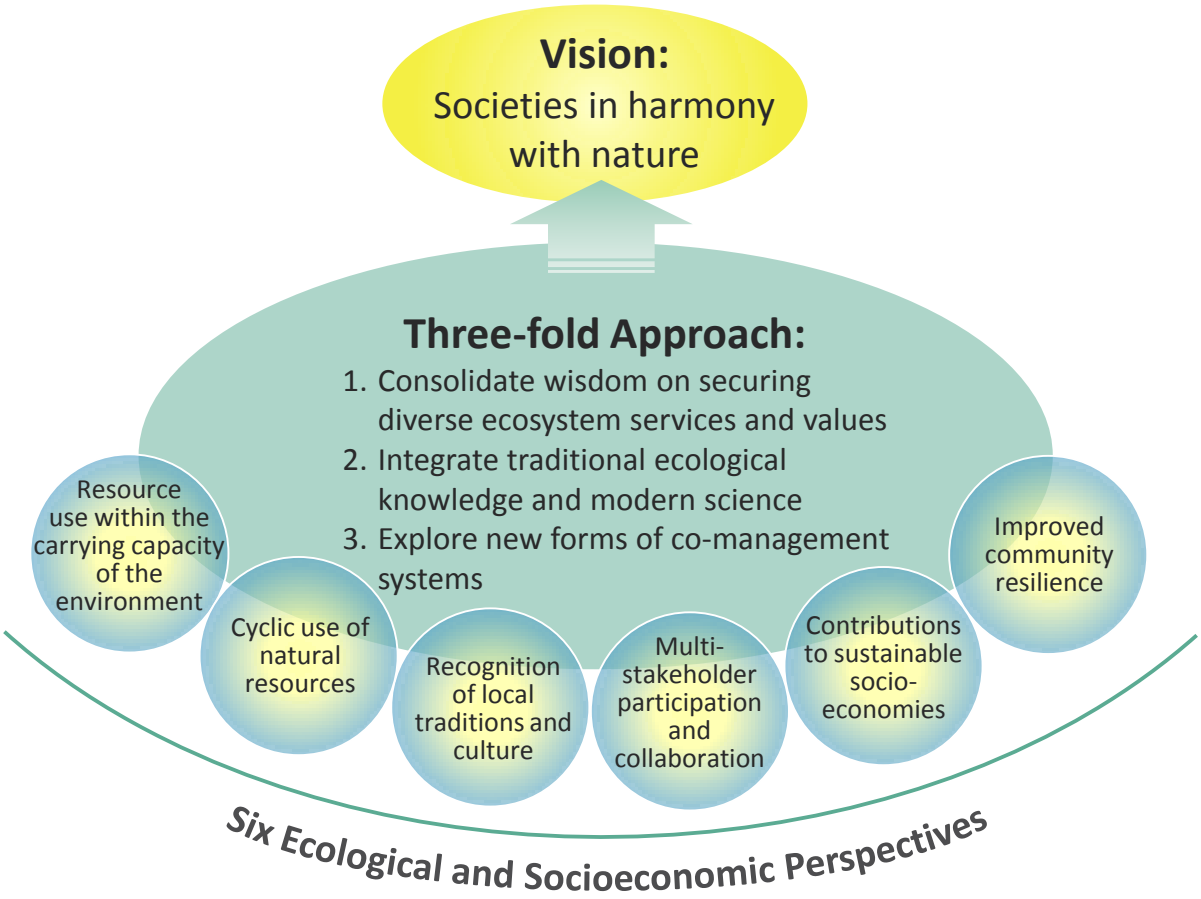


Figure 1. The conceptual framework of the Satoyama Initiative

As one of its core functions, IPSI serves as a knowledge-sharing platform through the collection and sharing of information and experiences on SEPLS, providing a place for discussion among members and beyond. More than 110 case studies have been collected and are shared on the IPSI website, providing a wide range of knowledge covering diverse issues related to SEPLS. Discussions have also been held to further strengthen IPSI's knowledge-facilitation functions, with members suggesting that efforts should be made to produce knowledge on specific issues in SEPLS in order to make more targeted contributions to decision-makers and on-the-ground practitioners.

It is in this context that a project to create a publication series titled the "Satoyama Initiative Thematic Review" was initiated in 2015 as a joint collaboration between UNU's Institute for the Advanced Study of Sustainability (UNU-IAS), which hosts the IPSI Secretariat, and the Institute for Global Environmental Strategies (IGES), an IPSI partner and research institute based in Japan. The Thematic Review was developed as a compilation of case studies providing useful knowledge and lessons focusing on a specific theme that is important for "socio-ecological production landscapes and seascapes (SEPLS)". The overall aim of the Thematic Review is to collect experiences and relevant knowledge, especially from practitioners working on the ground, considering their usefulness in providing concrete and practical knowledge and information as well as their potential to contribute to policy recommendations. Each volume is also accompanied by a synthesis chapter which extracts lessons learned through the case studies, presenting them for policy-relevant academic discussions. The first volume of the Satoyama Initiative Thematic Review was published in 2015 with the theme "enhancing knowledge for better management of SEPLS". The second volume's theme was "mainstreaming concepts and approaches of SEPLS into policy and decision-making ", covering topics including advocacy, multi-stakeholder engagement, facilitation and coordination of institutions, concrete tools and information useful for policymakers and stakeholders.

## Purpose of the Satoyama Initiative Thematic Review Volume 3 (SITR-3)

A notable characteristic of SEPLS is the 'intangible cultural' link, formed between humans and nature through production processes, that has been the basis for resilient landscapes and seascapes and the communities that reside in them (UNU-IAS, Bioversity International, IGES and UNDP, 2014). The cases in this volume depict biodiversity-rich landscapes and seascapes with significant traditional knowledge (TK), skills, and practices associated with natural resources that are in decline to various degrees. Despite this decline, these socio-ecological systems continue to maintain certain principles of management and use, and have, according to their individual contexts and various challenges, undertaken to strengthen underlying natural and social features. The focus of this volume is to identify drivers linked to sustainable livelihoods in SEPLS that are crucial to meet needs for human well-being and to foster sustainable use of natural resources.

The eleven case studies in this volume describe experiences from countries in Asia, Europe, Africa and North America, with various socio-political and ecosystem contexts. Authors were asked to identify challenges and opportunities in sustaining livelihoods, social and ecological changes that have occurred and approaches being deployed to strengthen natural and social resilience in the landscapes and seascapes where they work. Some of these experiences are very specific to certain sites, while others have elements in common, indicating similarities in drivers affecting the landscape or seascape and thereby livelihoods. Responses vary among the sites, determined primarily by socio-political considerations, but can be clustered under various broad categories from market-based approaches to integrated solutions deploying both modern and traditional practices for management and value addition.

Like previous volumes, this publication was developed through a multi-stage process including both peer review and discussion among the authors at a workshop. Authors had several opportunities to get feedback, which helped them to make their manuscripts more useful and easy to understand for readers. First, each manuscript received comments from the editorial team relating primarily to their contributions to the theme of the volume. Peer review was then conducted by the authors of other chapters, with each author receiving feedback from two other authors who were requested to comment on whether the manuscript was easy to understand and informative, provided useful lessons, and so on. The aforementioned workshop was then held to enable the exchange of feedback between authors. Here, the authors presented their case studies and received comments both from the two designated reviewers and from the other workshop participants. The

workshop also served as a place for discussion to further deepen understanding on the theme and to extract findings across all the case studies. The basic ideas contained in the synthesis chapter were developed from the presentations and discussions during the workshop, and the chapter was made available for review by authors and selected experts before finalisation.

We believe that the above process used for developing this publication offers an opportunity for authors from both academic and non-academic organisations to contribute to knowledge-building in an accessible and interactive way, as well as to provide high-quality papers written in simple language for academics and a broader audience alike. It is our hope that this publication will be useful in providing information and insights on sustainable management of SEPLS for practitioners, researchers and policymakers.

We would like to thank all of the authors who contributed their case studies and the other participants in the case study workshop. We also greatly appreciate the efforts of IGES for their continued collaboration in the publication process of this volume. Our grateful thanks are also due to the Ministry of the Environment, Japan for supporting the activities of IPSI and its secretariat hosted by UNU-IAS.

Suneetha M. Subramanian, Shamik Chakraborty, Beria Leimona
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Chapter 1

# Sustainable livelihood options in SEPLS for human well-being

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# 1. Introduction

## 1.1. Socio-ecological systems in production landscapes and seascapes: problems and complexity

Socio-ecological systems in production landscapes and seascapes – areas where the natural landscape or seascape is heavily complemented by human production activities such as agriculture and fisheries– are being degraded around the world, leading to diminished resilience of natural systems and human well-being (Ostrom, 2009; Nayak et al, 2014; Gu and Subramanian, 2014). Major causes of this degradation include less-sustainable agricultural practices such as monoculture or low crop species diversity, overuse of chemicals, and increasing abandonment of rural areas, all of which can result in a simpler, less diverse ecosystem. While such practices may have short-term, mostly financial, merits such as simplification of agricultural work, they often lead to a reduction in ecological function to sustainably provide ecosystem services and benefits (Swift et al, 2004; Mazumder and Berrens 2007). As a consequence, concerns have been raised regarding negative effects on human health and well-being due to a loss of the sustainable management of ecosystems that enable human livelihoods (Kumar and Takeuchi 2009). It is in this context that we need to identify and revisit social and ecological factors in production landscapes and seascapes in order to find ways to restore ecosystem diversity and resilience. The Satoyama Initiative (see Preface) promotes the concept of "socio-ecological production landscapes and seascapes" (SEPLS) – places characterised by dynamic mosaics of land- and sea-uses and natural habitats, where social and ecological components interact to produce diverse benefits – as one way to conceptualise and promote the diverse ecosystems in landscapes and seascapes that provide for sustainable human livelihoods and well-being.

## 1.2. Links between livelihoods and SEPLS

SEPLS generally require high levels of management by humans in order to maintain a sustainable production system that provides for human well-being. Thus their ecosystems are dominated by human activities, including traditional and local practices as well as modern production methods. These activities are considered means of livelihood, as they secure necessities for human lives. Characteristics of people's means of livelihood in SEPLS around the world are highly site-specific, as SEPLS are unique systems with specific social and ecosystem attributes, functions and services that influence how people manage their resources, which in turn influences the nature of the landscape or seascape itself. It is, therefore, application of people's ecological knowledge that makes it possible for them to procure the ecosystem services that support their livelihoods and well-being, often instilling a sense of identity and strong link to place in the local resource users.

The case studies in this volume highlight these dynamics in different socio-ecological and political contexts. Table 1 gives an overview of the case studies, and Figure 1 illustrates the locations of the landscapes and seascapes covered.

Table 1. Overview of the case studies

| Chapter number (country) | Title (author) | Socio-ecological context and problems | Focus |
|---|---|---|---|
| Chapter 2 (Chinese Taipei) | Indicator species for agrobiodiversity in rice paddy fields: Research and its application to a new eco-labelling scheme in eastern rural Taiwan (Fan et al) | Organic farming can increase biodiversity in paddy fields and enhance pest prevention and control, pollination and soil development.<br><br>Change farmers' behaviour to promote organic farming practices. | Increasing consumer recognition, and their willingness to purchase agricultural products with ecological conservation significance.<br><br>A new eco-labelling scheme based on the identified agro-biodiversity indicator species. |
| Chapter 3 (Italy) | Sustainable fishing practices and a unique fishermen's community in the Orbetello Lagoon, Italy (Gualandi et al) | Economic exploitation (gaining fishing rights).<br><br>Exogenous pressures: regular disasters and overfishing in the open sea, deforestation | Modernizing traditional fishing and processing techniques to be sustainable. |
| Chapter 4 (Bangladesh) | The complementarity of human and nature well-being: A case illustrated by traditional forest resource users of the Sundarbans in Bangladesh (Titumir and Afrin) | In the Sundarbans Reserve Forest (SRF) area, powerful agents at local, national and international levels have been extracting resources beyond the sustainable limit. | Setting up cooperatives to promote the power of IPLCs for maintaining TK-based sustainable resource use. |

| Chapter number (country) | Title (author) | Socio-ecological context and problems | Focus |
|---|---|---|---|
| Chapter 5 (Indonesia) | Strengthening smallholder resilience and improving ecosystem services provision in Indonesia: Experience from Buol District, Central Sulawesi (Amaruzaman et al) | Smallholders' vulnerability from biophysical and socioeconomic shocks, in upstream, midstream and coastal communities of tropical agroecological environment. | Building the capacity and awareness of various development actors - government officers, private sector, and smallholders - to contribute in enhancing smallholders' resilience and improving ecosystem service provision through multifunctional tree-based agriculture |
| Chapter 6 (Cambodia) | Resin trees: A vital source of Phnong people's livelihood in transition in Cambodia (Sakkhamduang et al) | Self-sufficient Phnong ethnic communities living in the Mondulkiri protected forest area face vulnerability due to forest degradation from expansion of economic land concessions and illegal logging. | Understanding cause and effect of resin tree degradation on Phnong livelihoods through field research. |
| Chapter 7 (Ghana) | Making landscapes work: A case of the Kakum Conservation Area in Ghana (Osei-Owusu et al) | West Africa's upper Guinea forest hotspot.<br><br>Cocoa-based farmers' socioeconomic and traditional production practices are hampered inside the park area due to strict command and control measures for the protected area. | Integrating biological and cultural diversity within the landscape through conservation of traditional culture, certified cocoa production and ecotourism. |
| Chapter 8 (Vietnam) | Human-nature connection and well-being of the H're indigenous community in production landscapes of Kon Tum province, Central Highlands of Vietnam (Dang et al) | Socio-ecological interactions of indigenous H're community in the central highlands of Vietnam with their agricultural landscape, conserving agricultural biodiversity. | Conservation of locally managed ecological systems in the agricultural village through ecosystem mapping and awareness-raising inside and outside the community. |
| Chapter 9 (India) | FairWild certification: an approach for linking biodiversity conservation with sustainable livelihoods in the northern Western Ghats, India (Sarnaik et al) | Sacred grove landscapes of the tropical monsoon rainforests of Western Ghats in India. The ecosystems face degradation from land-use change from agriculture, tourism expansion, development projects and logging for immediate monetary gains. | FairWild certification scheme to enhance sustainable harvesting of non timber forest products from *Terminalia bellirica* and *Terminalia chebula* trees, which are also connected with forest ecosystem health. |
| Chapter 10 (Japan and Canada/ USA) | Coastal communities and livelihoods in a changing world: A comparison of the fisheries and aquaculture sector in Matsushima Bay, Japan and the Salish Sea, Canada/USA (Minohara et al) | Fisheries and aquaculture sector in semi-enclosed temperate seas in a changing socio-ecological and economic setting. | Complexity, uncertainty and contested nature of resource management in coastal communities. |
| Chapter 11 (Uganda) | Enhancing livelihoods of Lake Victoria fisher folk through control of the predator Nile perch in Uganda (Ahimbisibwe) | Degradation of socio-ecological system of lake Victoria region due to the introduction of the predator Nile perch in the lake for profit maximization to the fish export sector at the expense of biological diversity and local economies. | Awareness raising, promoting recovery of threatened endemic fish species, rebuilding traditional fishing villages, research on eradication of the predator Nile perch and enabling farmers to adopt Vetiver Grass Hedge Rows System to control eutrophication in Lake Victoria. |
| Chapter 12 (Kenya) | From payment to co-investment for ecosystem services: Stewardship and livelihood improvement in the Lake Naivasha agro-production landscape, Kenya (Nyongesa and Leimona) | Lake Naivasha Ramsar site and associated agroecosystems. The upstream smallholder community's livelihood and ecosystems are threatened by unsustainable land use practices such as farming on high-gradient and riparian areas, overuse of agro-chemicals, slash and burn of vegetation cover, cultivation across contours, and siltation. | Payment for ecosystem services (PES) scheme in the basin to reduce farm degradation, joint investments in social, ecological and financial capitals, considering opportunity costs, benefits, indigenous and local knowledge (ILK) and gender. |

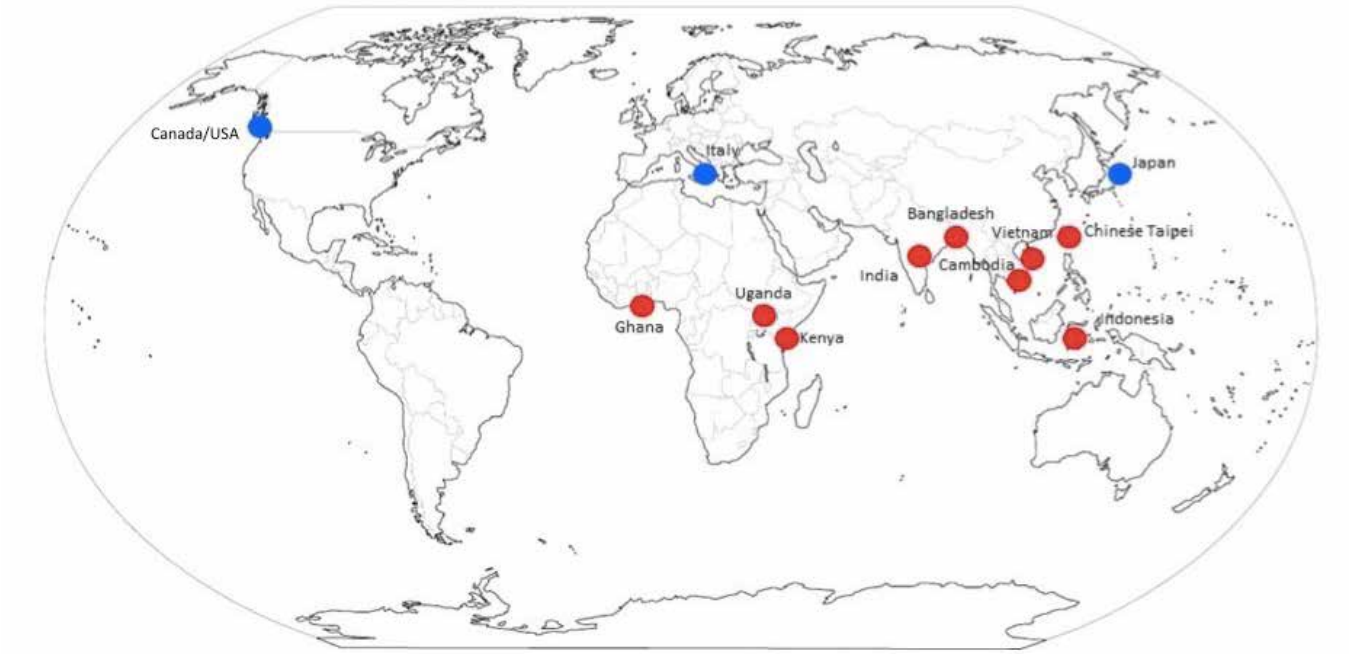


Figure 1. Locations of the case studies presented in the Satoyama Initiative Thematic Review Volume 3 (red: landscape; blue: seascape) - 7 in Asia, 3 in Africa, 1 in Europe, 1 in North America

Landscapes and seascapes experience dynamic, non-linear changes in their ecosystem biomasses. For landscapes, the transition can be seen as dynamic states of tree-cover from natural forests to monocrops and grasslands (Van Noordwijk 2014; Dewi et al. 2017). For seascapes and terrestrial waters, seagrass and other freshwater or marine vegetation form the biomass, and are also potential blue carbon stocks. When mapped onto a transition curve by landscape or seascape type, the Satoyama Initiative Thematic Review Vol.3 (SITR-3) case studies provide a relatively good representation of different states along the curve (Figure 2).

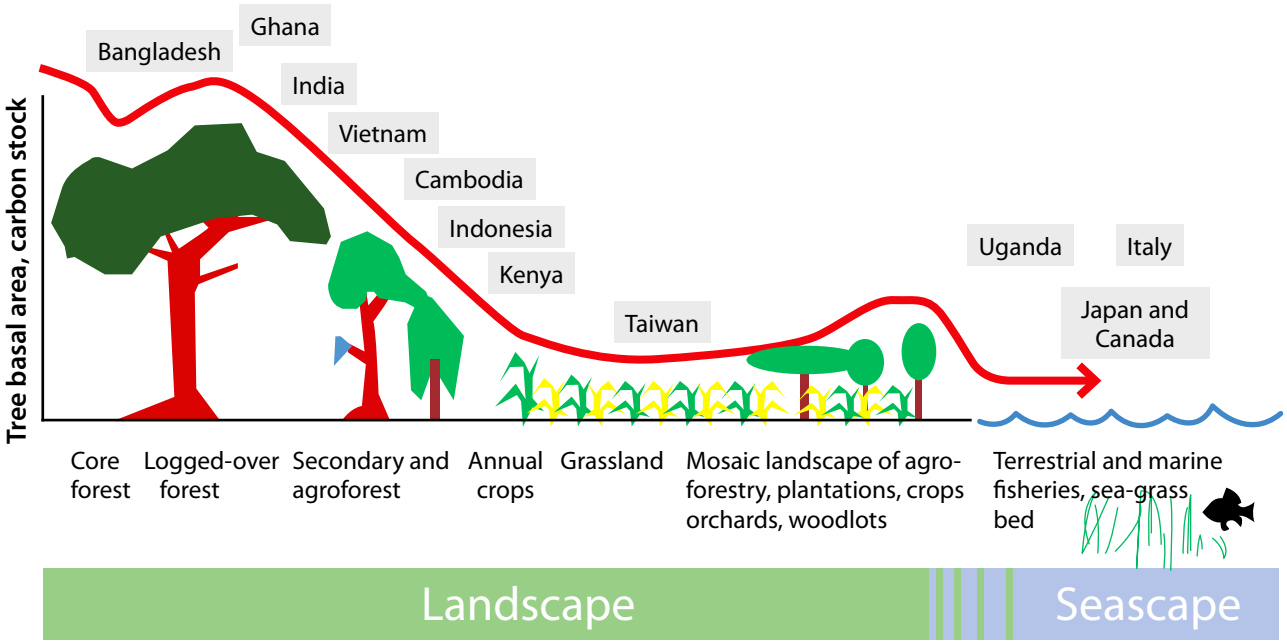


Figure 2. Landscape and seascape transition curve illustrating ecosystem characteristics in the case studies in the SITR-3 (Modified from Dewi et al. 2017)

## 2. Methodology

This chapter aims to provide a synthesis of the case studies presented in this volume, with material taken both from the manuscripts themselves and from discussions at an authors' workshop held from 28 to 30 June 2017 at the United Nations University in Tokyo, Japan. The workshop invited the principal authors of the case studies to present their cases and discuss social and environmental characteristics, and associated livelihoods, in their project areas. They were asked in particular to highlight relationships with biodiversity and ecosystem functions, and tools or mechanisms to strengthen or generate values, benefits and challenges to SEPLS. In this context, workshop discussions addressed the following two key questions:

- How and under what conditions can livelihood activities in SEPLS contribute to local socio- cultural and economic conditions?
- How can such conditions connect to peoples' well-being while supporting biodiversity?

These questions helped to contextualize the ways in which livelihood-related activities can impact biodiversity, determined by resource dependency, and including spill-over effects on ecosystems and biological resource stocks and flows. The workshop covered a wide range of linked drivers, and associated opportunities and challenges, that impact society and nature in production landscapes and seascapes.

## 3. Drivers of change: opportunities and challenges for livelihoods in SEPLS

In this section, we explore similarities and differences found among the case studies in terms of drivers affecting the landscapes and seascapes they describe, as well as some opportunities and challenges specific to a SEPLS approach that these point to. The analysis presented here is an attempt to synthesize the complex nuances involved in this context, developed through dialogue between all of the editors and authors.

It is important to note that livelihoods are spatially and temporally dynamic, subject to change due to various natural and anthropogenic, direct and indirect factors. The case studies in this volume describe a non-exhaustive set of direct and indirect drivers of change in production landscapes and seascapes and in livelihood systems. Direct drivers include land-use change, alien and invasive species, overexploitation, climatic variations, underuse and pollution, while indirect drivers include demographic change (e.g. population increase or decrease), socio-economic and political factors (e.g. poverty, corruption), science and technology (e.g. genetically modified crops, mechanized agriculture) and natural disasters[1] (e.g. impacts on human well-being through disruptions in the flow of goods and services by earthquakes, tsunamis, major storms etc.).

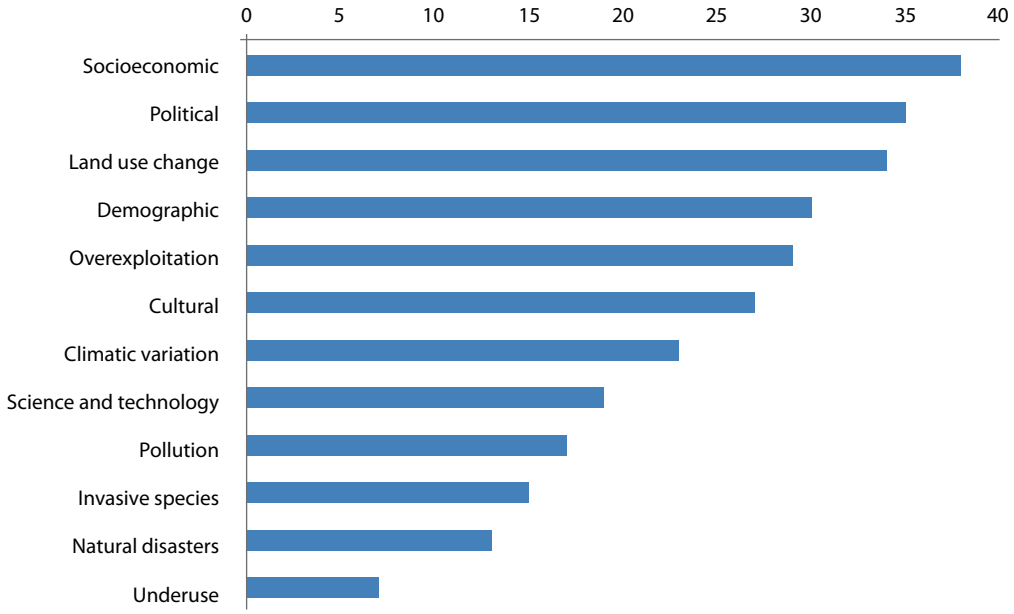


Figure 3. Cumulative Likert scale points for drivers of change identified in the case studies

1 Natural disasters are raised as an indirect driver here as they indirectly impact components of human well-being, for example through long-term loss of livelihood, while they also have direct short-term effects, such as through loss of production in a particular year or span of several years, which do not necessarily mean the loss of livelihood itself.

Table 2: Drivers of change identified in the case studies

| Case Studies / Drivers of change | 1 Chinese Taipei | 2 Italy | 3 Bangladesh | 4 Indonesia | 5 Cambodia | 6 Ghana | 7 Vietnam | 8 India | 9 Japan and Canada/USA | 10 Uganda | 11 Kenya | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demographic | | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | 8 |
| Socioeconomic | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | 8 |
| Political | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | 9 |
| Cultural | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 10 |
| Science and technology | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | | 7 |
| Climate variation | | | ✓ | ✓ | | | | | ✓ | | | 3 |
| Natural disasters | | | ✓ | ✓ | | | | | ✓ | | | 3 |
| Land-use changes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | 10 |
| Invasive species | | | | | | | | | | ✓ | | 1 |
| Overexploitation | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ | 8 |
| Underuse | | | | | | | | | ✓ | | | 1 |
| Pollution | ✓ | ✓ | | | | | | | ✓ | ✓ | ✓ | 5 |
| **Total** | 5 | 8 | 7 | 7 | 7 | 5 | 5 | 6 | 8 | 9 | 6 | |

Legend: ✓= direct link found

Figure 3 and Table 2 show various drivers of change in the landscapes and seascapes, and consequently livelihoods, as identified in the case studies in this volume. Socioeconomic and political factors, land-use, demographic changes and over-exploitation of resources are seen to be the top drivers and are seen to impact livelihoods and the SEPLS system in some combination across all of the case studies. Socioeconomic drivers are also seen to work in combination such as for instance seen in interactions with agrotechnology (improving seeds, fishing methods) in many cases. Effects of these drivers are not always negative; for example cultural drivers with traditional knowledge components can have positive effects that improve community well-being and the natural environment.

Political factors show a huge influence on livelihoods in these case studies. Political incoherence regarding traditional land use leads to losses of land-use rights for people who hold traditional knowledge (TK), and results in intensive and environmentally harmful monocultural cash-crop cultivation, illegal logging, unsustainable timber harvesting, and neglect of traditional knowledge when managing and harvesting non-timber forest products (NTFPs), for example in the cases from Bangladesh, Cambodia and Ghana (Chapters 4, 6 and 7).

Perverse economic instruments such as quota systems for harvesting fish and NTFPs, or subsidies that promote less ecologically-friendly production practices or harm marginalized communities were also identified as factors leading to deterioration of production landscapes and seascapes. These kinds of economic instruments require careful science-based decision-making to avoid adverse effects. Policies and regulations can also be responsible for introducing alien and invasive species, which can change species association and cause a loss of the biological diversity that traditional livelihoods rely on (see Chapter 11). Politics and power imbalances in land-use management may be associated with developments in new technologies or practices that are inappropriate for the ecosystem or local livelihoods, or with rapid modernization and economic intensification in response to non-traditional demands such as export markets, as in the cases from Cambodia and Uganda (Chapters 6 and 11). Primary cultivation of cash crops over food crops is an ongoing problem in many production landscapes and seascapes, and it appears that understanding of the diverse ecosystem benefits to long-term economic activity from a more biodiverse landscape or seascape is gradually being lost, as in the cases from Chinese Taipei, Indonesia and Ghana (Chapters 2, 5 and 7). In case studies from developed countries, TK is observed to be lost primarily due to aging societies or rural depopulation – causing, for example, decreases in traditional fishermen and the TK they hold in Italy and Japan and Canada/USA (Chapters 3 and 10) – pointing to a need for new mechanisms for the maintenance of TK related to sustainable resource

harvesting and production. It is in this sense that TK could benefit from integration with modern science, in order to be recognized in broader policy processes.

Some drivers are more specific to certain situations where there are specific combinations of demographic, political and other factors. For instance, underuse can be a problem where the population is declining, weakening TK and leading to less resilient resource-use activities and livelihoods. However, these more specific drivers show an equal degree of complexity within the cases where they are found, involving political decisions leading to unsustainable use, erosion of TK and ineffective co-management. This demonstrates how drivers work across all cases in complex ways, and with interrelated effects. Climatic variations and natural disasters, together with mismanagement, further exacerbate non-linear and uncertain changes to the landscapes and seascapes in Bangladesh, Indonesia, Japan and Canada/USA, and Kenya (Chapters 4, 5, 10 and 12).

These drivers of change can work negatively or positively depending on complex factors, and depending on whether their effects are understood and consequent decisions are made by appropriate stakeholders. A common tendency across all of the case studies here is the re-assertion of rights, responsibilities and recognition of the people in the landscape or seascape over their resources, with the purpose of access to resources and autonomy over their economy. Access to resources and autonomy translate to tenure over territory and greater influence towards decision-making that is culturally acceptable, economically viable and ecologically sustainable in Bangladesh, Vietnam and Kenya (Chapters 4, 8 and 12).

This then brings us to the issue of how to ensure livelihood security while guaranteeing that socioeconomic, cultural and ecological characteristics of production landscapes and seascapes are maintained sustainably. The case studies in this volume point to various approaches and tools that have been shown to be effective.

## 4. SEPLS management approaches and tools towards sustainable livelihoods

It has been found that as a general rule, social, human and financial investments made to improve landscapes and seascapes and restore natural capital are easily made up for by benefits obtained from the improved ecosystems (de Groot et al. 2013). Among the case studies in this volume, this is demonstrated directly by some, for example in Indonesia and Kenya (Chapters 5 and 12), while others show a more indirect link, for example in Chinese Taipei, Ghana and India (Chapters 2, 7 and 9). The observations that major drivers of change are interrelated and are seen in common across different cases reflect the findings that working with a number of identified approaches and tools, emerging in response to the two key questions asked in the workshop, can yield good results. While the approaches and tools presented below may have shortcomings, such as being unable to capture all the diverse aspects of environmental issues, ecosystem services and benefits from landscapes and seascapes, they can address many high-priority and identifiable problems and solutions. They include:

- **Integrated and transdisciplinary approaches** (integration of traditional knowledge with modern science, engaging different stakeholders to assess challenges, identify solutions, and explore how to feed this knowledge into decision-making): Ecosystem components in production landscapes and seascapes have a greater chance of being conserved in a biodiverse form and producing important ecosystem services that benefit local livelihoods if management strategies and practices are based on transdisciplinary scientific recommendations. Furthermore, broad-based stakeholder participation is critical when communities are faced with options involving trade-offs between ecological and economic interests, and encourages them to have stronger motivation for action. SEPLS are multifunctional ecosystems dominated by human activities, and integrated and transdisciplinary approaches are therefore suggested by all of the case studies in this volume.
- **Social mobilization towards good governance**: Changing behaviour to be more environmentally friendly and improving trust and collectiveness to link economic activities from production to consumption with greater accountability can be very powerful vehicles for governance. The growing trend towards community-based enterprises, or community cooperatives, is an example of co-managed, collective business models led and controlled by local communities in Italy and Vietnam (Chapters 3 and 8).
- **Communication and awareness-raising**: These may be carried out within a single landscape or seascape or also extended to stakeholders elsewhere, such as businesses and private-sector entities, urban consumers or governments, as livelihoods are in many ways related to market-based tools. These are important factors common to many of the case studies in this volume.
- **Tools to secure rights**: Recognition of customary rights, community titling, property rights and tenure security for indigenous peoples and local communities (IPLCs), intellectual property rights over intangible assets including knowledge and practices, and documentation of these rights is a necessity to motivate innovation

and secure local livelihoods in some SEPLS, as in the case from Cambodia and Vietnam (Chapters 6 and 8). At the same time, easing of strictly controlled rights, for example lifting barriers to new entrants, can be a viable option, especially in high-risk and uncertain production or harvesting activities, such as the case from Japan and Canada/USA (Chapter 10).

- **Sustainable commodity certification and incentives for ecosystem service provision**: Case studies in this volume describe certification for rare and endangered flora in sacred grove landscapes in India (Chapter 9) and a payment for ecosystem services (PES) scheme that links upstream and downstream stakeholders in Kenya (Chapter 12). It can be observed in the latter case study, however, that PES schemes need to include co-investment options for both ecosystem-service providers and beneficiaries to ensure their fairness and sustainability. This type of stewardship may entail different actions and decisions by stakeholders, but enables common understanding of conservation and development goals, and more importantly, shared social, human and financial investment. Sustainable commodity certification combined with agricultural and environmental regulations may safeguard vital ecosystem services, change consumer behaviour and engage practitioners as well as the business sector in wider implementation. Branding of products as environmentally friendly has potential for landscapes and seascapes not yet commonly recognized as having high biological value, to improve local livelihoods, as in the case from India (Chapter 9). These types of tools can also help to educate people about the ecological importance of certain species from which products originate.

## 5. Principles

From the chapters in this volume and experiences presented by workshop participants, certain core principles can be identified that help maintain the sustainability and resilience of SEPLS. These principles address both human-nature and human-human relationships in order to achieve human well-being and livelihoods that do not conflict with natural systems. They include:

- *Responsibility towards, and stewardship of, the landscape or seascape,* including all members of communities that reside there and different stakeholders involved in their use and maintenance
- *Inclusiveness in decision-making and building capacity to make appropriate decisions, and in participation in economic activities* including access to financial services and markets
- *Acknowledgment of interactions between people and nature*, respecting the interdependent relationships between elements that affect the sustainable management and use of natural resources
- *Harmonious relationships between humans and nature*, sensitive to the carrying capacity of the landscape or seascape

Table 3 presents an attempt to map how the case studies relate to the components of the conceptual framework of the Satoyama Initiative. We observe that among these case studies there is relatively common emphasis on the "ecological and socioeconomic perspectives" of resource use within the carrying capacity of the environment, recognition of local traditions and culture, contributions to sustainable socio-economies and improved community resilience and multi-stakeholder participation and collaboration, while cyclic use of natural resources is emphasized in relatively few cases. The components of the "threefold approach" – wisdom on diverse ecosystem services and values, integrating traditional knowledge and modern science, and new forms of co-management systems – are more or less equally represented in the cases.

In this sense, the cases are relevant to current trends, as there is growing emphasis in policy circles such as the Intergovernmental Science-policy Platform for Biodiversity and Ecosystem Services (IPBES) on the diverse ecosystem-services values that arise from the landscape and on respecting local priorities alongside those of other stakeholders (Pascual et al. 2017). This includes recognition of TK in various forms from local ecological knowledge, sectoral knowledge such as fishers' or farmers' knowledge, indigenous knowledge and folk knowledge (IPBES 2013), and all of these are represented in this volume. It is noteworthy that the case studies describe current perceptions and practices of the communities in the landscapes and seascapes concerned, and are therefore indicative of various priorities in improving their well-being and closely linked to their livelihoods.

## 6. From local experiences to national and international goals

The drivers of change to production landscapes and seascapes and thereby livelihoods suggested by the experiences described in the case studies in this volume are not new in the academic literature, and innovative practices based on them can contribute to international conservation priorities such as the Aichi Biodiversity Targets of the Convention on Biological Diversity's Strategic Plan for Biodiversity 2011-2020. This type of work in landscapes

Table 3. Relationship of the case studies to the conceptual framework of the Satoyama Initiative

| | Six Ecological and Socioeconomic Perspectives | | | | | | Three-fold Approach | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1. Resource use within carrying capacity | 2. Cyclic use of natural resources | 3. Recognition of local traditions and culture | 4. Multi-stakeholder participation and collaboration | 5. Sustainable socio-economies | 6. Improved community resilience | 1. Wisdom for diverse ecosystem services and values | 2. Integrate traditional knowledge and modern science | 3. New forms of co-management |
| 2. Chinese Taipei | | ✓ | | ✓ | | | | ✓ | ✓ |
| 3. Italy | ✓ | | ✓ | | ✓ | | ✓ | ✓ | |
| 4. Bangladesh | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 5. Indonesia | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| 6. Cambodia | ✓ | ✓ | ✓ | | | | ✓ | | |
| 7. Ghana | ✓ | | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| 8. Vietnam | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| 9. India | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ |
| 10. Japan and Canada/USA | | | ✓ | | | ✓ | ✓ | ✓ | |
| 11. Uganda | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 12. Kenya | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Total** | 8 | 4 | 8 | 6 | 7 | 8 | 8 | 8 | 8 |

Legend: ✓= direct link found

and seascapes is especially important considering current movements of human populations, particularly in biodiversity-rich developing countries, and resultant over- or under-exploitation of resources, decrease in traditional knowledge systems, rural depopulation, urbanization and industrialization. As these trends are often linked to resource politics, they make conservation and protection of natural resources primarily through protected-areas systems difficult, although still important (Wandesforde-Smith and Watts 2014; Lopes et al. 2015). It is in this sense that a more integrated approach to conservation of the functions and processes that produce ecosystem services is needed outside protected areas in order to ensure sustainable livelihoods that support biodiversity.

Recently, IPBES has stressed the importance of including values of indigenous and local knowledge systems related to biodiversity for safeguarding natural resources and enhancing "nature's contribution to people" (NCP) (Pascual et al. 2017). The many resource-use values raised by communities affected by degraded ecosystem services can provide valuable feedback to IPBES, as a diversity of land-use practices and stakeholder viewpoints can point to a wide range of different conceptualizations of ecosystem values that can be helpful for maintaining NCP while minimizing loss of ecosystem services and associated livelihoods.

## 7. Local solutions and innovative strategies for livelihoods in SEPLS

While the case studies in this volume are presented in part to provide guidance to international processes like IPBES, it is also worth keeping in mind that the cases primarily describe local, on-the-ground experiences, and therefore contain good practices for practitioners working in the field. A number of local solutions and innovative strategies are found in the cases, including: integrating hard scientific knowledge into local land-use practices; identifying indicator species that can be used to indicate unsustainable use in the future in Chinese Taipei (Chapter 2); creating local cooperatives to recognize IPLCs, help them protect their land rights, and support them in remaining self-sufficient in Bangladesh and Italy (Chapters 4 and 3); creating PES or other market-based mechanisms to ensure greater control over resource use, availability and benefits in Kenya (Chapter 12); and facilitating endogenous community culture-oriented communication, based on community rules and rituals, to

ensure a production-oriented culture's survival in Vietnam (Chapter 8). An appropriate combination of these may be applicable in other landscapes and seascapes that are facing similar issues, contextualized to the local situation, in order to ensure the well-being of the local population, good functioning of ecosystems and conservation of biodiversity. An effective system of drivers, including economic incentives and policy guidance, and appropriate for the interests of local communities and ecosystems, is vital for the revitalization and sustainable management of socio-ecological production landscapes and seascapes. As described above, the case studies in this volume contain examples with good potential to contribute to such a system, since any such system will need to focus on human livelihoods as one of its most important elements.

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Chapter 2

# Indicator species for agrobiodiversity in rice paddy fields: Research and its application to a new eco-labelling scheme in eastern rural Taiwan

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## Abstract

Paddy fields occupy around 150,000 hectares and cover about 19% of arable land in rural Taiwan. They are considered to be the largest artificial wetland of freshwater habitats. Proper management of paddy fields plays a crucial role in providing local community livelihoods and maintaining the biodiversity of artificial wetlands. Many studies have shown that organic farming can increase biodiversity in paddy fields and enhance pest prevention and control, pollination and soil development. However, the types of species more easily affected by conventional or organic farming are still unclear.

This research aimed to change the behaviours of farmers by investigating the differences in invertebrate community structure between organic farming and conventional farming in paddy fields of eastern rural Taiwan, making farmers understand the importance of the ecological environment. Further, increasing consumer recognition enhanced the willingness to purchase agricultural products with significance for ecological conservation.

Twenty-two variables concerning farming practices and habitat heterogeneity were investigated, followed by principal component analysis (PCA) to show the main context. Through the selection of predators, findings showed that *Tetragnatha maxillosa* Thorell (1895), *Micraspis discolor* Fabricius (1798) and *Tetragnatha javana* Thorell (1890) not only had higher frequencies of occurrence but also higher sensitivity to different farming practices. Results showed that there are positive linear relationships between the abundance of the three aforementioned species and the richness and abundance of invertebrates in paddy fields. These species could be used in the future as indicator species to reflect artificial disturbances. Results also showed that conventional farming practices could reduce habitat heterogeneity and cause negative effects on the agrobiodiversity of rice paddy farmlands.

In order to apply the outcomes of the research to benefit both local livelihoods and biodiversity, the Hualien District Agricultural Research and Extension Station (HDARES) worked together with local farmers and other stakeholders, including government, to develop a new eco-labelling scheme based on the identified agrobiodiversity indicator species. The new eco-labelling scheme therefore extended the existing Green Conservation Label for environmentally friendly agricultural products in Taiwan by incorporating non-endangered species as indicators. Challenges of the new eco-labelling scheme

included how to make consumers understand the connotation of this eco-labelling, how to encourage them to purchase agricultural products that are significant for ecological conservation, and how to further increase the farmers' income and improve their livelihoods. The new eco-labelling scheme is expected to attract more farmers willing to join in environmentally friendly farming in eastern rural Taiwan.

**Keywords:** Local livelihood; Agrobiodiversity indicator species; Organic farming; Eco-labelling scheme

## 1. Introduction

Paddy is one of the major crops in the Asian monsoon region. Through environmentally friendly farming and proper management of paddy fields, biodiversity in socio-ecological production landscapes (SEPLs) can be revitalized and conserved. In Taiwan, paddy fields occupy around 150,000 hectares of land. They are considered to be the largest artificial wetlands of freshwater habitats. Proper management of paddy fields plays a crucial role in maintaining the ecological functions of artificial wetlands. Besides food production, paddy fields provide other ecosystem services including flood control, groundwater recharge, water quality control, local climate mitigation, fish culture and other non-rice products, and culture, landscape and biodiversity conservation (Natuhara 2012, p. 99). However, during the process of agricultural intensification, conventional farming has often been associated with toxic pesticides and chemical fertilizers, cementing of field banks, irrigation and drainage systems and simplified food production such as mono-cropping. These methods have not only intensely degraded the farming environment, but also have directly endangered biodiversity in the agro-ecosystem (Medley et al. 1995, p. 162; De Jong 1997, p. 189; Tilman et al. 2001, p. 281; Reidsma et al. 2006, p. 88; Vitousek et al. 2009, p. 1519; Natuhara 2012, p. 102).

Environmentally friendly farming activities are crucial to agrobiodiversity management, and methods for maintaining sustainable agro-ecological farming systems have garnered growing interest (Vickery et al. 2004, p. 33; Power 2010, p. 2959; Swinton et al. 2007, p. 246; Zhang et al. 2007, p. 259; UNU-IAS 2010a; UNU-IAS 2010b; UNU-IAS 2012). Additionally, it is necessary to balance biodiversity conservation and agricultural productivity (Butler, Vickery & Norris 2007, p. 381). Agricultural policies have started to act toward the adjustment of two goals, namely, ensuring food security and increasing biodiversity. Moreover, new farming methods such as organic farming have been developed in past years to address these goals (Seufert, Ramankutty & Foley 2012, p. 229).

In recent years, due to emerging food safety problems and the mainstream acceptance of the value of biodiversity, consumer demand for organic rice has increased, and consumers are willing to buy it at a relatively high price. Based on rising public recognition of the value of biodiversity, local crop farming assisted by the Hualien District Agricultural Research and Extension Station (HDARES) should not only be considered in terms of economic productivity, but also as beneficial to the health of farmers and consumers, as well as to biodiversity in and surrounding the farmlands. As outlined in the goals of the Aichi Biodiversity Targets, we would like to identify the underlying causes of biodiversity loss and help to mainstream biodiversity into policies and practices. We would like to play a vital role in leading eco-agriculture in Taiwan in line with the concepts and practices of the Satoyama Initiative.

The research worked to develop and implement a new eco-labelling scheme based on the identified agrobiodiversity indicator species and multi-stakeholder participation in order to increase the added value of agricultural products. The three goals of the research were as follows:

- Use the identified indicator species that reflect the situation of farmlands, to promote environmentally friendly farming.
- Explore the correlation between agricultural habitats and fauna. Results will be used as a reference for assessing the degree of integrated ecosystem services in paddy fields.
- Promote eco-labelling to improve the environment and improve the livelihoods of farmers.

## 2. Methodology

### 2.1. Research sampling

The research sample area is situated within Fuli Township, in Hualien County of Taiwan. Fuli has the oldest organic cultivation history and the highest ratio of organic planting in Taiwan (Figure 1a and Figure 1b).


Figure 1a. Sampling sites in Fuli Township of Hualien County, Taiwan, where samples were conducted in several administrational units: Dong-Li Village (DL_O, DL_C), Chu-Tian Village (CT_O, CT_C), Luo-Shan Village (LS_O), Shi-Pai Village (SP_O, SP_C), Fu-Li Village (FL_O), Syue-Tian Village (ST_O, ST_C), Fong-Nan Village (FN_O). The letter behind the abbreviation of the village represents the cropping practices: O, organic cultivation; C, conventional cultivation (Source: HDARES)

Figure 1b. Fuli Township in Hualien County, Taiwan, as the sample area for research (Photo: HDARES)

### 2.2. Invertebrate diversity and development of an agricultural biodiversity index for paddy fields in Eastern Taiwan

Similarity percentage (SIMPER) analysis investigates the contribution value of the sample size difference from a single species to similarity distance (Shepherd et al. 1992, p. 140; Clarke & Gorley 2006). Species with greater contribution to assemblages similarity distance were determined (average value of sample similarity distance/standard deviation of sample similarity distance > 1) and were viewed as species that are more sensitive to differences in farming practices. These species were then subjected to two-sample t-tests to determine whether their abundance differed in fields using distinct farming practices. A linear regression model was then applied to the sensitive species with significant differences to evaluate the correlation between abundance in the field (single period) and that of the invertebrate assemblages in the field, as well as with the number of species.

### 2.3. Measurement of agricultural habitat and principal component analysis of environmental variables

Twenty-two variables concerning farming practices and habitat heterogeneity were investigated, followed by principal component analysis (PCA) to demonstrate the main context from variable extraction and dimensionality reduction (Daffertshofer et al. 2004). It was discovered that the environmental conditions of the paddy fields and their surroundings can be divided into four distinguishable types: artificial inputs, status of field banks, adjacent land-use, and drainage/irrigation, as shown below (Table 1).

Table 1. Environmental conditions of paddy fields

| Types of environmental variables | Requisite variables | Interpretation |
|---|---|---|
| Artificial inputs | • Nitrogen input | • Measured input of nitrogen (kg/ha) |
| | • Organic compound fertility input | • Measured organic fertilizer input (kg/ha) |
| | • Agrochemical inhibitor | • Use of agrochemical inhibitors in the field, such as: herbicides, pesticides and fungicides (times) |
| | • Physical weeding in field | • Weeding in field by physical or mechanical methods (times) |
| Status of field banks | • Physical weeding on field banks | • Weeding in field by physical or mechanical methods (times) |
| | • Elevation | • Measured elevation of field (m.a.s.l.) |
| | • Mean of field bank width | • Mean of field bank width from the observation (cm) |
| | • S.E. of field bank width | • S.E. of field bank width from the observation value in each field site (cm) |
| | • Mean of field bank height | • Mean of field bank width from the observation value in each field site (cm) |
| | • S.E. of field bank height | • S.E. of field bank height from the observation (cm) |
| | • Ratio of cementation | • Area of cementation divided by total bank area (%) |
| | • Ratio of weeds | • Area of weeds divided by total bank area (%) |
| Adjacent land-use | • Ratio of weeds | • Area of weeds divided by a 5m extended region outward from field site (%) |
| | • Ratio of stone | • Area of pebble stone divided by a 5m extended region outward from field site (%) |
| | • Ratio of rice field | • Area of rice field divided by a 5m extended region outward from field site (%) |
| | • Ratio of non-rice cultivation | • Area of non-rice cultivation divided by a 5m extended region outward from field site (%) |
| | • Ratio of cement road | • Area of cement road divided by a 5m extended region outward from field site (%) |
| | • Ratio of building | • Area of building divided by a 5m extended region outward from field site (%) |
| Drainage/ Irrigation | • Days of continuous standing water | • Frequency of keeping water in field in a flooded state (days) |
| | • Days of field drainage | • Frequency of drainage of flooded field (days) |
| | • Water depths | • Average water depths of rice cultivation (cm) |
| | • Irrigation | • Average water use of rice cultivation ($m^3$) |

Species were classified according to their ecological function: predators, parasitoids, pests, graminivores, scavengers, pollinators, and visitors. The total number of species, total number of individuals, total individuals of a particular functional group (N), number of species in a particular functional group (S), and intensity of particular functional groups ($I = \Sigma(ni/N)2$, ni: abundance of particular species; N: summation of the group abundance; Odum 1983) were calculated separately. The functional group parameters that linearly correlated to the principal component axis were then determined through calculation of the Pearson correlation coefficient, and a scatter diagram was produced.

## 2.4. Extension of the new eco-labelling scheme

The index is designed to promote making farming practices more environmentally friendly thereby reducing the use of agricultural chemicals. This study used the agricultural biodiversity index and cooperated with Yinchuan Sustainability Co. Limited to help farmers assess environmentally friendly farming practices in their fields, as well as to plant hedges and grass blankets around the fields to increase farmland habitat diversity and provide shelter from natural enemies. The study also assisted farmers in applying for the Green Conservation Label

introduced by the Forestry Bureau and the Tse-Xin Organic Agriculture Foundation. Establishment of the label system renders the production environment healthier, increases the value of farmers' agricultural products, and ensures food safety for consumers.

## 3. Results

### 3.1. Farming practice-sensitive dominant predator species as indicator species for agricultural biodiversity in paddy fields

Species were classified according to their ecological function: predators, parasitoids, pests, graminivores, scavengers, pollinators, and visitors. A key research finding was that paddy fields in organic farms are 1.3 times richer in species than fields farmed conventionally. SIMPER was used to screen for species that are more sensitive to distinct farming methods. Results showed that among the 29 farming practice-sensitive species, only *Tetragnatha maxillosa* Thorell (1895) ($p = 0.008$), *Micraspis discolor* Fabricius (1798) ($p = 0.020$) and *Tetragnatha javana* Thorell (1890) ($p = 0.021$), three predators belonging to natural enemy species, displayed significant differences in relation to distinct farming practices. In addition, according to linear regression analysis, these three sensitive species not only occurred more frequently but also were positively correlated to overall biodiversity (Figure 2 and Table 2). We selected them as the indicator species for farmland biodiversity (Figure 3).

The habitat environment of the paddy fields under conventional farming has changed due to the impacts of farming methods, which is specifically reflected in the change of the proportion of the ecological functional group. Although the fields have a higher proportion of rice-harming species and predators, as well as a larger number of species, organically farmed paddy fields have the potential to resist different kinds of pest damage in the future.

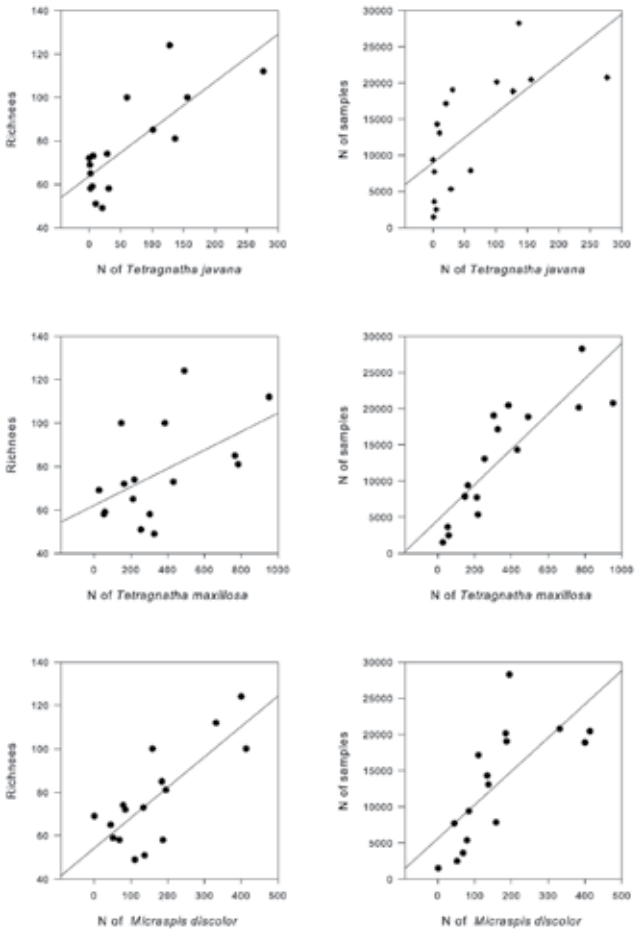



Figure 2. Scatter diagrams display the positive linear relationships between richness and abundance of invertebrate assemblages along with three indicator species in paddy field (Source: Fan *et al.* 2016)

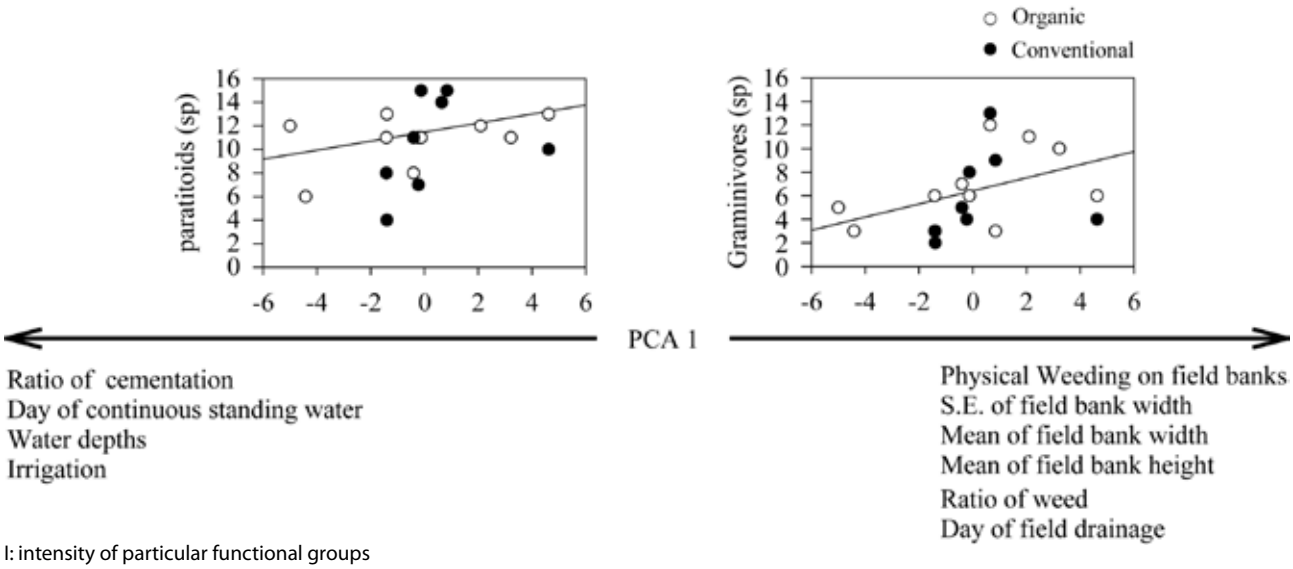
Table 2. Simple linear regression models fit by three indicator species refer to features such as richness (S) or abundance (N) of invertebrate assemblages.

| Linear regression equation | R-Sq (%) | *p*-Value |
|---|---|---|
| S = 54.2 + 0.140 N *M. discolor* | 60.9 | $p < 0.001$ |
| S = 63.8 + 0.217 N *T. javana* | 60.5 | $p < 0.001$ |
| S = 62.0 + 0.042 N *T. maxillosa* | 28.5 | $p = 0.033$ |
| N = 5628 + 46.4 N *M. discolor* | 51.9 | $p = 0.002$ |
| N = 8999 + 68.3 N *T. javana* | 46.3 | $p = 0.004$ |
| N = 4623 + 24.4 N *T. maxillosa* | 51.5 | $p < 0.001$ |

Figure 3. *Tetragnatha maxillosa* Thorell (1895), *Micraspis discolor* Fabricius (1798) and *Tetragnatha javana* Thorell (1890) are appropriate to be used as agro-biodiversity indicators and species promoting environmentally friendly farming (Photo: HDARES)

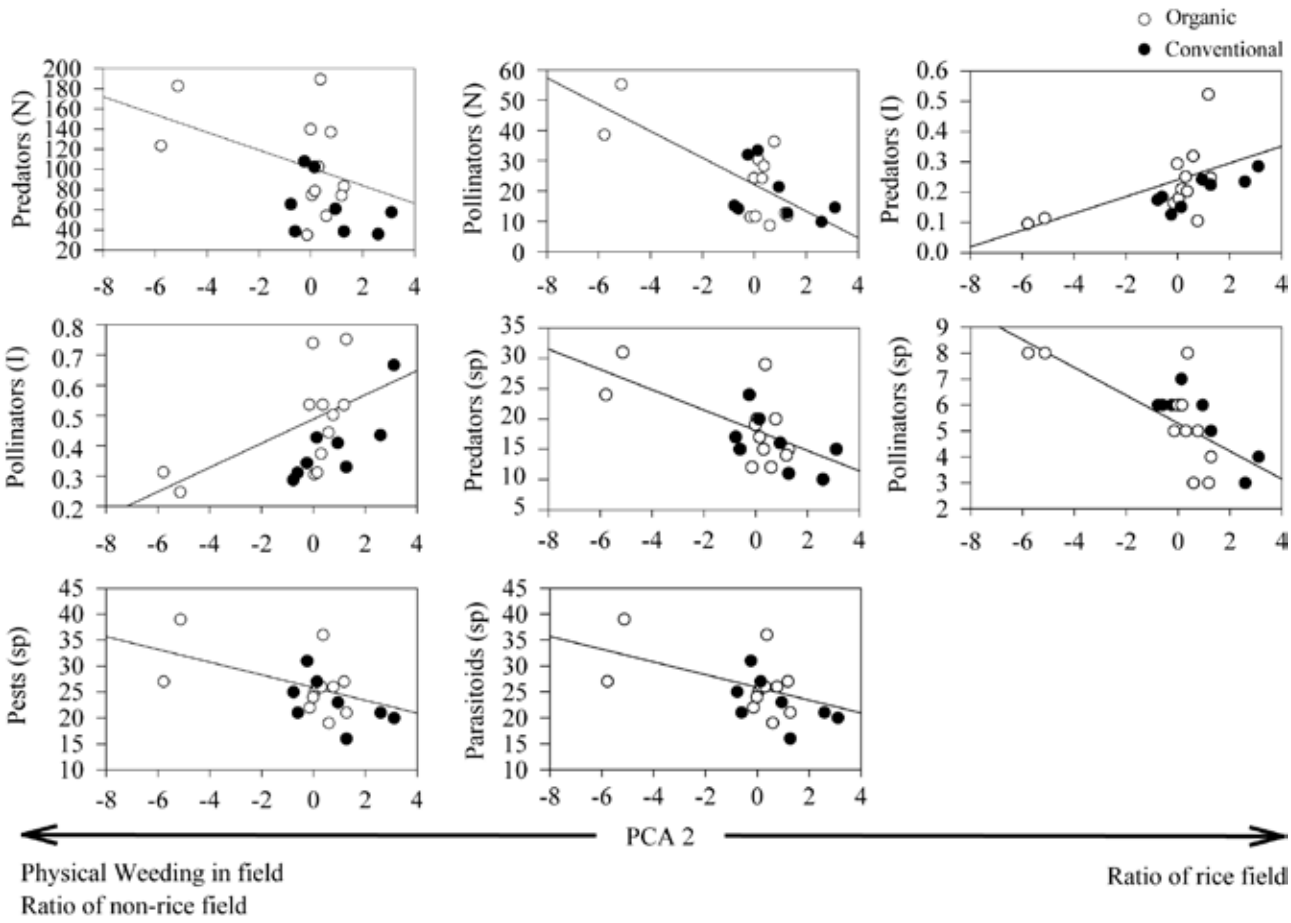
### 3.2. Habitat heterogeneity, agrobiodiversity and ecosystem services in paddy fields

Through pilot research, we discovered that farming methods with different degrees of intensity influence the formation of biological groups. Three distinct gradients of axis were extracted and showed significant linear relationships among the total abundance, richness and intensity of the particular functional assemblage composed of predators, parasitoids, pests, graminivores, scavengers, pollinators and visitors. The first principal axis strongly correlated with variables in terms of the status of field banks and drainage/irrigation that could explain 27.4% of total environmental variance. The second principal axis had stronger correlations with adjacent land-use that could explain 20.1% of total environmental variance. The third principal axis mostly correlated with artificial inputs that could explain 14.3% of total environmental variance. PCA was used to extract each principal component axis representing distinct environmental trends. The negative side of the first PCA axis mainly represented a higher level of cementation and narrower ridges, and the positive side indicated more weeds and irregular ridges. The higher degree of cementation displayed a negative linear correlation with parasitoid and graminivorous species within the paddy fields. Ridge cementation led to a decline in the number of Braconidae, Chalcididae, and Melyridae species. Increasing the number of days of field drying increased the number of Braconidae, Pteromalidae, and Chalcididae species, as well as those of graminivorous species such as those in the Melyridae and Miridae families. In contrast, increasing the number of days of field flooding and irrigation decreased the number of parasitoid and graminivorous species in the field (Figure 4). The positive side of the second PCA axis indicated an increase in the proportion of other types of crops or weeds in the vicinity of the paddy fields, whereas the negative side represented monoculture of rice in the vicinity and intensive cultivation of the paddy fields. Increasingly diversified use of the land surrounding the paddy fields displayed a positive linear correlation with the abundance of predators such as Syrphidae, Coenagrionidae, Libellulidae, Carabidae, and that of pollinators such as Anthomyiidae, Dolichopodidae, and Apidae, as well as a correlation with the number of species of predators, pollinators, pests, and parasitoids. Monoculture of rice in the vicinity resulted in a rise in the intensity of predators (*Micraspis discolor, Tetragnatha maxillosa,* and *Araneus inustus*) and pollinators (*Chirosia sp, Dioxyna sororcula,* and *Pegomya sp*) (Figure 5). A noteworthy result was that the organic samples were mostly located on the positive side of the third PCA axis, which represented organic fertilizer usage and lower nitrogen input in the fertilizers. By contrast, the negative side of the axis indicated chemical pesticide usage and higher nitrogen input. The use of chemical pesticides including herbicides, insecticides, and fungicides demonstrated a negative linear correlation with the abundance of pests (*Sogatella furcifera*). Excessive chemical pesticide and fertilizer input caused an increase in the intensity of parasitoids, whereby the assemblages' individuals focused on some of the dominant species (Figure 6).



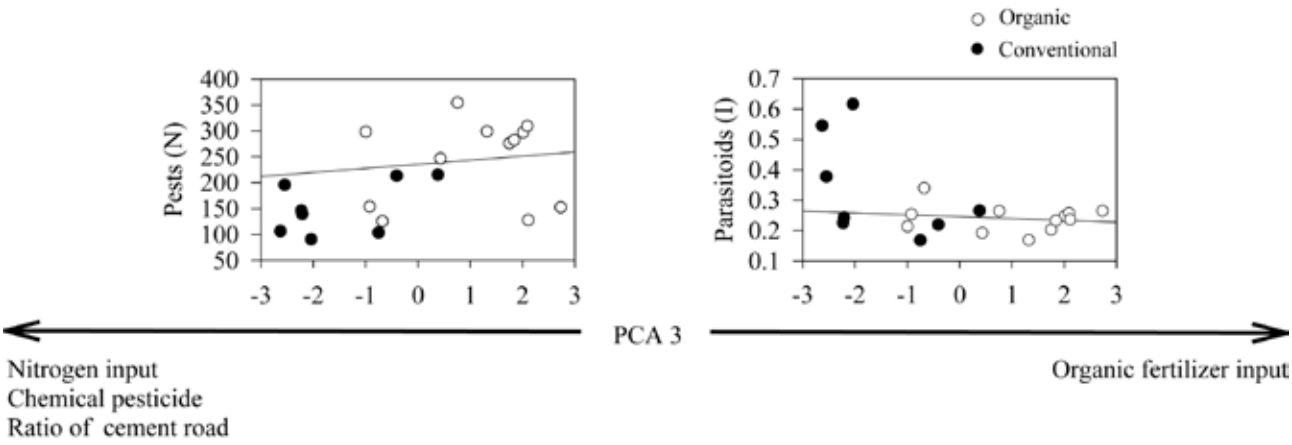

I: intensity of particular functional groups
N: total individuals of a particular functional group

Figure 4. The simple linear regression model displays each feature of a functional group in a significant linear relationship along with the third principal component axis (Source: Fan *et al.* 2016)




I: intensity of particular functional groups
sp: number of species in a particular functional group
N: total individuals of a particular functional group

Figure 5. The simple linear regression model displays each feature of a functional group in a significant linear relationship along with the second principal component axis (Source: *Fan et al.* 2016)




I: intensity of particular functional groups
N: total individuals of a particular functional group

Figure 6. The simple linear regression model displays each feature of a functional group in a significant linear relationship along with the third principal component axis (Source: Fan *et al.* 2016)

### 3.3. Innovation value of green conservation

According to the results of this study, the positive side of the third PCA axis indicated organic fertilizer usage and lower nitrogen input in the fertilizers, whereas the negative side represented chemical pesticide usage and a higher nitrogen input. Although organic and conventional farming practices did not have significant effects on the rice yield, a comparison revealed that the earnings from organic farming had a positive linear correlation with the third PCA axis, suggesting that organic farming generated higher profits than conventional farming (Table 3). Apart from earnings highlighting the value of organic rice, the indicator species discovered in the organic paddy fields demonstrated the innovation value of organic rice, which takes into account the livelihoods of farmers while maintaining biodiversity.

The Green Conservation Label is promoted by the Tse-Xin Organic Agriculture Foundation with the help of the Forestry Bureau. The core goals of this label are to promote environmentally friendly farming and to encourage the purchase of Green Conservation Label products. To put these goals into practice, HDARES cooperated with the Tse-Xin Organic Agriculture Foundation and came up with some innovative measures, as follows:

- Add indicator species that reflect the current situation of farmlands such as *Tetragnatha maxillosa* Thorell (1895), *Micraspis discolor* Fabricius (1798) and *Tetragnatha javana* Thorell (1890).
- Explore agricultural production that is beneficial to establishing habitat environments during the production process and use this production method as the standard for awarding the Green Conservation Label.
- Constantly inspect the production process of rice based on scanning and observation by farmers, to know whether various farming measures contribute to establishing the habitat environment, and then apply adjustments.

Table 3. Simple linear regression models were fit by yield and earning with each principal component axis.

| | linear function | $R^2$ | F | p-value |
|---|---|---|---|---|
| | PCA1 | | | |
| Dry grain yield (kg/ha) | $Y = 5376 - 155.8\ X_{SCORE1}$ | 20.60% | $F_{1,18}=4.67$ | $p = 0.044$ |
| Earnings (NT/ha) | $Y = 5376 - 155.8\ X_{SCORE1}$ | 10.55% | $F_{1,18}=2.12$ | $p = 0.162$ |
| | PCA2 | | | |
| Dry grain yield (kg/ha) | $Y = 5376 + 134.7\ X_{SCORE2}$ | 11.30% | $F_{1,18}=2.29$ | $p = 0.147$ |
| Earnings (NT/ha) | $Y = 180683 + 1142\ X_{SCORE2}$ | 0.30% | $F_{1,18}=0.05$ | $p = 0.819$ |
| | PCA3 | | | |
| Dry grain yield (kg/ha) | $Y = 5376 + 1\ X_{SCORE3}$ | 0.00% | $F_{1,18}=0.00$ | $p = 0.994$ |
| Earnings (NT/ha) | $Y = 180687 + 14600\ X_{SCORE3}$ | 34.92% | $F_{1,18}=9.66$ | $p = 0.006$ |

## 4. Discussion

### 4.1. Study of indicator species sensitive to agrobiodiversity of organic paddy fields

It was our goal to screen out indicator species that exactly reflect the changes in the environment of paddy fields and thus promote agricultural activities in harmony with nature. Based on the state of many regulations and suggestions on the application of indicators internationally, we mainly considered the guidance in OECD (1999, 2001), combining these with field research to make selections.

Environmental conditions separately affect the species composition of different biological functional groups. Take the predator of the natural enemy we focused on as an example. The quality of this functional group (number of species, proportion of dominant species) and the quantity of it (total quantity) are degraded by increased frequency of weeding and the influence of cementation, rendering the decrease in number of species and the total quantity, as well as an increase in the proportion of dominant species, making it difficult to conduct rice pest control. As for the promotion of environmentally friendly agriculture, research was available for our reference, and the habitat heterogeneity surrounding the paddy fields also played an important role. The negative influence resulting from deterioration of habitats is as harmful as conventional pesticide application.

### 4.2. Habitat manipulation and diversification of paddy fields to facilitate ecosystem services and reduce chemical inputs

Besides the research and application of agrobiodiversity indicator species for rice paddies, we collected and selected a variety of Taiwan native wildflowers and mixed various

native plants that differed according to environmental adaptability, plant growth characteristics and purposes, to create wildflower turf. Native wildflower turfs are blended with a variety of plants that could increase tolerance to environmental changes. They blossom with the seasons, providing nectar and pollen for insects. They can be applied to farmland ridges or orchards to build diversity in habitats (Figure 7). Because plants are the basis of ecosystems, recovering diversified native plants could attract diversified species and increase farmland biodiversity as well as stabilize farmland ecosystems and reduce the incidence of pests and diseases (Figure 8).

As concerns degradation of ecosystem services and loss of biodiversity in farmland landscapes resulting from changes of the gradient of agricultural intensification, experts have different trend predictions (Perfecto and Vandermeer 2008). Functional agrobiodiversity advocates that proper practices can increase and improve the functional supply and food production, which are brought by agricultural biodiversity. These proper measures are encouraged to be widely applied in the planning of landscapes for agricultural production (ELN-FAB 2012). For the management of habitats, there are the following principle suggestions: (a) promoting low input farming practices, (b) reserving grasslands on rice paddy field banks, (c) maintaining the diversity of the landscapes surrounding the paddy fields, (d) preventing excessive consumption and disturbance of biotic community, and (e) conducting of proper drainage and reducing water used for irrigation. We also provide platforms like farmer schools for farmers to give feedback and share relevant technologies.

Figure 7. Techniques introduced to farmers for creating native wildflower turfs (Photo: HDARES)

Figure 8. Most of the native wildflowers are nectar-rich flowering plants, which can attract natural enemies and pollinators to fields, helping farmers to reduce chemical pesticide usage (Photo: HDARES)

### 4.3. Incorporating indicator species into the Green Conservation Label as an incentive for environmentally friendly farming and consumer support

From transplanting to becoming a bowl of rice on the consumer's table, every step of agricultural practices may affect the ecosystem of paddy fields. Take the research on indicator species and the following guidance for habitat management that we have promoted as examples. Through one year of promotion, the number of farmers who have recognized the concept of the indicator species and habitat heterogeneity and obtained the Green Conservation Label has increased from 7 to 24.

This is a brand new attempt for HDARES, the Tse-Xin Organic Agriculture Foundation and the farmers. In the past, the awarding of the existing Green Conservation Label was mostly focused on encouraging agricultural production in farmlands surrounding areas where there were protected species. By successfully introducing the indicator species, common in the paddy fields and reflecting the biodiversity of farmlands, as one of the standards for issuing the Green Conservation Label, we thereby suggested adding qualifying conditions to existing standards, namely maintaining habitat heterogeneity that is beneficial for biodiversity. Therefore, the application scale of the Green Conservation Label has been extended, encouraging more farmers to get interested in environmentally friendly production (Figure 9). We cooperated with the Tse-Xin Organic Agriculture Foundation, farmers, the Rice Production and Marketing Group, the Agribusiness Company (Yin-Chuan Organic Rice) and the Forestry Bureau in this case. Our achievements enabled successes in both maintaining farmers' income and conserving biodiversity (Figure 10).

The innovative indicator species were chosen in this research based on field investigations and scientific analysis. Farmers in eastern Taiwan already had a high level of acceptance of organic agriculture or environmentally friendly farming and had increased the value of rice by planting according to organic farming methods. Through the promotion and application of the indicator species, farmers strengthened their confidence in organic agriculture, and came to understand that their farming methods are good for the ecological environment. They can thus opportunely adjust their agricultural operations and decrease the impacts to the ecological environment.

Based on the Green Conservation Label, the Tse-Xin Organic Agriculture Foundation has held the "Footprints in the Field Farmers Market" every Saturday in the National Taiwan Museum Nanmem Park, expanding marketing opportunities. In addition to buying via the internet or in supermarkets, consumers can purchase environmentally friendly agricultural products here. Farmers not only can sell their agricultural products, but also introduce environmentally friendly farming concepts to the consumer face to face. Farmers have more confidence in their farming practices, and the consumers that purchase these products feel relieved. More and more farmers markets similar to the "Footprints in the Field Farmers Market", are being set up. Likewise, organic farmers in other townships in Hualien want to join this scheme. Farmers can sell their agricultural products with organic certification at 1.5 to 2 times a higher price than conventional products. Although these farmers did not raise the price of rice, they have sold more to consumers that support environmentally friendly farming. The farmers' livelihoods have also been improved. In addition to the higher product value, they care more about their farmlands and sustainable agriculture. They are willing to try environmentally friendly farming, balancing the ecological environment and livelihoods, leading to a win-win situation. In the future, it is expected more research institutes will develop new agricultural indicator species for different crops and agricultural environments.


Figure 9. We extended the application scale of the Green Conservation Label and cooperated with the Tse-Xin Organic Agriculture Foundation, farmers, the Rice Production and Marketing Group, the Agribusiness Company and the Forestry Bureau in this case (Photo: HDARES)

Figure 10. We cooperated with this Farmers of Rice Production and Marketing Group (Photo: HDARES)

To sum up, the process and outcome of the research corresponded well with the three-fold approach of the Satoyama Initiative (Table 4).

Table 4. Process and outcomes of the research correspond well with the three-fold approach of the Satoyama Initiative

| | |
|---|---|
| **Vision** | |
| Realize harmonious coexistence of agricultural production (take rice production as an example) of eastern rural Taiwan and the natural environment | |
| **Three-fold Approach** | |
| Consolidate wisdom on securing diverse ecosystem services and values | Create a knowledge base through research to improve the supply of agricultural ecosystem services. Increase the number of natural enemy species using practices like creation and management of habitats, and reduction of the application of pesticide. |
| Integrate traditional ecological knowledge and modern science | Guide the farmers to shift the current low input cultivation mode to an organic mode and, through research, find the correlation between the indicator species and the ecological environment to protect agricultural biodiversity. |
| Explore new forms of co-management systems | Make the application of the Green Conservation Label adopt the indicator species and establish habitat management. Assist farmers in management of farmlands with the help of competent authorities of the agricultural environment policy, academic institutions, NPOs, as well as farmer organizations. |
| **Five Key Perspectives in the Approach** | |
| Resource use within the carrying capacity and resilience of the environment | Increase ecosystem services by means of friendly farming so as to reduce artificial inputs. |
| Cyclic use of natural resources | Require the effectiveness of resource use during the farming process. Frugally use natural resources and use the by-products of rice in multiple ways. |
| Recognition of the value and importance of local traditions and cultures | Respect the traditional low input cultivation mode, such as encouraging maintenance of the traditional gravel ridge and planting native weeds instead of the intensive cement ridges in modern agriculture. |
| Multi-stakeholder participation and collaboration | Conduct research and application of indicator species directed by HDARES along with the assistance of farmers, officers and experts: National Dong Hwa University, Tse-Xin Organic Agriculture Foundation, Yinchuan Organic Rice, local farmers; carry out service of guidance platform by our farmer school. |
| Contributions to socio-economies | Guide farmers to obtain the Green Conservation Label and the recognition of consumers through the establishment of production-marketing models to feedback into the environmentally friendly farming. |

## 5. Conclusion

This research aimed to explore the differences in the structure of invertebrate communities for organic farming and conventional farming in paddy fields of eastern rural Taiwan. The goal was to identify agrobiodiversity indicator species which could be helpful in monitoring the integrity of agricultural environments and promoting environmentally friendly farming. Twenty-two variables concerning farming practices and habitat heterogeneity were investigated and principal component analysis (PCA) was carried out to show the main context. Through the selection of predators, the findings showed that *Tetragnatha maxillosa* Thorell (1895), *Micraspis discolor* Fabricius (1798) and *Tetragnatha javana* Thorell (1890) not only had higher frequencies of occurrence but also higher sensitivity to different farming practices. The results showed there to be positive linear relationships between the abundance of the three aforementioned species and the richness and abundance of invertebrates in paddy fields, which could also be used in the future as indicator species to reflect artificial disturbance. The results also showed that conventional farming practices could reduce habitat heterogeneity and cause negative effects on agrobiodiversity of rice paddy farmlands.

In order to apply the outcome of the research in a way that could benefit both local livelihoods and biodiversity, the Hualien District Agricultural Research and Extension Station (HDARES) worked together with the Tse-Xin Organic Agriculture Foundation, local farmers, the Yin-Chuan Organic private company and the Forestry Bureau to develop a new eco-labelling scheme based on the identified agrobiodiversity indicator species. The new eco-labelling scheme therefore extended the existing Green Conservation Label for environmentally friendly agricultural products in Taiwan by incorporating non-endangered species as indicators. The new eco-labelling scheme has attracted green consumers to purchase the relevant products and encouraged more farmers to participate in environmentally friendly farming in eastern rural Taiwan.

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Chapter 3

# Sustainable fishing practices and a unique fishermen's community in the Orbetello Lagoon, Italy

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## Abstract

Situated in Central Italy, in Southern Tuscany, the lagoon of Orbetello is a unique ecosystem connected to the sea. It covers an area of 27 square kilometres and is both a reproduction site for several fish and an economic resource for the local population. This large, mirror-like body of water was once regulated entirely by nature, but is now subject to human pressures making its management increasingly complex.

The lagoon has been in use since Etruscan and Roman time periods and regulation of its fishing practices has taken place at least since 1414, when the lagoon was under the control of the Siena Republic. Fish processing also has a historic tradition here. Different from classic smoking and marinating methods, two unusual processing techniques are a legacy of the Spanish rule of the 16th and 17th centuries. These methods are called *sfumatura,* whereby fish are seasoned with a sweet pepper-based sauce, and *scavecciatura*, which is a kind of *escabeche* that uses a hot marinade of vinegar, rosemary, garlic and peppers.

Traditional fishing techniques employing the *lavoriero, martavello* and the *tramaglio* are still used to catch a variety of fish. Sea bass, sea bream, grey mullet, eels, small clams, small fish called *calcinelli*, *mazzancolle* (a type of shrimp) and a small kind of crab called *femminelle* are the most commonly caught species. Over time, these techniques have been modernized, but they have maintained their sustainability. The fish come into the nets on their own, based on the season and the tides. Orbetello fishermen today have recuperated ancient traditions mixing in some modern fish farming techniques that remain sustainable for the lagoon. Unfortunately, the fishermen's sustainable activities are made increasingly difficult by regular disasters caused by external factors, such as overfishing in the open sea, that have reduced the stock coming into the lagoon. In the 1980s and 1990s the local community almost disappeared. They have now managed to form a cooperative to join forces and have recovered. Thanks to their long culinary traditions, fishermen have been able to sell their sea products to supermarkets and shops as well as use them for local dishes served in local restaurants.

This unique system has been made a Presidium by Slow Food. Slow Food Presidia sustains quality production at risk of extinction by protecting unique regions and ecosystems, recovering traditional processing methods and safeguarding native breeds and local plant varieties.

**Keywords:** Lagoon; Fishing; Orbetello; *Lavoriero*; Mediterranean

## 1. Ecosystem management history

### 1.1. A long history of lagoon management

Situated in Central Italy, in Southern Tuscany, the lagoon of Orbetello is a unique ecosystem connected to the sea. It covers an area of 27 square kilometres and is both a reproduction site for several fish and a direct economic resource for more than 100 families of the total local population of 14,000 (Figure 1). This immense, mirror-like body of water was once regulated entirely by nature, but is now subject to human pressures making its management increasingly complex.

Although Orbetello is not the only case of lagoon fishing in Italy, it certainly is one with a long history of documentation and management. There is extensive documentation (Damiani 2013) on the struggle to balance the economic exploitation of the lagoon (gaining fishing rights) and the maintenance of a healthy ecosystem. Management or mismanagement of the territory surrounding the lagoon (for example through deforestation) has wielded effects on the marine ecosystem. Surprising facts were discovered regarding the negative effects of deforestation on the marine ecosystem (Pantaloni 2014). The Orbetello fishermen learned that cutting trees reduced the fish stock in the eighteen hundreds. An important issue that the documentation revealed was the debate surrounding who should manage the delicate marine ecosystem that represented at the same time both the livelihoods of an entire era, as well as a nature reserve. Despite making some mistakes, such as a lack of consistency in the maintenance of canals, the documentation suggests that the local people, given the power, mostly took steps in the right direction. Mismanagement, such as renting out the lagoon to the highest bidder that just wanted to use it to make fast cash, on the other hand, occurred when higher ranking politicians got involved, mostly motivated by the search for funds from fishing rights to be used elsewhere, such as for various city expenses. The Orbetello story is a mixture of gastronomy, intercultural exchanges, land and sea management, and passion, which has secured the sustainable livelihoods of a small group of fishermen (about a 100) so far.


Figure 1. The Orbetello Lagoon seen from Orbetello (Photo: Guido Gualandi)

### 1.2. The first written set of rules of 1414

The need for regulating fishing practices in the lagoon arose probably during Etruscan and Roman times. The first copy of the rules (Statuti 1797) is from 1414, when Orbetello was controlled by the Republic of Siena. At the time, Italy was divided into a number of different independent states and partially controlled by foreign powers. The 1414 fishing rules are detailed and concern regulations about where to fish, as well as outline forbidden fishing areas, reserved fishing areas, bans on large animals near fisheries and the size of fish and fish prices (Damiani 2013, p. 11). The setup of 1414 shows that the two fisheries of Nassa and Fibbia were managed by the local council, either directly or rented to a third party. Notes reveal that fish prices were regulated, the location where fish were to be sold in the village was also determined, and that the price of fish would increase during Lent because Christians could not eat any meat due to religious requirements. Other notes from 1489 and 1540 (Damiani 2013) show that to preserve the stock, some fishing methods were forbidden and a ban was imposed that prohibited the catching of fish weighing less than half a pound. Already at that time the need to maintain the stock was felt, as was the need to restrict the number of people fishing in different areas. The best areas for fishing, where the lagoon exchanges with the sea via tidal waves, was the most regulated and managed (recurring rules in Damiani 2013).

### 1.3. Unfair distribution of fishing rights and livelihoods

In the long history from 1400 to 1900, the Orbetello City Council distributed fishing rights in the best part of the lagoon to the party that could pay the highest fee, mostly established via a public auction. This system, when fully functioning, effectively divided the community into two parties, the renters that had the best fishing area and the other party that was excluded. The excluded, i.e. the rest of the fishermen, called themselves "free fishermen" or "noble fishermen" in opposition to the renters. While establishing fishing rights in the best area certainly reduced the amount of fishing, it also threatened the livelihoods of others. The Orbetello free fishermen's area was limited to the eastern part of the lagoon that contained less fish and was a fraction of the western one. Damiani (2013) remarks that most free fishermen had very limited revenue and their survival was

put at stake when they were excluded from the best areas. The free fishermen suffered fines, their boats were seized and they were even put into prison when they were caught fishing in the forbidden areas. Instead of these penalties causing a decrease in the amount of trespassing into the forbidden fishing areas, the penalties only increased over time, making it evident that the fishermen could not survive if denied access to the best part of the lagoon. In 1789, the Orbetello City Council even used revenues from fishing rights as collateral for receiving some funds to restructure their hospital. It is evident from the city archives that this rental model was clearly useful for the local council cash flow but was grounds for a deep revenue inequality within the local fishing community.

### 1.4. The creation of a unique gastronomy

Orbetello (and the small surrounding areas) remained for about two and a half centuries (between 1557 and 1801) under the "State of the Presidi" or the "State of the Garrisons", a possession of the Crown of Spain, administered via the Viceroy in Naples, after it went to France and Tuscany. Meanwhile it went through sieges and wars that we will not investigate here except for their role in exposing Orbetello to Spanish culture and especially to new fish preservation techniques that had not yet been introduced to local production. Most notably, it introduced the *bottarga* from Orbetello consisting of salted, cured fish roe, of the local variety of grey mullet. Another fish preservation technique they were exposed to was *scaveccio*, fish marinated in onion and vinegar, also unknown at the time to the local population but very popular in the rest of the Spanish territories. *Ceviche* is a similar interpretation of fish preparation with acidic condiments but with a very different evolution in South America.

### 1.5. A few records of historical problems

The Orbetello records (Statuti 1797) show that the lagoon has been a pretty stable ecosystem until the last century. The lagoon froze in 1603, 1709 and 1755 with no negative consequences on fishing and once in 1788, leading to fish scarcity for a few years. There is also a record of one flood in 1758. Certainly a more worrisome natural event occurred when the water became murky and started giving off a bad smell. This event was recorded in the years 1722 to 1725. Deforestation also had a negative effect on the lagoon. Complete deforestation occurred when the northern dunes, the area of Feniglia, which was entirely covered with woods, was sold to new owners in 1804 who used the area for logging and cleared it for pastures (Pantaloni 2014). The northern dunes are a strip of sand and pebbles composed mostly of detritus from the nearby river Albegna. The dunes separate the lagoon from the sea on the north side. Once these areas were bare due to deforestation, erosion increased, causing sand and dirt to fall into the lagoon. The wind and rain also led some areas of the lagoon to dry up and suffocate or form swamps and wetlands, increasing malaria and reducing fish habitats and water cleanliness. In 1610, the famous painter Caravaggio, died here of malaria.

In 1842, road construction caused further problems to the lagoon's water movement. A road was built on a dam in the middle of the lagoon, cutting the water body in two and reducing the natural exchange of water. Furthermore, another road inland along the coast further reduced the flow of river water into the lagoon. The roads were surely important for local transportation but did not take into account the lagoon's water circulation needs.

Management evolved in modern times and led to the creation of a cooperative**.** A particular incident caused a change in the type of lagoon management. In 1899, the Orbetello City Council was unable to find a renter for the western part of the lagoon due to the deteriorated conditions of the water. Fish were less abundant, the canals were full of mud and sand, and it was difficult for fish from the sea to access the lagoon (Damiani 2013, p. 58). At the same time, new political parties had changed the council as well. The council voted to manage the fishing rights themselves, giving assignments to different fishermen chosen randomly from the town. The chosen fishermen would then have to pay for the fishing rights by giving the council one-third of the catch every day. A set of rules was designed ad hoc for this. Meanwhile the council would start fixing the lagoon problems. The provincial powers did not seem to agree with this new system, but allowed it to continue (Damiani 213, p. 62).

This represents a change of model that lasts until 1907, when the western lagoon is once again rented out until 1945, when it switches back into the hands of the council again. In 1946, 13 "free" fishermen founded a cooperative to manage fishing in the lagoon, and in 1960, the cooperative absorbed some other fishing companies. It remained the only one in 1989, with the City Council as partner. It took the name of *Orbetello Pesca Lagunare Spa (OPL)*. From 1993, the council left as a partner and the cooperative became an entity of its own, owned solely by fishermen. Its structure is composed of two different entities: the *Orbetello Pesca Lagunare* (see Figure 2), that sells the fish and products, and the *La Peschereccia*, the traditional cooperative that owns the fishing rights and manages the restaurant. In exchange for guaranteed fishing rights until 2019, the cooperative pays the City Council a fixed cost plus ten percent of fish sales. It is also required to provide the residents of Orbetello with a certain amount of fish at a controlled price. The cooperative is a particular type of company in which owners

Figure 2. Area to store fishing tools (Photo: Guido Gualandi)

can only be individual people and by which there cannot be any profit apart from the well-being of the partners. Each partner (in this case, each fisherman) has only one vote and every partner's vote counts the same. The cooperative's main aim is to maintain the jobs of the partners. Because the cooperative is an inclusive entity, it absorbed most if not all the free fishermen, therefore redistributing fishing rights to all "free" fisherman in an equal way. It has the advantage of giving the same salary to all, but its structure is less flexible than that of a regular commercial company, so changes take time to be implemented.

## 2. Maintaining the ecosystem

### 2.1. A new awareness

Shortly after the inauguration of the road, there was an increased awareness manifested by the City Council on the issues of lagoon health and hygiene. For example, fishermen left their tools made of wood, ropes and reeds in the water, with the result that they would eventually rot. The City Council started to ask that the fishermen remove their tools, a requirement that the fishermen did not understand clearly and that led to the initiation of a series of negotiations between the council and the fishermen. The lagoon was registered as public property in 1902, and from this time Grosseto Province began to maintain the canals and clean the vegetation on the shores. In 1910, ownership rights of the northern dunes were revoked and a reforestation plan was started that led to the replanting of trees on 460 hectares.

Bigger problems arrived when the administrative machine redistributed responsibilities and stopped the necessary maintenance of the shores and canals. In the 1950s, for about ten years, nothing was done and the health of the ecosystem started to degenerate. Overfishing further contributed to the deteriorating situation. The City Council was unable to manage the lagoon properly, and as a result exchange of water with the sea was reduced and fish in the lagoon were scarcer. Consequently, fishermen's revenues started to decline due to lack of fish (Damiani 2013, p. 78). This led to a public discussion between all stakeholders: Orbetello residents, the district magistrate, the City Council administration, the fishermen, the union and the local political parties. Local newspapers started to publish enquires, almost daily for over two years.

### 2.2. A sustainable system

| Good Practices | Bad Practices |
|---|---|
| Harvesting excess algae proactievely | Reacting when the problem has arrived instead of acting proactively |
| Changing the water pumps periodically | Not maintaining the equipment properly |
| Keeping the channels clean to help water movement | Letting sediments accumulate |
| Selecting the fish to sell and keep those not needed alive | Fishing in large amounts when market demand is weak |

Figure 3. Some good and bad practices

Clearly, a new approach was needed. Finally, the solution that was found and that would persist for the next 30 years was to create a cooperative (as described in 1.6 above). A clear redistribution of responsibilities was necessary. The system that was developed persists today and has the fishing tools, boats, fixed installations and buildings maintained by the fishermen, who pay rent, while the local administration is responsible for the maintenance of the shores and canals. After nearly all the fish died in 1991-1992, the lagoon was declared to be of public nature and was therefore able to receive state funds as well as European funds. All the heavy maintenance was taken care of by the state between 1992 to 2011, with special permission to act proactively. From 2012, approval by regional authorities was introduced and the system is not working as smoothly due to the added level of bureaucracy. Furthermore, according to the fishermen, the

maintenance of the pumps and the harvesting of algae is not done in a consistent manner by the state.

### 2.3. The ecosystem is still fragile

According to the fishermen, some remaining critical points for the ecosystem are as follows.

- Erosion and swamps created due to inland canals not being maintained and filling the lagoon
- Human presence that produces pollution via sewage or agricultural practices (use of fertilizers or pesticides)
- Water pollution and eutrophication that kills aquatic animals
- Increasing water temperature that provokes uncontrolled vegetal life, in particular algae such as *Cladophora*, *Ulva laetevirens*, *Enteromorpha*, and *Gracilaria verrucosa*
- Increased water salinity that affects the ecosystem's particular conditions of low salinity due to fresh water mixing with sea water

Likewise, factors that are specifically hindering the abundance of fish are as follows.

- Overfishing (with modern techniques such as GPS and improved nets) in the Mediterranean, which leads to fish scarcity in the lagoon
- The fragile eel reproduction cycle (see Ciccotti 2007), reducing the number of eels dramatically

## 3. Looking ahead: problem solving

### 3.1. Some of the solutions

The water temperature and water exchange issue have now been partially addressed by the installation of large pumps that can move water from the sea into the lagoon, therefore lowering the temperature of the water of the lagoon. However, this exchange must have limits, as it is not desirable for the lagoon to have the same water as the sea and thus lose its unique features. One problem that cannot be solved is the input of fresh water, which is very low as some of the rivers and canals are partially obstructed or have been diverted for agricultural use. In some instances, fresh water input would not be desirable either as the water is full of nitrates which would increase eutrophication. Making the area a nature preserve has also solved the problem of deforestation. Furthermore, while human presence is heavy around the lagoon it is not directly near it. ARPAT, a regional environment agency, also monitors the lagoon water daily during the summer to measure the amount of oxygen. This is to ensure that if oxygen levels are too low, water from the sea is pumped in. In extreme cases, oxygen is added to the water. Furthermore, if large amounts of algae occur in the lagoon due to high temperatures and nutrients from agricultural fertilisers, the excess algae can be harvested; however, special permission is required to dispose of the algae. Since permission is not systematically granted, at low tide, algae flows into the sea. This large amount of algae damages nearby tourist beaches and can kill fish. Global warming will present the most difficult challenge. Between 25-29 July 2015, 200 tons of fish died after a water temperature hike (Consorzio Lamma 2015). The data by Consorzio Lamma show an average temperature well above the average recorded from 1955 to 2015. A comment by a local fisherman shows resignation in this case, "we do what we can, but sometimes we know it is just for the sake of doing something."

### 3.2. Responses to fish scarcity

It is common knowledge that one of the major problems in the world is overfishing. The lagoon is no safe haven as it depends on fish from the sea to populate its waters. Overfishing in the Mediterranean is an acute problem as attested by a statement on the EU website (CFP, Common Fisheries Policies 2017) which asserts:

> Fish stocks in the Mediterranean have been declining for decades. According to the scientific advice (CFP 2017), in the Mediterranean, the large majority of fish stocks assessed are shrinking and some are on the verge of depletion: despite recent efforts the situation is not improving. Managing fish stocks is complicated by the fact that many of them are shared with non-EU countries.

Merely pointing a finger at non-EU countries is not the solution. The EU has introduced quotas and the obligation to land all catch from 2019. In fact, most of the catch is now discarded either because it is ruined or not valuable enough. Despite these efforts, the problem is far from being solved. At the local level of Orbetello, the solution to overfishing is to use nurseries or buy young fish to supplement what the sea can no longer provide, population of the lagoon. Young fish are attracted to the lagoon because of its calm waters and ideal environment, but with stock being low, not enough fish enter. To meet growing demand for cheap fish, another solution has been to create fish farms, even if the product is then sold as farmed. These two solutions have been beneficial as they have managed to meet the demand for most species. Eel is still a problem. If you read the ancient documents you realize that some species are not present anymore and are probably extinct. One that is now in danger is the eel. As it has a complex reproduction cycle, the European eel is strictly monitored by EU institutions. As Ciccotti (2007, p. 57) states,

> The European eel, *Anguilla anguilla* L. 1758, is recognised today as an international marine species and a shared resource among European and Mediterranean countries. For this species, major problems exist in relation to a continent-wide decline in recruitment observed in the course of the last decades, and to a contraction in adult eel capture fisheries.

The particularity of the situation is that eel is fished locally in lagoons and rivers but has to be managed internationally. So far, the only local response is to buy young fish when available and repopulate the area.

### 3.3. Innovations to traditional fishing methods

Traditional fishing techniques employing the *lavoriero, martavello* and the *tramaglio* are still used to catch a variety of fish (Figure 3). Sea bass, sea bream, grey mullet, eels, small clams called *calcinelli*, *mazzancolle* (a type of shrimp) and a small kind of crab called *femminelle* are the most commonly caught species of fish. The *lavoriero* is a barrier once made from wood and now mechanized. It is positioned in the channels that allow the exchange of water between the lagoon and the open seas. This system takes advantage of the high tide: as water enters the lagoon from the sea, it attracts shoals of fish towards the barrier and funnels them into a series of "deceptive chambers" that lead them to the "capture chamber". Here the fish, still alive and in the water, are selected by size and either hoisted up with nets or released. Today fish are stored in mobile cages in the lagoon waiting to be sold if demand is low. In some seasons, not only the high tide but also the reproductive instincts of the fish push them towards the lagoon's outlet. Sexually mature fish are allowed to pass so that they reach the coastal waters where they can reproduce. From here, the younger fish, thanks to the low tide, can re-enter the lagoon. The *lavoriero* is used to catch all of the lagoon's fish species, as is the *tramaglio*, a bottom-set net formed by three layers of netting, used primarily in the summer and in November, December and January.

In the lagoon, the *martavello* and the traps are even more selective, as they only catch eels, femminelle (winter crabs), *mazzancolle* shrimp and blennies. During the winter, the *martavello*, a funnel-shaped net with a final chamber, is fixed inside "deceptive structures" made from nets, canes and poles. In the summer, it is fixed inside mobile and less complicated structures known as *crocioni* that can be moved daily (as registered in Slow Food Presidium rules).

### 3.4. Sustainable fish management

As it is impossible for local communities to solve international fishing problems, of which they are the victims, they can only concentrate on local sustainable practices. This section will describe some of the practices adopted in Orbetello. Fishing in Orbetello is carried out during the right seasons so as to allow for reproduction, and small-sized fish are freed. In the lagoon, this is easier than in the open sea. This is due to the fact that fixed installations let some small-sized fish pass, but if small fish are caught, they are released back into the sea (Figure 4). Also, market demand is particularly defined by size and timing. In the past, large amounts of fish were caught at times when there was no demand from clients, creating the conditions for a price drop or product waste. Furthermore, different clients want different products—supermarkets prefer smaller sizes, while restaurant distributors prefer bigger ones. The cooperative has built a system to meet these different demands. When fish are caught during the right season, operators are able to send them to several mobile cages suspended in the lagoon. There they are stored for a few days to a few months, then selected live to satisfy the demand of different markets (Figure 5). Fish are not fed while in the cages, but there is ample space to move around and feed naturally, although not as much as if they were free.

Figure 4. Fisherman catching eels in the lavoriero (Photo: Guido Gualandi)

Figure 5. Fixed installations to catch only certain sizes, when certain types are caught by mistake they are released (Photo: Guido Gualandi)

Figure 6. Mobile cages to store fish for several months (Photo: Guido Gualandi)

Figure 7. The restaurant (Photo: Guido Gualandi)

With this cage management, waste is minimal compared to open sea fishing and revenues are maximized. The sustainability of this system is such that even if fish are scarcer today, stocks are not depleted and revenues are maintained. This is possible thanks to the precise selection of only what is in demand, therefore reducing waste to zero. Fishermen have said that open sea fishing practices are no longer sustainable. For example, bycatch or bottom trawling ruins the ecosystem and creates a lot of waste that could be easily avoided. Global markets have reduced fish prices and many countries do not respect good fishing practices.

### 3.5. New cooperative activities contribute to maintaining livelihoods

Traditionally, the cooperative has been restricted only to fishing activities, however fish processing has a historic tradition. Besides classic smoking and marinating techniques, two unusual techniques are a legacy of the Spanish rule of the 16th and 17th centuries. They are *sfumatura,* whereby the fish is seasoned with a sweet pepper-based sauce, and *scavecciatura*, which is a kind of *escabeche* that uses a hot marinade of vinegar, rosemary, garlic and peppers. Different kinds of fish are used depending on the season, and local festivities follow the rhythm of the catches and life in the lagoon. The cooperative has opened a transformation site where they are able to prepare products to be sold locally or to prepare for distribution. Products sold include traditional marinated fish, dried fish eggs and canned fish sauce, used for pasta.

The fishermen also manage a restaurant where one can enjoy their fish locally (Figure 6). This has become a very lucrative activity and the number of people employed is now above 100.

The fishermen are also involved in many social activities in town. The *barchini* race in the water of the lagoon has been running since 1768. Food festivals mix products from the lagoon with those of the land.

### 3.6. The Slow Food Presidium: *Bottarga* and *Pesca Tradizionale*

Last but not least, this unique system has been made a Presidium by Slow Food. Slow Food is a non-profit organisation that protects the environment and sponsors clean food. Slow Food Presidia sustains quality production methods at risk of extinction by protecting unique regions and ecosystems, recovering traditional processing methods and safeguarding native breeds and local plant varieties (see Slow Food International). The Orbetello Presidium was established in an effort to reverse the current trends and maintains the objective of ensuring that the fishermen, involved for the first time in managing the lagoon, work to improve the lagoon's environmental situation. They must make requests for and monitor the interventions necessary to restore and maintain its health. The Presidium applies political pressure as it can publicly talk to the media and the general public about fishing in the lagoon. All the work of maintaining sustainable fishing and preserving the ecosystem still rests in the hands of the cooperative and the local government. For example, the cooperative is responsible for the fish population and respecting the sustainability of their practices, while the local government does the exceptional work such as oxygenating the lagoon (done in 2017 to try to stop asphyxiation of fish due to record temperatures) and works on the lagoon's edges.

The Presidium protects historical fishing and fish processing traditions, focusing on the protection of traditional techniques and wild species: sea bass, grey

Figure 8. Fishing station in Orbetello (Photo: Guido Gualandi)


Figure 9. Some of the fishers (Photo: Marco Tisi)

mullet, eels, *calcinelli* (small fish), *mazzancolle* (shrimp) and *femminelle* (crabs). Protection involves specifically the *Bottarga di Orbetello*, or dried fish roe. The Presidium rules cover every aspect of production from fishing to sale. The traditional fishing methods in the lagoon have also became a Slow Food Presidium, so all products issued by the fishing techniques described in section 3.3 above receive the Slow Food label. The Slow Food label also helps to market the products efficiently and offers unique visibility in the consumer market. As Slow Food Presidia are appreciated by consumers, their products sell at a higher average selling price.

## 4. Conclusions

Communities of fishermen (Figure 8) have been living off the lagoon for more than 2,000 years. However, depending on how the water was managed, they have benefitted in very different ways, sometimes barely surviving and other times thriving. Most of the problems that have affected the lagoon throughout its long history have been man-made: deforestation, modification to the environment, overfishing, pollution and lately, global warming and destructive fishing practices. Exclusive fishing rights to one small party have also created great inequality among fishermen in the past.
If community members wish to maintain their livelihoods, they need to be proactive toward change and continue to find new solutions. In the past, maintaining the canals and releasing small or sexually mature fish was enough. Prices had always been controlled, but the fish economy was only local for a long time. Now with a global economy, high average selling prices are more difficult to achieve. Selling fish at an acceptable price level has been an important area of focus and was partially addressed by building temporary holding cages. Yet today more actions have to be taken. Low fish prices due to globalization and increasing temperatures impose changes in traditional fishing systems as livelihoods are no longer maintained. If temperatures keep increasing, fish in the lagoon might simply die. Additional environmental problems in the Orbetello lagoon have an international dimension in that its fishery is affected directly by activities in the Mediterranean Sea and the European Union policy on fisheries. Likewise, a history of external interference in the management of fisheries and recently globalization, have left little or no space for traditional management practices and preservation of the lagoon and related livelihoods, although traditional fishing practices are still in use.

In particular, globalization has altered the balance of goods and services produced by the lagoon and redistributed the economic benefits flowing from them, adversely affecting the livelihoods of the local fishing community. The fishermen introduced a new system of stock management and created alternative revenues, such as transformation of fish and new hospitality activities, to increase lowering margins. Increasing water temperatures demand daily monitoring and adjustments using sea water to diminish temperature, oxygen injections or pumping of asphyxiated water out. Fish stocks have to be maintained artificially by buying young fish as not enough are coming in on their own from the sea anymore. For fishermen, maintaining their livelihoods will be an expensive task: just fishing is not enough and revenues must be maintained by diversifying fishermen's activities (for example adding hospitality) while keeping the core business healthy.

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Chapter 4

# The complementarity of human and nature well-being: A case illustrated by traditional forest resource users of the Sundarbans in Bangladesh

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## Abstract

This chapter attempts to examine whether livelihood patterns of indigenous people and local communities (IPLC) have contributed to the conservation and sustainable utilization of resources through a case study on the Sundarbans of Bangladesh. The Sundarbans is the largest mangrove ecosystem of the world enriched with high biodiversity. The combination of various types of ecosystems (forest, coastal and wetland) makes the Sundarbans home to several uniquely adapted aquatic and terrestrial flora and fauna. These biotic along with other abiotic resources of the Sundarbans contribute directly or indirectly to the economy both at local and national levels. A significant number of local people have maintained their livelihoods by depending on these resources. This chapter, by identifying the Sundarbans Reserve Forest (SRF) area as a socio-ecological production landscape and seascape (SEPLS), reveals that powerful agents at local, national and international levels have been extracting the resources of the Sundarbans beyond the sustainable limit. On the contrary, the IPLCs are playing an important role in the restoration of natural resources through traditional knowledge and practices, which in turn can establish a sustainable resource management system. This chapter also attempts to demonstrate that the institutional fragility, the existing nature of the power sharing arrangement, the nature of the political settlement and most importantly the exclusion of the IPLCs in the conservation and management process, have contributed to loss of biological diversity. Accordingly, this chapter presents empirical evidence showing that the local people of the Sundarbans have been practicing unique production methods that can significantly contribute to the revitalization and sustainable management of resources through symbiotic human-nature relationships.

This chapter is based upon the data reservoir of the Unnayan Onneshan research institute, which undertakes several biodiversity conservation programmes and conducts research on the Sundarbans. A significant amount of data was collected through participatory observations, questionnaire surveys, key person interviews and focus group discussions. The study particularly draws on the traditional knowledge of the forest people of three cooperatives that the Unnayan Onneshan helped to set up—the *Harinagar Bonojibi Bohumukhi Unnayan Samity*, the *Koyra Bonojibi Bohumukhi Unnayan Samity* and the *Munda Adivasi Bonojibi Bohumukhi Unnayan Samity.* Members pursue their livelihoods as wood and golpata collectors (*Bawalis*), fishermen (*Jele*), honey collectors (*Mouals*), shell collectors (*Chunary*), and crab collectors.

**Keywords:** Livelihoods; Biodiversity; Conservation; IPLC

## 1. Introduction

This chapter presents a case study of the Sundarbans of Bangladesh to examine whether the livelihood patterns of indigenous people and local communities (IPLCs) have contributed to the conservation and sustainable utilization of the biodiversity resources of this largest mangrove forest ecosystem of the world. In the face of severe deterioration of the natural environment, the challenge is to explore ways to conserve natural resources while allowing sustenance of people's livelihoods. The definition of livelihood is extensively discussed. The most popular definition is by Chambers and Conway (1992), which states that "*a livelihood comprises people, their capabilities and their means of living including food, income and assets (stores, resources, claims and access)*". The term socio-ecological production landscapes and seascapes (SEPLS) was coined to refer to areas shaped by production activities characterized by harmonious human-nature interactions that can sustain biodiversity while also supporting human well-being (Bergamini et al 2013). The conceptualization of the linkage between these two terms, "livelihoods" and "SEPLS", can be interpreted to recognize that humans have adapted to local ecosystems by carefully modifying their features and derive livelihoods from close interactions with their surroundings (Ichikawa 2013, p. 57). This study recognizes this linkage and shows that the Sundarbans forest region is a case of a highly productive ecosystem that provides a wide range of valuable forest resources where the local people's livelihood strategies play a central role in the management of these resources. This, accordingly, proves the underlying complementary relationship between human beings and nature in the course of supporting the well-being of the both.

In the next section, a brief profile of the Sundarbans is presented by identifying this mangrove forest ecosystem as a SEPLS example. The third section offers a brief description of the activities carried out by the cooperatives, facilitated by the Unnayan Onneshan. Key results have been interpreted with necessary explanations in the fourth section. The penultimate section discusses the results to wrap up the major findings which can help practitioners and policy makers apply such lessons in broader contexts to tackle future challenges. The final section ends with concluding remarks.

## 2. The Sundarbans as a socio-ecological production landscape and seascape (SEPLS)

The three perspectives drawing on the SEPLS concept—structure, benefits and changes—deepen understanding on various types of production landscapes and seascapes (Ichikawa 2013). This chapter also uses these perspectives to present the Sundarbans as a perfect case of a SEPLS. Firstly, key characteristics of this mangrove ecosystem, including its location and the dynamic nature of different types of habitats (forest, wetlands, coastal), have been

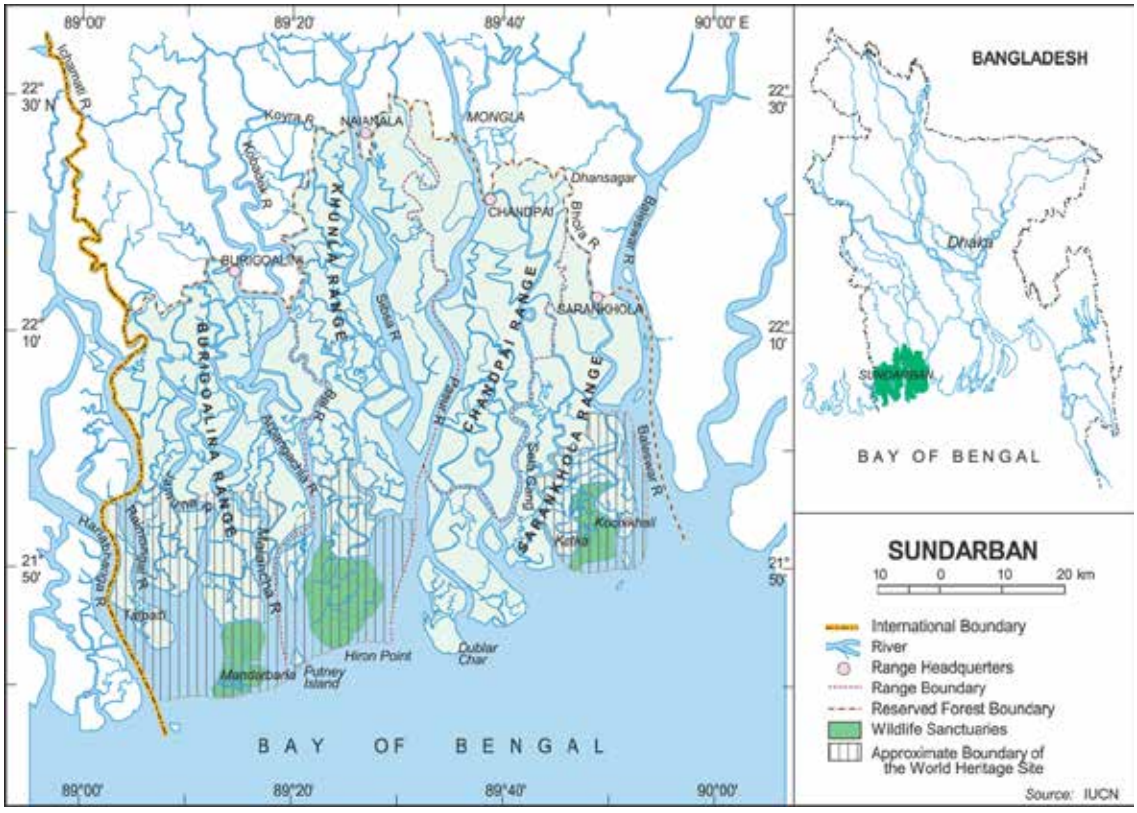


Figure 1. Location of the Sundarbans (Source: IUCN, 2014)

briefly outlined to define its structure. Thereafter, the diverse benefits the Sundarbans provides in the form of maintenance of biodiversity and supply of goods and services are highlighted. Lastly, the chapter presents an overview on major changes in the Sundarbans, resulting from the interactions between people and nature.

## 2.1. Structure: dynamic mosaics of habitats and land uses

The Sundarbans is a symbol of majestic beauty and tranquillity, a wilderness of nature and a hotspot of biodiversity. It is located at the great delta of the Ganges, Brahmaputra and Meghna (GBM) rivers at the edge of Bay of Bengal, and is the largest contiguous single-tract mangrove ecosystem in the world (Figure 1). It is located in the southwest corner of Bangladesh, between 21°30′ and 22°30′ North and 89°00′and 89°55′ East (Islam 2010). A significant part of the total area of this mangrove swamp lies within India (West Bengal State). The Bangladesh portion is larger than the portion in India, with an area of 6,071 km$^2$ (62% of total area), and which constitutes 39.5% of the total forest area of Bangladesh (Roy & Alam 2012).

Of the Bangladesh part, 70% is land area and the rest (30%) is water (Kabir & Hossain 2008). The wetlands of the Sundarbans consist of about 200 islands separated by about 400 interconnected tidal rivers, creeks and canals (Rahman, Rahman & Islam 2010). The Sundarbans was recognized as a Natural World Heritage Site in 1997 by UNESCO and as a Ramsar Site of international importance in 1992 (IUCN 2014).

The combination of various types of ecosystems (forest, coastal and wetland) makes the Sundarbans a home to several uniquely adapted aquatic and terrestrial flora and fauna. The Sundarbans alone supports 53% of birds, 43% of animals, 42% of reptiles, 36% of amphibians, 29% of plants and 17% of fish species of the country's total biodiversity resources (Baten & Kumar 2010).

## 2.2. Benefits: maintaining biodiversity and providing humans with goods and services

The Sundarbans is unique in terms of supporting viviparous plant species. Further, it harbours 334 species of trees, shrubs, herbs and epiphytes and about 400 species of

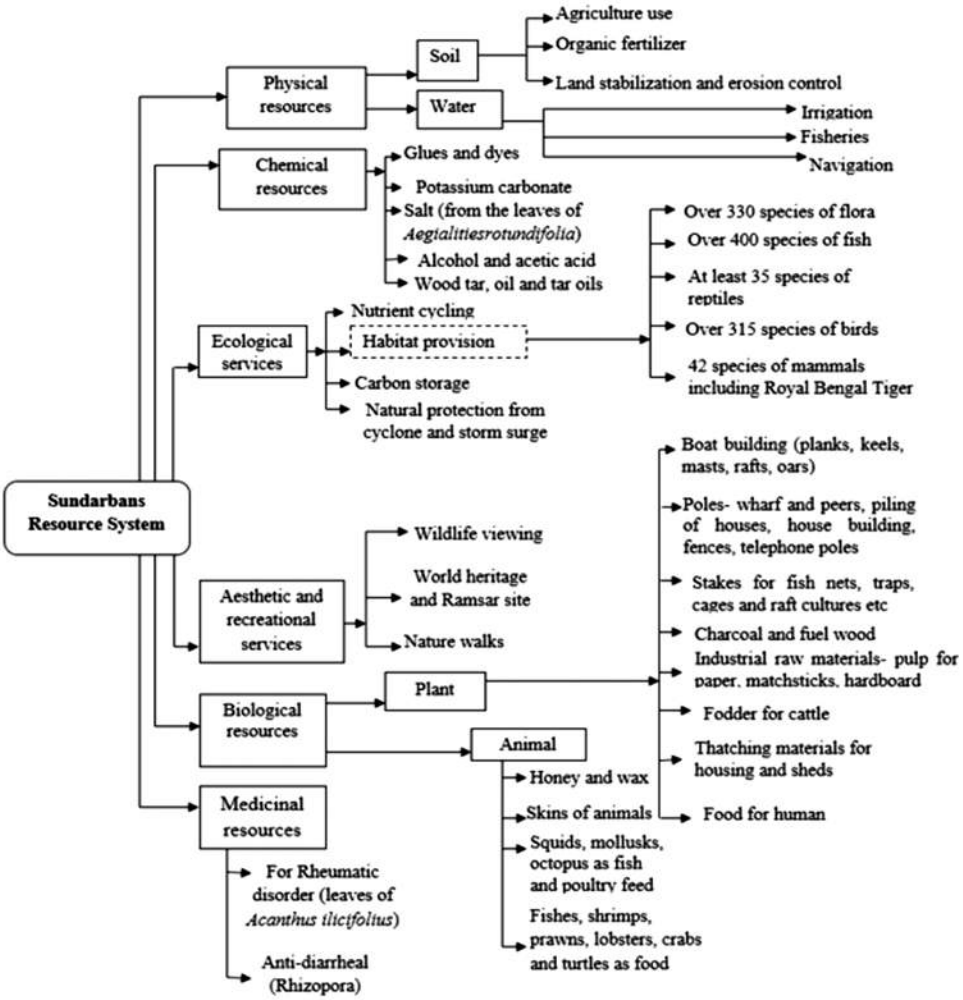


Figure 2. The Sundarbans resource system (Source: adapted from the data reservoir of Unnayan Onneshan)

wild animals (Behera & Haider, 2012). The sundri (*Heritiera fomes*) is the most important tree species, upon which the Sundarbans is named. Other prominent species are: gewa (*Excoecaria agallocha),* baen *(Avicinnia officinalis),* passur (*Xylocarpus mekongensis*), keora (*Sonneratia apetala*), goran (*Ceriops decandra*), ora (*S. caseolaris*) and hental (*Phoenix paludosa*). The Sundarbans also offers high value non-timber forest products like golpata (*Nypa fruticans*), honey, wax, fish, and crabs.

This forest region is also rich in its faunal diversity. There are 448 species of vertebrates including 10 amphibians, 58 reptiles, 339 birds and 41 mammals (DoE 2015). Based upon other accounts, the species number of available fauna can be identified as: 400 fishes (Rahman, Rahman & Islam 2010), 24 shrimps, 7 crabs, 8 lobsters (Rahman & Asaduzzaman 2010) and 77 insects of different orders. This forest provides habitats for diverse aquatic wildlife such as the estuarine crocodile (*Crocodylus porosus*), turtles (*Lepidochelys olevacea*), dolphins (*Platanista gangetica* and *Peponocephala electra*) and molluscs like the giant oyster (*Crassostrea gigas*). Nevertheless, the Royal Bengal Tiger (*Panthera tigris*) is the most magnificent animal. According to the census of 2004, around 440 tigers resided in the Bangladesh part while the most recent estimate puts such to around 106 tigers (Bangladesh Foreset Department [BFD] 2015)[i]. It is also home to thousands of spotted deer (*Axis axis*) and barking deer (*Muntiacus muntjak*).

These biotic along with other abiotic resources of the Sundarbans contribute directly or indirectly to the economy both at local and national levels. Figure 2 shows how the resources of the Sundarbans have been utilized for different purposes, contributing both to the lives and livelihoods of local people and to the economy of the country.

The livelihood pattern in the Sundarbans area actually varies with seasons and supports an estimated 3.5 million people directly or indirectly (Sarker et al 2016). Wood and golpata collectors (*Bawalis*), fishermen (*Jele*), honey and wax collectors (*Mouals*), shell collectors (*Chunary*), and crab collectors are among the major occupational groups of the adjacent forest region. The local people have maintained their livelihoods, specifically by depending on the resources of the Sundarbans, in primarily two ways (Getzner & Islam 2013). First, local households earn cash income by selling ecosystem products, such as fish, honey and so on at local markets. Second, the use of natural resources provides substantial subsistence such as food, fresh water and timber. The lives and livelihoods of the local people are mainly related to the physical and biological (or, biodiversity) resources as depicted in Figure 2.

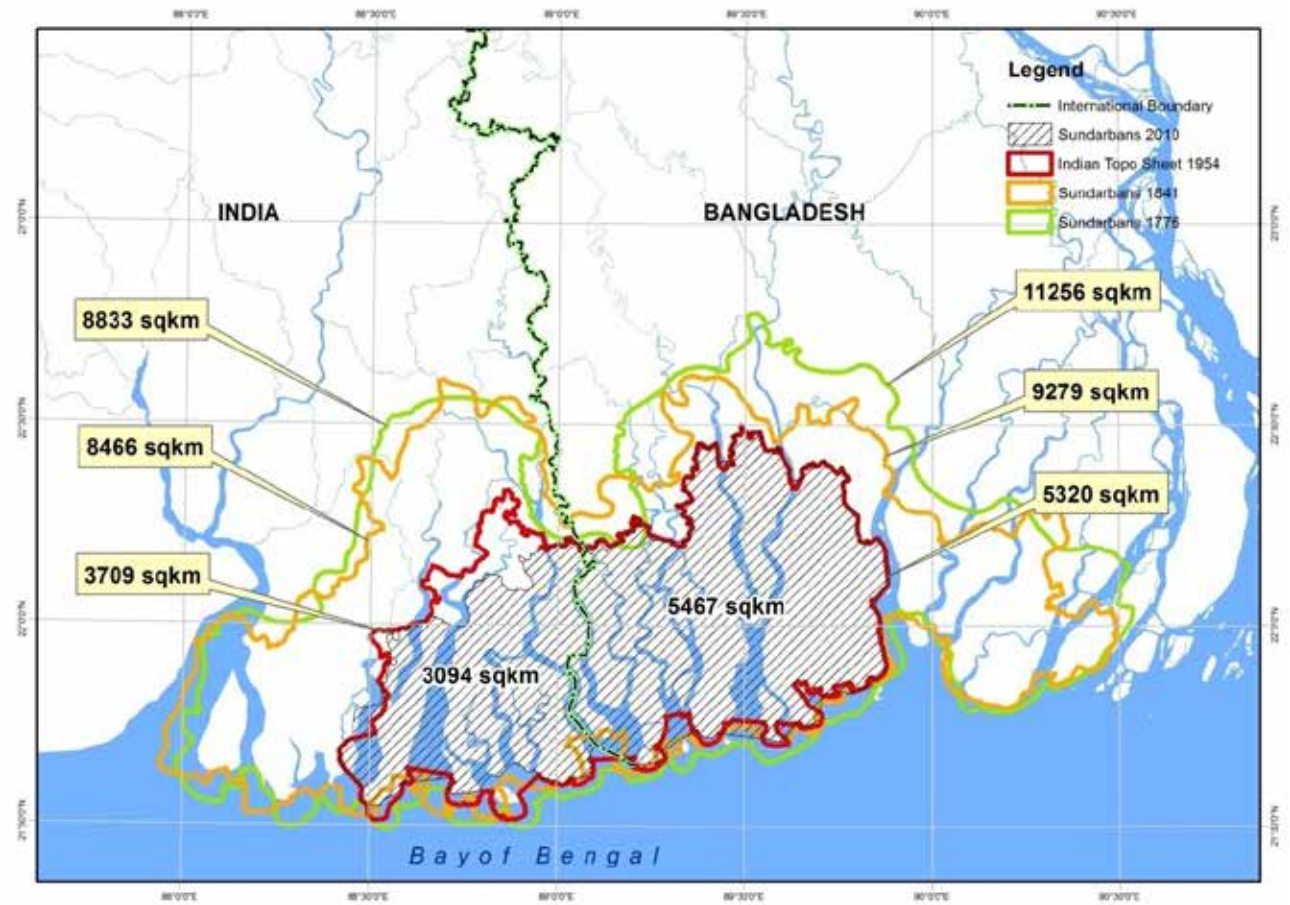


Figure 3. Mangrove forest change of the Sundarbans from 1776 to 2010 (Joint Landscape Narrative by India and Bangladesh), (Source: CEGIS, 2016)

Table 1. Growing stock of the Sundarbans according to different inventories (FAO 2011)

| Year of publication of inventory results | Organisation performing inventory | Sundri (number of trees per hectare) | Gewa (number of trees per hectare) | All tree species (number of trees per hectare) |
|---|---|---|---|---|
| 1959 | Forest and Forestal Engineering, Canada | 211 | 61 | 296 |
| 1983 | Overseas Development Authority | 125 | 35 | 180 |
| 1996 | Forest Resource Management Project, Forest Department, Government of Bangladesh | 106 | 20 | 144 |

## 2.3. Changes: shaped by the interactions between people and nature

The Sundarbans has experienced major ecological and physiographical changes due to anthropogenic pressures and climatic disorder, which have taken a heavy toll on the regenerative capacities of the forest and its ability to maintain sustainability. Such pressures have resulted in the continuous decline of forest coverage and of biodiversity resources.

In 1776, the size of the Sundarbans was 17,000 km$^2$. At present, it is only almost half this total area (Islam & Gnauck 2009). A recent report shows declining trends in forest areas both in India and Bangladesh (Figure 3). Aziz and Paul (2015) studied changes in the forest cover, marsh and water areas between1989 and 2000, and also up to 2010 in the Khulna and Chandpai ranges and found that *sundri* trees had declined during both time spans. Also, the total forest area declined by 3.60%.

The reduction of volume of important tree species of the Sundarbans can also be analysed through forest inventories (Table 1). Three important inventory reports on the Sundarbans were prepared in 1959, 1983 and 1996 (FAO 2011).

The trend in growth of trees in each case is found to be declining. Another recent study (Giri et al 2015) identified mangrove forest coverage (gain and loss) from 2000 to 2012 in South Asia and stated that the forest coverage of the Sundarbans decreased by 1.2%from 1970 to 2000.

The degradation of floral diversity also wields negative impacts on faunal diversity. As many as 20 globally threatened species inhabit the Sundarbans. The most endangered species are the *Batagur baska* (turtle), the Ganges River dolphin and the Irrawaddy dolphin. Other threatened wildlife species include: pythons, king cobras, adjutant storks, white-bellied sea eagles, clawless otters, masked fin-foots, ring lizards, river terrapins, fishing cats, spoon-billed sandpipers, and eagles (DoE 2015). The most important faunal species, the Royal Bengal Tiger, is also listed as an endangered species by the IUCN.

Based on the above discussion on the structure and benefits of the Sundarbans, Table 2 provides a summary of the characteristics of the Sundarbans as regards SEPLS. The two major indicators for identifying SEPLS have been specified here based on the definition provided principally by the Satoyama Initiative and illustrated by others (Gu & Subramanian 2012; Ichikawa 2013; Bergamini et al 2013). It should, however, also be noted that the balance of such a SEPLS has continuously been threatened as has been briefly discussed in the sub-section on changes, resulting from interactions between nature and external people.

Table 2. The Sundarbans as a SEPLS (prepared by the authors)

| Indicators | Relevant to Sundarbans? (Yes/No) | Why Relevant? |
|---|---|---|
| Mosaic of production landscape/ seascape | Yes | It is a mangrove forest that includes forest, coastal and wetland ecosystems, supporting diverse production activities. |
| Harmonious interaction between humans and nature and well-being of both | Yes | It provides the IPLCs different options for maintaining livelihoods and the IPLCs provide protection to the forest and its resources through traditional livelihood practices. |

## 3. Description of activities

The discussion provided in the above sections clearly demonstrates that the ecosystem of the Sundarbans is ecologically and economically important, but that it has become more vulnerable as it faces major changes with the passage of time. The Unnayan Onneshan (UO) research institute, by conducting several research activities, identified that the IPLCs have hardly any rights over forest resources and negligible power to execute choices and livelihood strategies in a sustainable way. The power is actually in the hands of external agents (e.g. the Forest Department, local money lenders, dacoits, and politically powerful individuals). Thus, the UO felt that the forming of cooperatives could serve as a vehicle to promote the power of IPLCs and to create a scope for collective actions, including equipping people in the practice of traditional knowledge and livelihood strategies. The results of the activities of cooperatives are briefly described below.

The UO provided technical assistance to form three cooperatives—the *Koyra Bonojibi Bohumikhi Unnayan Samity* (Koyra Forest Dependent Peoples' Cooperative), the *Horinagar Bonojibi Bohumukhi Unnayan Samity* (Horinagar Forest Dependent Peoples' Cooperative), and the *Adibasi Munda Unnayan Samity* (Indigenous Munda Cooperative)—through the Community Based Management of the Sundarbans project that has been running since 2006. The members of the cooperatives are from the two *upazilas*[ii] of the Khulna district—Koyra (unions[iii] of North Bedkashi, South Bedkashi and Koyra Sadar) and Paikgacha (Chandkhali and Goroikhali)—and are involved in the cultivation of resources from the different and adjacent parts of the Sundarbans. An estimated 73,000 people of Sundarbans communities live in these two *upazilas* (Figure 4). The cooperatives have 300 resource users as members and more than 5,000 resource users are the indirect beneficiaries of the formed cooperatives.

The UO provides logistic and technical support to the cooperatives. The cooperatives serve as a common ground for sharing information, experience and enhancing cooperation among members. The members conduct regular meetings to discuss different problems and devise collaborative actions and solutions. They usually meet formally twice a month to chalk out work plans and discuss the progress of activities. Generally, they meet during the first week of every month to prepare a monthly work plan and during the last week of every month to evaluate progress. Thus, they develop common understanding on managing the Sundarbans, and foster sharing of traditional knowledge and practices. On a whole, the establishment of cooperatives

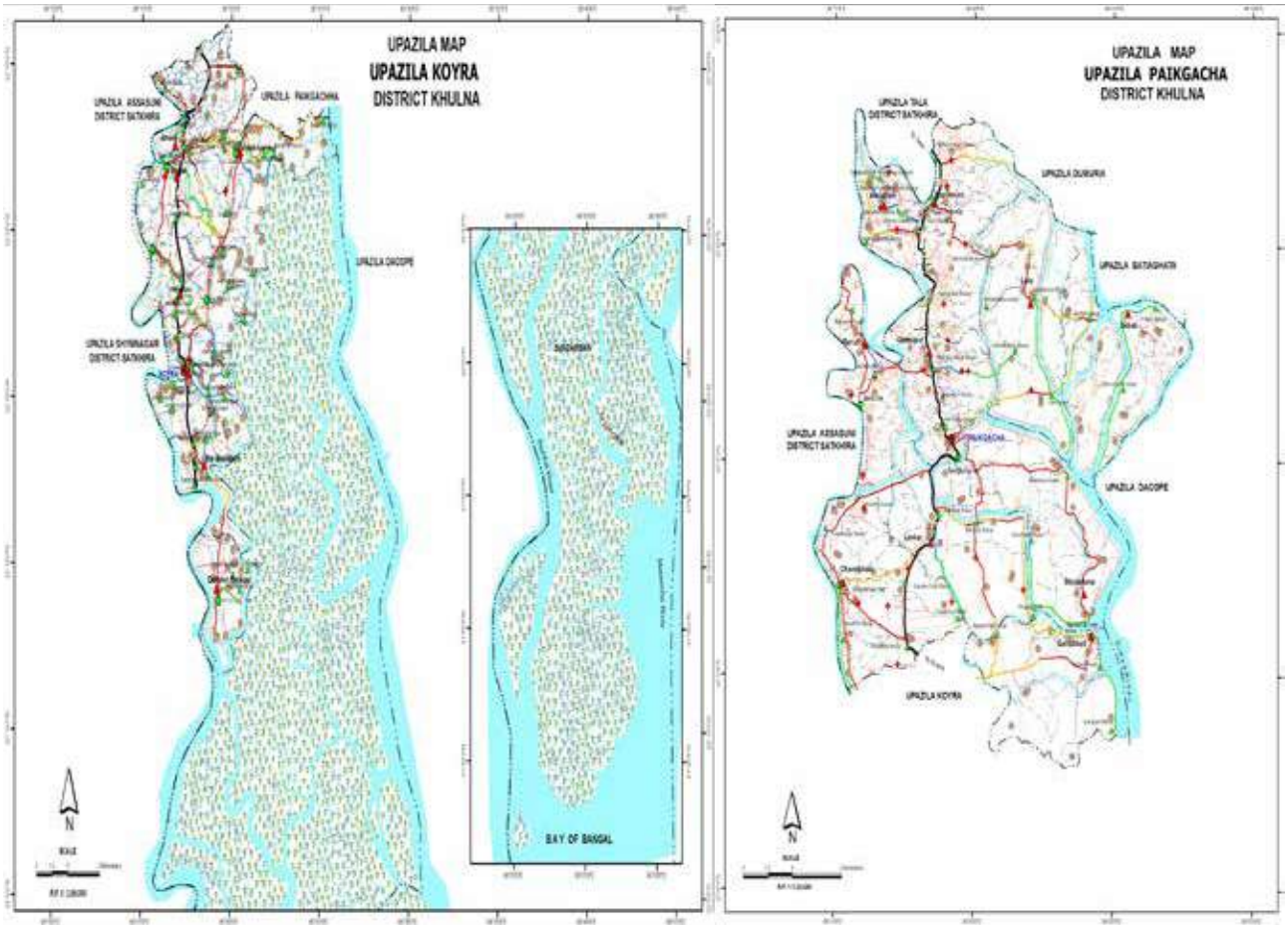


Figure 4. Resource harvesters or cooperative member locations – Koyra and Paikgacha (Source: LGED, GoB[vi], 2017)

on the one hand has helped traditional forest peoples to follow the path toward claiming their rights in a journey towards self-sufficiency. On the other hand, the cooperatives foster the participatory monitoring and sustainable use of the biodiversity resources of the region. Apart from this type of progress, socioeconomic development in the local communities has been further advanced by the various regular activities of the cooperatives—the creation of common funds through the subscription and utilization of funds for individual needs.

The UO has also facilitated the Community-based Mangrove Agro-Aqua-Silviculture (CMAAS) practice and some biodiversity conservation programmes. Finally, the UO conducts regular research on the Sundarbans.

## 4. Results of activities

Biodiversity conservation programmes, run by the cooperatives, and several research activities have enabled the Unnayan Onneshan to discover the underlying factors that cause extraction of resources beyond the sustainable limit and to examine the livelihood strategies of the local people. This section discusses these results drawing on different studies conducted by the UO (Kabir & Hossain 2008; Baten & Kumar 2010; UO 2010; Baten 2011; Titumir 2014; Titumir 2015; Titumir, Afrin & Islam 2017). Since these are bullet-point-type summarized versions, specific references are not given for findings presented below, excepting those collected from other sources.[iv]

### 4.1. Major factors inducing resource extraction and degradation

- Encroachment into the forest region

  The Forest Department (FD) is the leading management authority of the Sundarbans Reserve Forest (SRF). Due to legislative flaws and enforcement problems, exploiters, specifically politically and economically powerful groups, have continued to encroach into the forest region and extract resources.

- Land reclamation and shrimp cultivation

  Conversion of land into commercial shrimp farming is the largest human threat to the Sundarbans mangrove ecosystem. These farms are put in place by powerful local people, connected to political and administrative structures at the local and national levels.

- Marginalization of local and indigenous people

  The National Forest Policy of 1994 recognized community participation in the management process. However, the current management system is viewed by local people as an overly restrictive process that limits their involvement. They face many barriers to exercise their rights to use resources. This results in a form of tenurial insecurity among the local inhabitants.

- Industrialization and development projects near (or around) the forest

  In recent decades, powerful agents at both national and international levels have successfully pursued the government to approve many development projects. For instance, the most recent and highly controversial is the Rampal Power Plant Project, a coal-based power plant, fraught with triple jeopardies in the three domains of environment, economy and technical feasibility, and which may be dangerous to the integrity of the Sundarbans. The UNESCO World Heritage Committee has cited a series of flaws.

- Rent-seeking tendencies and extralegal management

  There are allegations that government agencies and functionaries have not only facilitated land-grabbing by rich and powerful interests but also are rapacious in their own right. Forest Department officials reportedly harass collectors of forest produce for extra tolls. There is evidence on the cutting and selling of trees by timber traders and smugglers, and the killing of animals by poachers with the alleged involvement of forest officials.

- Exotic species for commercial profit

  Following a suggestion from donor agencies, the government has introduced some exotic species in the adjacent areas of the Sundarbans under a social forestry programme. These exotic species do not comply with natural ecosystems and consequently are altering ecological processes.

- Climate change and natural disasters

  On 15 November 2007, the cyclone *Sidr* hit Bangladesh's southwest coast. The Sundarbans absorbed the main blow of *Sidr*, saving human lives by slowing down nature's wrath. According to the Forest Department, one fourth of the Sundarbans forest area was damaged by *Sidr*. Specifically, 8% to 10% of the forest was destroyed completely, while 15% was partially damaged.[v] The cyclone *Aila* struck the same region again on 25May 2009. A large number of trees were uprooted and infrastructure damaged in the Sundarbans and its adjacent regions. Climate change has wielded negative impacts by increasing the salinity of water and soil composition. The forest is also becoming vulnerable to sea-level rise, a consequence of climate change.

### 4.2. Traditional rules and practices followed by IPLCs

This sub-section is key to understanding the intrinsic relations between livelihood strategies and the sustainability of nature in the context of this specific case study on the Sundarbans. It illustrates that traditional practices lead the IPLCs to harvest the resources of Sundarbans in a manner that is fully compatible with the requirements of conservation and sustainable use. The communities sensibly believe that the forest provides their livelihoods and that it must be protected from all sorts of misuse and abuse for the present and future generations. Therefore, they follow certain rules according to which they harvest resources with the utmost care and love for the nature.

- Rules followed by *Mouals* (honey/wax collectors)

  Honey is considered to be an important non-wood forest product. The giant honeybee (*Apis dorsata*) is the principal honey producing species of the SRF. When collecting honey from honeycombs, usually during the months of April, May and June, the *Mouals* (honey/wax collectors) usually cut a specific section (about two-thirds) of the honeycomb and leave the rest for reproduction. They also try to make sure that no young bees are killed while collecting honey and squeeze beehives by hand, never using metal tools. They revisit the colonies after a period of one month or more depending upon the size of the colony and the flowering conditions of nearby vegetation. When collecting the honey, the *Mouals* produce smoke using dry leaves but never put fire on beehive. Honey is a sacred food to them and therefore, they are careful not to adulterate honey.

- Rules followed by *Bawalis* (wood collectors)

  The *Bawalis* (wood collectors) follow several rules to ensure the sustainable harvest of wood. They leave at least one stem in each clump of trees after cutting. Once the *Bawalis* have harvested wood from a compartment, they will not use the same compartment for harvesting the following year, but will harvest on a cyclical basis so that there is an adequate regrowth of plants. They usually cut wood where there is an abundance. They do not cut young and straight trees. The *Bawalis* believe that this tidal forest is a sacred place and that the Creator washes the forest twice a day and maintains its sanctity. When the *Bawalis* cut wood, they are guided by such beliefs and try to maintain sustainable use of the forest.

- Traditional practices of *golpata (Nypa fruticans)* harvesters:

  According to the rules followed by *golpata* harvesters, exploitation in any area is not allowed more than once a year and is not allowed during June to September specifically as it is the growing period of *golpata* (*Nypa fruticans*). They cut only leaves that are approximately nine feet long, and the leaves are cut in a way so that the central leaf and the leaf next to it in each clump is retained. They maintain the rule that the flowers and fruits shall in no way be disturbed when cutting leaves. They also maintain that young plants with only one utilizable leaf should not be cut.

- Customary rules followed by *Jele* (traditional fishermen):

  The *Jele* (traditional fishermen) know that catching fry (young fish) will ultimately deplete the number of fishes

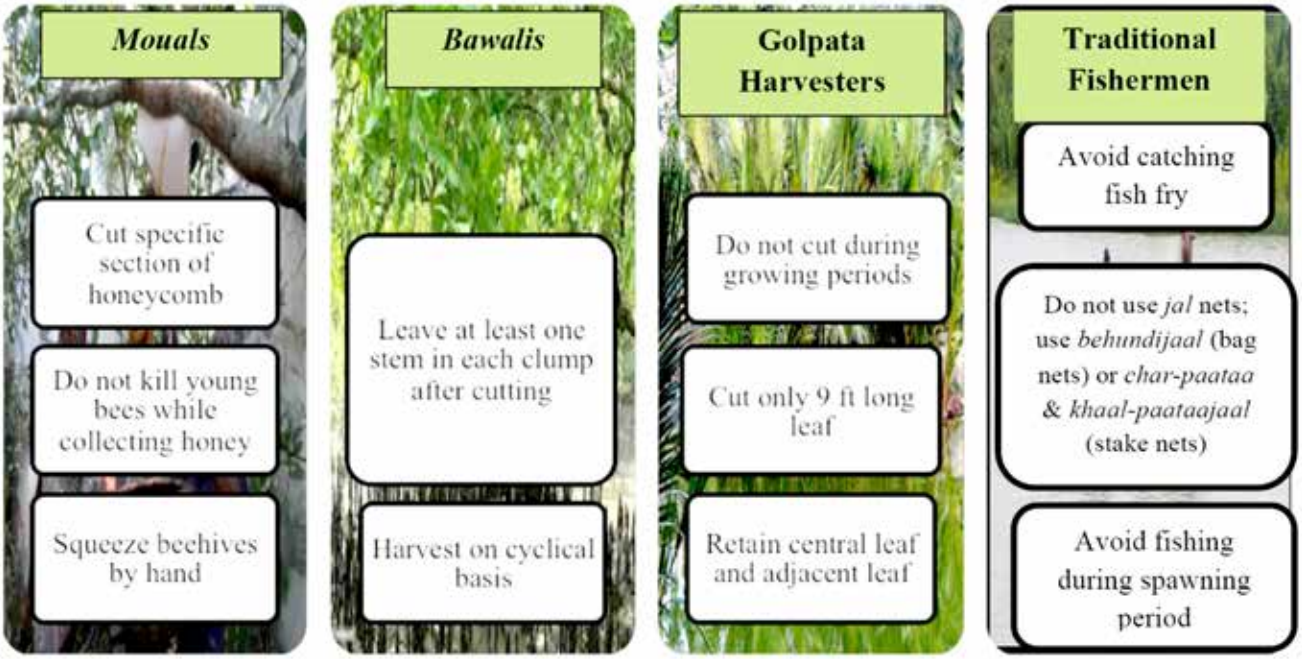


Figure 5. Traditional rules and practices followed by IPLC occupational groups at a glance (Source: authors)

in the water bodies and thus they try to avoid doing so. They usually do not use *jal* nets (very small-meshed nets). Rather, they use nets *behundijaal* (bag nets) or *char-paataa* and *khaal-paataajaal* (stake nets), which have been innovated and customized scientifically to benefit the Sundarban's unique waterscape. They use big-meshed nets for rivers and small-meshed nets for closed water bodies. They do not catch all species of fish and also avoid fishing during spawning periods.

### 4.3. Diversification of livelihood patterns

In addition to the above-discussed traditional rules and practices, the IPLCs have diversified their livelihood options by utilizing their traditional knowledge and experiences as responses to the continuous deterioration of their livelihood opportunities due to man-made pressures. They continuously try to cope with changing conditions through initiating innovative management practices. For instance, they have developed innovative techniques in agriculture that are adaptive to local biophysical conditions while ensuring environmental sustainability. In response to commercial shrimp cultivation that has emerged as a major threat to this mangrove ecosystem, an alternative—Community-based Mangrove Aqua Silviculture (CMAS)—has been innovated by the local community.

- Innovative techniques in agriculture

  Local small farmers grow their rice seedlings in raised land with less risk of saline water contamination to ensure maximum survival before transplantation in fields. The local communities harvest rice plants at 8 to 12 inches high from the ground, responding to high salinity contents in soil and water. Practically, saline contaminated rice straw decomposes within a very short time if used as roofing materials. Therefore, they are allowed to decompose in the field, which in turn adds organic matter, mainly nitrogen, to the soil and also reduces saline intensity, which is beneficial for the growth of their next crop. Since most of them are landless, local small farmers grow vegetables on sheds or roofs, in yards or the backyards of their houses.

Figure 6. A CMAAS Farm (Source: Unnayan Onneshan)

- Community-based Mangrove Agro-Aquasilviculture (CMAAS)

  CMAAS refers to the practice of integrated cultivation of some mangrove faunal species such as crabs, oysters or fishes (e.g: shrimps, *bhetki* [*Lates calcarifer*]) and floral species such as *golpata* (*Nypa fruticans)*, *keora* (*Soneratia apetala*), and *goran* (*Ceriops decandra*), at the same time on any swampy land of brackish water. In addition, integrated cultivation of some mangrove floral species like *golpata* and a few faunal species like tengra (*Mystus tengara*), *baila* (*Awaous guamensis*), and tilapia (*Tilapia nilotica*), are practiced on fresh water swampy land.

Table 3. Economic and ecological returns of CMAAS (Prepared based on findings of research by UO, 2010)

| CMAAS | | |
|---|---|---|
| **Economic Returns** (Benefits>Cost) | **Mangrove Cultivation (flora):**<br><br>Total income (per *bigha*/per year): BDT 56,250<br><br>Total cost (per *bigha*/per year): BDT 1,800<br><br>Net benefit: BDT 54,450<br><br>Cost Benefit Ratio: 1:32 | **Mangrove Aqua Farming (fauna):**<br><br>Total income (per *bigha*/per year): BDT 183, 000<br><br>Total cost (per *bigha*/per year): BDT 14,750<br><br>Net benefit: BDT 173,250<br><br>Cost-Benefit Ratio: 1:12 |
| **Ecological Returns** | Biodiversity conservation, protection from river and land erosions, reduced pressure on the Sundarbans, provision of breeding ground for aquatic species, no use of chemical fertilizers, no pollution of water, carbon sequestration, utilization of salinity rich land, etc. | |

Note: A*bigha*, a unit of land measurement, is 1,600 $yd^2$ (0.1338 hectares or 0.3306 acres) and is often interpreted as being 1/3 acre (precisely 40/121 acres). In metric units, one *bigha* is hence 1,333 $m^2$. 1 USD = 80 BDT

CMAAS culture is found to be more profitable and have negligible environmental impacts, whereas commercial shrimp culture is cost effective but wreaks havoc on the environment. The economic and ecological returns of CMAAS culture are presented in Table 3.

## 5. Discussion and major findings

Results imply that there is a significant number of anthropogenic pressures that not only cause degradation of biodiversity resources but also negatively hamper the balanced relationship between the biotic and the abiotic components of this mangrove ecosystem. The human induced pressures have mainly intensified with the advent of neoliberalism as the sole strategy of accumulation of wealth, with profits being considered more important through commercialization of forest products and neglect of the intrinsic ecological value of biological resources and diversity. These commercial enterprises, formal and informal, are found to be highly organized in their extractions of resources, and most often are politically patronized and administratively supported.

The continuous encroachment into the forest region, conversion of mangrove forest land into commercial shrimp cultivation farms and the marginalization of IPLCs signify that institutional fragility exists in management of the Sundarbans. Specifically, the unstable nature of property rights, harboured by politically and administratively powerful groups, restricts access to resources by the traditional resource users of the Sundarbans and squeezes their tenurial security. Thus, the power sharing arrangement and the nature of the political settlement also matter in the utilization and management process of resources in this context. Such imbalanced and tilted power sharing in the management of biological resources ultimately results in continued degradation and loss of biodiversity on the one hand, as well as the persistent poverty of the local people in the Sundarbans, on the other. The situation has been further aggravated by natural disasters and climate change. This scenario is depicted in the following diagram (Figure 7):

This study has scrutinized the livelihood patterns of the IPLCs, the resource dependent communities of the Sundarbans, and results show that their livelihood strategies (both traditional practices and innovative tools) are hugely effective and beneficial for the protection and maintenance of the natural mangrove ecosystem. More in-depth understanding of their livelihood strategies, however, can be achieved through cost benefit analysis and comparative analyses between the practices of the IPLCs and the methods imposed by external agents. This study only documents the customs and rules of resource harvesting, which are found to be nature friendly. Based on the findings, the study recommends focus to be put on livelihood strategies, which can ensure conservation and sustainable use of the biodiversity of the Sundarbans.

Yet, the policies of the government most often marginalize indigenous and customary institutions or simply overlap and create confusions among resource users. The formal management body, the Forest Department, in certain cases, considers the local forest dependent livelihood activities as a threat, while the informal systems based on patron-client relationships harbour a system of overexploitation of resources. The future challenge is, therefore, to understand the evolving nature of institutions—both traditional and formal—to design a comprehensive strategy for biological diversity, combining conservation, sustainable use and access and benefit sharing as fundamental pillars, while integrating these livelihood strategies and innovations, emanating from traditional knowledge and practices, into such a strategy.

The lessons from this case study can also be applied with necessary modifications to improve policy decisions and management interventions of similar types of SEPLS indifferent countries of the world. There is no denying the necessity to revise laws, regulations and policies relating to the use of resources and to secure the rights of IPLCs. A collaborative management approach needs to be promoted through innovation of various forms of institutional arrangements and livelihood options.

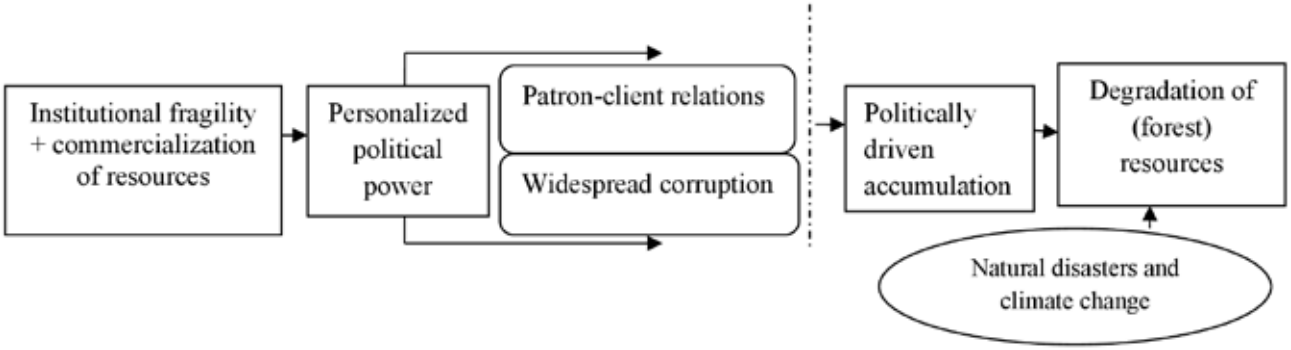


Figure 7. Factors inducing biodiversity resource degradation (Source: authors)

## 6. Conclusions

As a Contracting Party to the Convention on Biological Diversity (CBD), Bangladesh is committed to implementing conservation and sustainable management of its biological diversity. These findings, however, reveal that the most important biodiversity hotspot of this country, the Sundarbans, is under the threat of continuous degradation. Its resources have been exploited beyond the sustainable limit due to the structural rigidities, embedded in, and reproduced by, institutions and unequal power sharing arrangements. In this process, the lives and livelihood conditions of the indigenous people and local communities (IPLCs) are also being adversely impacted. The traditional knowledge-based livelihood strategies of the IPLCs are found to be effective in maintaining sustainable utilization and conservation of this forest ecosystem. Yet, their knowledge has often been neglected under the formal institutional management system. Such unique production methods, as practiced by the local people of the Sundarbans, can significantly contribute to the revitalization and sustainable management of resources through symbiotic human-nature relationships. These kinds of knowledge-based livelihood strategies of the local people, which ensure collaborative management system of SEPLS and equitable benefit sharing, should be promoted at different tiers of policy levels—ranging from international to local—to steer the course of socio-economic development onto a pathway that combines the welfare of human beings and of nature.

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i *The Guardian*, 27 July 2015.
ii An *upazila* (sub-district) is an administrative unit in Bangladesh.
iii A union is an administrative tier and an *upazila* consists of a number of unions.
iv Local Government and Engineering Department, Government of the People's Republic of Bangladesh.
v These studies are part of UO research activities of different years. More description on each of them has not been provided due to the word limit of this paper.
vi *The Daily Star*, 20 November 2007.

Chapter 5

# Strengthening smallholder resilience and improving ecosystem services provision in Indonesia: Experience from Buol District, Central Sulawesi

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## Abstract

This paper describes the processes and initial impacts of an action research project to strengthen the resilience of smallholders and simultaneously address environmental issues in Buol District, Indonesia. The remote and degraded landscape of Buol, located along the coastline of the Sulawesi Sea, while offering various livelihood options also makes farmers more vulnerable to environmental and socioeconomic changes. A low capacity to deal with frequently occurring extreme events, such as floods, droughts, and agricultural pests and diseases, as well as a lack of skills in increasing agricultural productivity, were the major problems facing the Buol smallholders. As a consequence, the Buol farmers only applied short-term strategies in managing their livelihoods. In addition, the capacity of the local government to respond and provide solutions to issues and challenges was limited. Under the Smart Tree-Invest project, ICRAF conducted a series of studies combined with pilot activities in the field to provide good practices for consolidating biophysical and socioeconomic information and on-the-ground actions to enhance resilience and provision of ecosystem services. This action research heralds that nested interventions on differing scales is essential, from the community to district level. At the community level, tree farming learning groups and participatory watershed monitoring were organized to increase farmers' capacity in managing their landscape and to generate environmental and social data required for analyzing development impacts. At the district level, the establishment of a multi-sectoral government forum and a series of capacity building events to quantify and monitor ecosystem services were facilitated. These activities aimed to increase the capacity of the local government in planning green development by improving coordination among sectors and promoting application of co-investment principles between public-private sectors to maintain and enhance ecosystem services. Replication and upscaling of pilot activities funded by the district's budget at the end of the pilot project were the key successes of the project, indicating raised awareness, ownership and trust, and proving that this type of action research can improve the livelihood capital of communities.

**Keywords:** Smallholders; Resilience; Vulnerability; Ecosystem services; Indonesia

## 1. Introduction

Smallholder farmers in tropical countries are vulnerable to biophysical and socioeconomic shocks that intensely affect their livelihoods (Harvey et al. 2014; IFAD 2009), exacerbated by their lack of capacity to adapt to changes and inadequate access to the livelihood capital (natural, physical, financial, social, and human) needed to improve their resilience (Van Noordwijk et al. 2011). The inadequate capacity and insufficient access to capital of smallholders can be ameliorated by applying sustainable agriculture pathways. One option is management of multifunctional tree-based agriculture that both intensifies production and maintains the capacity of the agricultural landscape to provide ecosystem services (Jamnadass et al. 2011; Verchot et al. 2007).

Studies show that landscape diagnostics with a multi-disciplinary approach are crucial in the initial decision-making phase of natural resource management. Correspondingly, this study under the "Climate-smart, Tree-based, Co-investment in Adaptation and Mitigation in Asia" (Smart Tree-Invest) project of the World Agroforestry Centre applied participatory and scientific research to clarify livelihood vulnerability on various scales and develop appropriate action plans. The goals of the action research study were to strengthen the resilience of smallholders, address environmental issues, and improve the provision of ecosystem services in the socio-ecological landscapes of Buol, Indonesia. The project sites, located in upland and coastal landscapes, represent forest frontier areas that face the threat of conversion to monoculture cropping and plantations.

This article consists of three main parts; the first part describes the context wherein environmental and livelihood issues in the area were explored using a vulnerability assessment framework. The second part presents the activities carried out towards enhancing livelihoods and improving the environment in the degraded landscapes of Buol. The third part elaborates on the initial impacts of activities, assessed from the perspective of the five types of livelihood capital.

## 2. Methods and approach

### 2.1. The Smart Tree-Invest project

The Smart Tree-Invest project was coordinated by the World Agroforestry Centre (ICRAF) from 2014 to March 2017. The project aimed to develop co-investment schemes through tree-based agriculture to improve the resilience of smallholders and the provision of ecosystem services.

Trees can provide livelihood benefits for smallholders that can help them to adapt to the changing climate and the socioeconomic and political situations that influence their resilience. Trees also provide ecosystem services, such as water regulation, disaster prevention, and carbon stocks, which benefit external actors. The term co-investment in landscape stewardship (CIS) evolved from the concept of payment for ecosystem services (PES). Instead of focusing on a market-based principle (ES buyer-seller) like in PES, CIS emphasizes co-management principles whereby all actors contribute and co-invest in the provision of ecosystem services (Leimona et al. 2015). The co-investment scheme is designed to link the

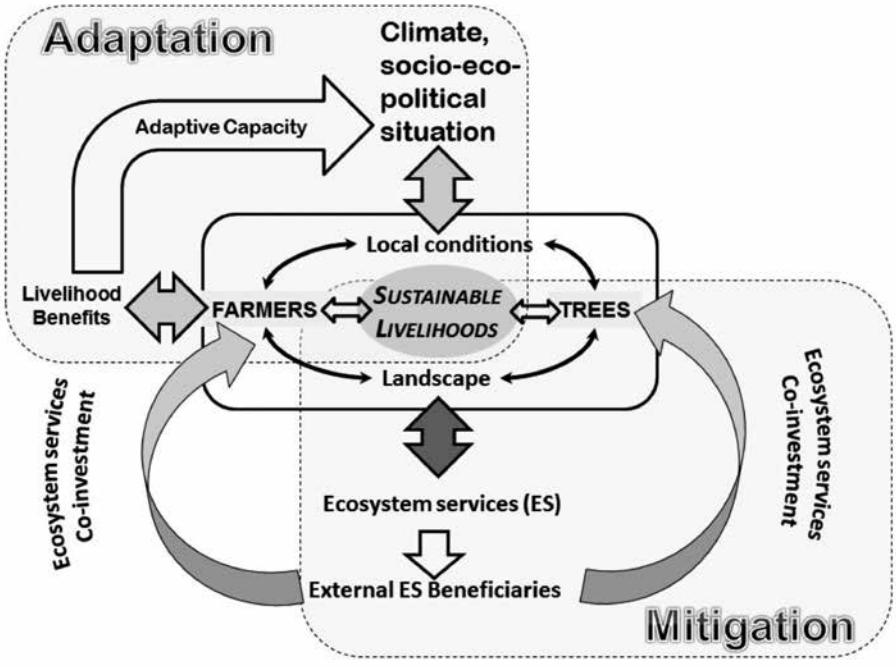


Figure 1. Link between adaptation and mitigation with farmers' resilience and ecosystem services

positive environmental impacts from smallholders' tree-based agricultural activities to rewards and incentives from external ecosystem services beneficiaries to create sustainable livelihoods (Figure 1).

During the initial stages, a scoping phase was carried out to comprehend the context of the landscape, particularly issues of vulnerability, and to identify potential actions to improve smallholder resiliency. Subsequently, pilot activities for the co-investment scheme were initiated, and best practices generated from the interventions were shared with policy-makers. Smart Tree-Invest applied a landscape approach, in which the project sites were perceived as clusters or landscapes that share similar socio-ecological traits, such as biophysical (i.e. farming systems, land cover, tree diversity) and socioeconomic (e.g. wealth status, ethnicity) characteristics.

### 2.2. Vulnerability assessment approach

For the landscape diagnostic, the project applied the Capacity Strengthening Approach to Vulnerability Assessment (CaSAVA, see Figure 2) framework that integrates biophysical and socioeconomic quantitative research with a participatory approach (Dewi et al. 2013). The diagnostic study consisted of a series of analyses on land use and land cover change, the quantification of ecosystem services (such as tree diversity and carbon stocks)[i], and assessment of smallholder vulnerability related to socioeconomic characteristics, using both Shock, Exposure, Response, and Impact (SERI) analysis, and Strength, Weakness, Opportunity, and Threat (SWOT) analysis.

The vulnerability assessment was carried out through a series of household surveys and group discussions with smallholders in the project site (Amaruzaman and Lusiana 2017). Group discussions were focused on SERI analysis of four aspects: land use, water resources, farming systems and biodiversity. Likewise, SWOT analysis focused on five types of livelihood capital. Impacts were mainly assessed through discussions and observations with stakeholders in the project site.

## 3. Livelihood and environmental context

### 3.1. Study site

The Buol District lies in the northern part of Sulawesi Island, on the border of Central Sulawesi Province. With a total area of 4,040 km$^2$, Buol is one of the poorest districts in the province. Due to its remote location and limited transportation options, Buol has low access to markets. Its landscape consists of upland forest in the south, agroforest and oil palm plantations in the centre, and cropland and settlements in the northern lowlands. A mangrove ecosystem lies in the northern areas along the coastline. The study site was divided into three landscape clusters: (1) upstream watershed (2) midstream watershed, and (3) coastal landscapes (Figure 3).

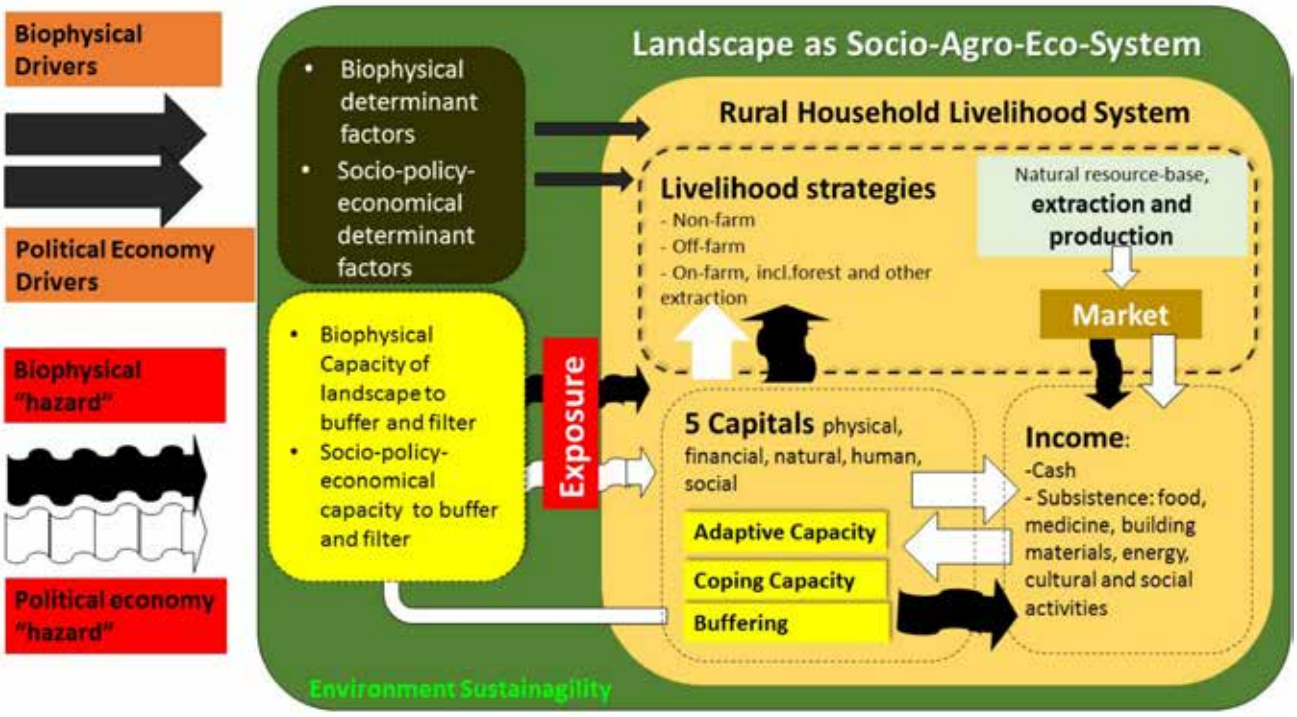


Figure 2. Capacity Strengthening Approach to Vulnerability Assessment (CaSAVA) framework (Dewi et al 2013)

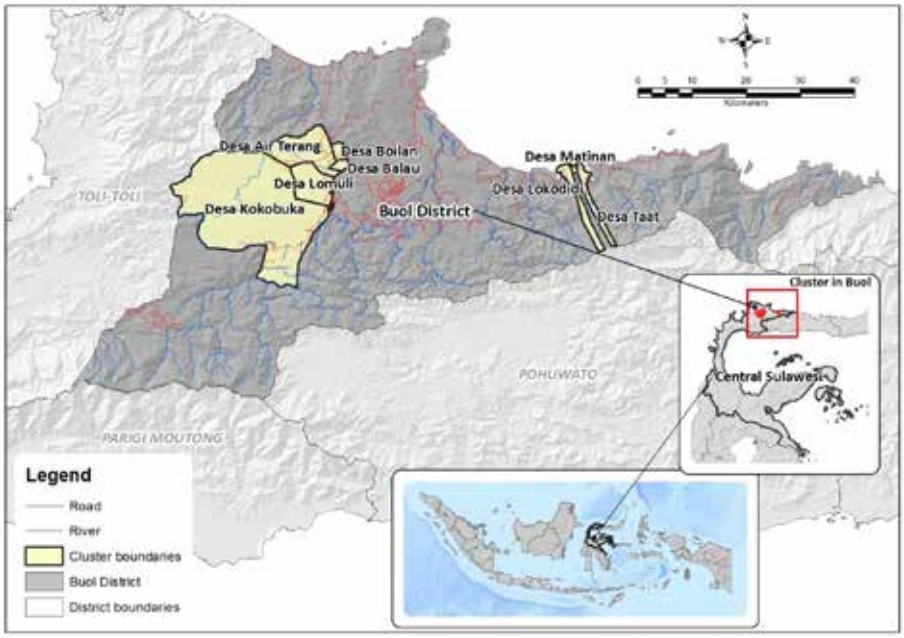


Figure 3. Location of Buol District and Smart Tree-Invest cluster sites

Agriculture is the main livelihood, with cacao, coconut, cloves, coffee, rice and seasonal crops as the main commodities. The majority of households have multiple livelihood options to complement their farming activities, such as working on the plantation, or in mining, coastal fisheries and government offices.

### 3.2. Land use and land cover change in Buol

Spatial analysis for the period of 1996 to 2014 showed that forest, comprised of both protected and degraded forests, was the most dominant land cover type in Buol, followed by various mixed systems (agroforestry[ii]) of cacao, coconut, fruit trees, and rice fields (Figure 4b). The major change during this time period was from forest to agroforest, and from forest and agroforest to oil palm plantation (8% and 6% of total district area, respectively), indicating the increasing pressure on forest and tree-based agriculture to shift towards monoculture systems (Tanika et al. 2015).

### 3.3. Socio-ecological and livelihood characteristics

The upstream cluster is on the boundary with the oil palm plantation and protected forest, thus many farmers do

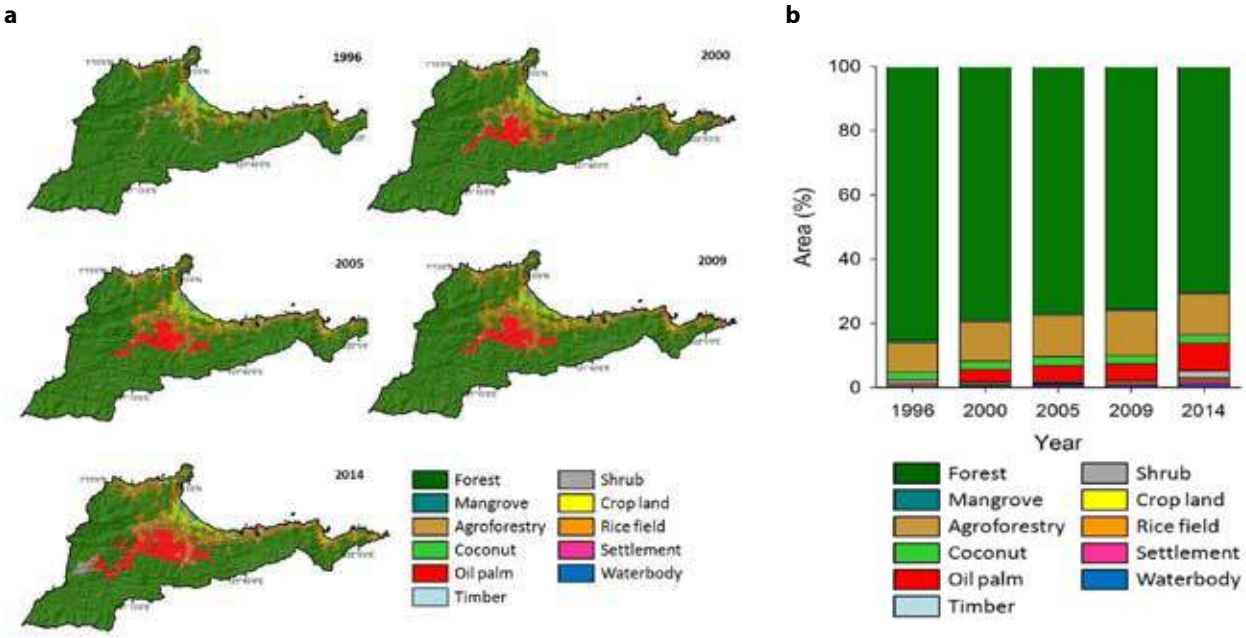


Figure 4. Land use and land cover a) map and b) area in Buol, 1996-2014

labour on the plantation. The majority of upland residents cultivate rice and annual crops, with better results in the midstream cluster due to the availability of technical irrigation. Most coastal farmers cultivate tree crops while enjoying more varied livelihood options compared to the two upland clusters, such as fisheries and mining (Table 1).

Rice and annual crops are more dominant in the upstream and midstream clusters, while tree crops (clove, cacao, and coconut) are the major farming commodity in the coastal cluster (Figure 5). The average annual income in three clusters ranges from 3,350 to 4,530 USD. The average per capita daily income in each cluster is slightly above the global poverty standard of USD 1.9 per day[iii] (Table 2). Farming sectors contributed to more than 50% of household income (Figure 5) with substantial contribution from non-farm activities such as plantation labour, mining, small businesses, and government office employment.

Table 1. Socio-ecological characteristics of the Smart Tree-Invest cluster sites

| Cluster | Upstream | Midstream | Coastal |
|---|---|---|---|
| Village(s) | • Kokobuka,<br>• Lomuli | • Boilan,<br>• Air Terang,<br>• Balau | • Taat,<br>• Lokodidi,<br>• Matinan |
| Origin of residents | Trans-migrants from Java, Bali and Lombok | Mixed between trans-migrants from Java, Bali and local Buol natives | Buol natives, migrants from nearby areas such as Gorontalo and South Sulawesi |
| Agricultural systems | Oil palm plantation, cacao, coconut, annual crops (rain-fed rice, maize, vegetables, tubers), mixed systems | Annual crops (irrigated rice, maize, vegetables, tubers), cacao, fruit-trees | Cacao, clove, nutmeg, rain-fed rice, fruit trees (mixed system) |
| Environmental issues | Lack of water for agriculture; erosion in newly-opened oil palm plantation areas | Frequent flooding, river bank collapse | Coastal vegetation degradation; coastal abrasion; increased sea-water height |
| Accessibility and infrastructure | Difficult access to the main town; Limited electricity and communications; No irrigation for agriculture | Moderate access to the main town; Moderate electricity and communications infrastructure; Technical irrigation for agriculture | Good access to district's main town;<br>Good electricity and communications infrastructure |
| Livelihood options | • Rain-fed rice and other crop-based agriculture<br>• Tree-based agriculture<br>• Labour on oil palm plantation | • Irrigated rice and other crop-based agriculture<br>• Tree-based agriculture | • Tree-based agriculture<br>• Coastal fisheries<br>• Community mining<br>• Rice and other crop-based agriculture |

(Source: Compiled from Household Survey 2014 (unpublished) and observations)

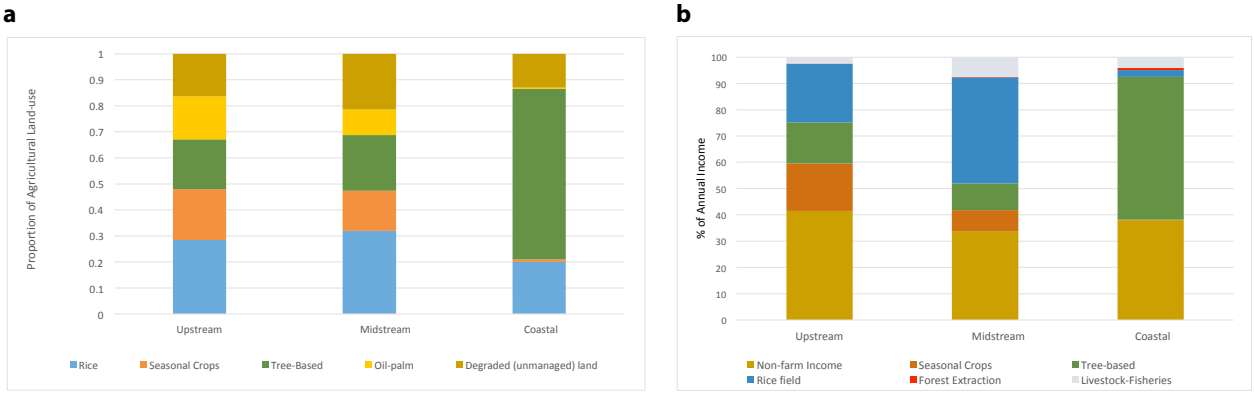


Figure 5. Proportion of a) household agricultural land use and b) household annual income sources in the clusters

Table 2. Annual household income for clusters (Source: Household Survey, 2014)

| Cluster | Avg no. of household members | Household annual income (USD) | | | Avg daily per capita income (USD) |
|---|---|---|---|---|---|
| | | Min | Max | Avg | |
| Upstream | 4 | 270 | 12,850 | 4,530 | 3.1 |
| Midstream | 4 | 330 | 18,930 | 3,350 | 2.3 |
| Coastal | 5 | 730 | 10,600 | 3,630 | 2 |

*1USD=IDR13,000

Table 3. Shock, exposure, response and impact analysis (Source: Modified from Lusiana et al, 2015)

| Shocks | Exposure in clusters | | | Impacts | Perceived potential buffer (Responses) |
|---|---|---|---|---|---|
| | Upstream | Midstream | Coastal | | |
| Flood | High | High | None | Crop failure; economic loss; infrastructure loss | Better flood infrastructure through construction of embankments and river straightening |
| Agricultural pests and disease | Low | Low | High | Reduction of yield; crop failure; loss of income | Knowledge on farm management; improved rural-advisory |
| Drought | High | None | None | Reduction of yield; crop failure | Alternative livelihood options; irrigation infrastructure; aid from the government |
| Increasing food prices | Moderate | Moderate | Moderate | Increased expenses; reduction of food | Food diversity and increased productivity; higher and stable income |
| Scarcity of fertilizer | Low | High | High | Reduction of yield and income | Membership in a farmer group; reduce dependency on chemical fertilizer |
| Decreasing agricultural product prices | High | None | None | Loss of income | Better knowledge to add value to the products; improve market access |


Figure 6. Perception of SWOT in the a) upstream, b) midstream, and c) coastal clusters (green=natural capital, blue=physical capital, red=financial capital, orange= social capital, purple=human capital)

## 3.4. Vulnerability analysis

### 3.4.1. Shock, exposure, response, and impact analysis

Floods, agricultural pests and disease, and drought are the main biophysical shocks experienced by smallholders, associated with land use changes in the landscapes. Socioeconomic shocks that impact farmers' livelihoods consist of increasing food prices, scarcity of fertilizers, and fluctuation of agricultural product prices. The majority of farmers are aware of ideal responses that can buffer the shocks. However, not many are able to perform these responses due to lack of knowledge and funds.

### 3.4.2. SWOT analysis

Knowledge on the types of livelihood capital that communities, including the village government, considered to be their strengths, weaknesses, threats and opportunities was helpful in better shaping the recommended co-investment activities to enhance the communities' livelihoods and address their vulnerability. The SWOT analysis shows that all clusters perceived natural capital as their dominant strength and opportunity. Infrastructure, human, and financial capital dominated areas of weakness and threats (Figure 6).

## 3.5. Co-investment schemes for livelihood and environment

The scoping phase identified several prerequisite interventions at the community, landscape, and district levels that were required for developing the co-investment schemes to improve the livelihoods of smallholders and ecosystem services in Buol.

SERI and SWOT analysis indicated that smallholders in Buol are vulnerable to biophysical shocks such as flood and drought. Limited financial capital, as reflected in household income, forced smallholders to apply short-term strategies in managing their farms, such as changing farm commodities or doing non-farming casual work. Lack of knowledge to cope with the shocks made them perceive infrastructure as the main solution to their environmental

Table 4. Recommended interventions at various scales

| No | Recommendation | Pilot activities | Level of intervention |
|---|---|---|---|
| 1 | Improve farmers' capacity to manage their existing tree-based farming | Capacity building for farmers through tree farm management learning groups | Smallholders (village) |
| 2 | Improve the capacity of communities in monitoring the landscape (landscape functions and services) | - Participatory watershed monitoring<br>- Capacity building on ecosystem services monitoring | Smallholders (watershed landscape) |
| 3 | Improve the capacity of the local government to act as an intermediary in developing co-investment schemes, including the capacity to design new co-investment programmes, recognize opportunities to link between conservation and development efforts, continuously facilitate monitoring of the landscape's ecosystem services by smallholders | - Capacity building on designing and implementing ecosystem services monitoring system.<br>- Capacity building on concepts of mitigation and adaptation, ecosystem service co-investment from agricultural perspectives,<br>- Innovative mind-set and skills to design green agriculture programme. | Local government (village, sub-district, district) |

problems. SWOT analysis revealed that the smallholders have only limited capacity in agricultural management, particularly in tree-based agriculture systems. However, the potential to develop tree-based agriculture in these clusters existed. This situation reflects the need for capacity building in tree-based agriculture for smallholders as a long-term strategy to improve their income and maintain the quality of their environment.

At the watershed level, reliable data to support the clarification of environmental problems were not available. The analysis also indicated the lack of capacity of the district government and local community to monitor and manage their landscapes. This situation also calls for capacity building and awareness raising on the monitoring of ecosystem services to enable stakeholders to acquire reliable data to sustainably manage the landscape.

At the district level, a multi-sectoral approach was required to facilitate the co-investment schemes. A coordinating body at the district level was expected to change the sector-focused action mind-set of government officers and improve cross-sectoral coordination. A series of capacity building activities was required to improve the knowledge and skills of local officers to enable them to support the co-investment schemes. Table 4 summarizes the recommendations for pilot activities in the co-investment scheme in Buol.

The scoping phase identified an absence of direct beneficiaries in the private sector in Buol that were capable of providing financial incentives for the smallholders; thus, the co-investment scheme required co-investors from the domain of public development. Within the remaining period of the project, the Smart Tree-Invest team mainly provided enabling activities to prepare the stakeholders for development of their co-investment schemes (Lusiana et al. 2015). Activities consisted of capacity building and awareness raising to improve livelihoods and ecosystem services management on the part of smallholders at the community, landscape, and district levels.

## 4. Improving smallholder livelihoods and ecosystem services

### 4.1. Activities at the smallholder and landscape scales

- **Tree farm management learning groups**

The project established learning groups in eight village sites[iv], aimed at improving the capacity of local smallholders and empowering them in tree farm management. Through the learning groups, the members were trained to improve land productivity with better farming techniques, and to produce their own tree seedlings, organic fertilizers, and organic pesticides.

The learning groups were designed to be participative and self-reliant. Membership is voluntary, and the pace of learning depended on the active participation of members. Group members selected their preferred commodities and contributed financially and socially—or co-invested—by providing their time and labour to construct learning plots and nurseries. Group members contributed materials and tools for group activities, and the project also contributed materials that are difficult for farmers to provide (i.e. nursery nets, germplasm).

- **Participatory watershed monitoring**

The project initiated participatory watershed monitoring that consisted of measurement of rainfall, water discharge and water turbidity by the local community. The participatory hydrological monitoring aimed to generate hydrological data for watershed assessment, increase community awareness on their watershed landscape, and increase the capacity of local communities to monitor their landscapes (Tanika and Lusiana 2016).


Figure 7. a) Commodity selection process, b) members of a learning group constructing their own nursery


Figure 8. a) Rainfall measurement, b) turbidity measurement, c) water height measurement

### 4.2. Activities at the district scale

- **Establishment of district multi-sectoral coordinating body**

Smart Tree-Invest facilitated the establishment of a cross-sectoral coordinating body called the Watershed Working Group in Buol District[v]. The Working Group consists of representatives from the district's Planning Agency, Agricultural Office, Environmental Office, Village Empowerment Office, Forest Office, and Public Works Office. The establishment of the Working Group aimed to improve cross-sectoral coordination in watershed management and support the facilitation of co-investment in ecosystem services in Buol.

- **Training on ecosystem services and tree farm management**

Capacity building for government officers[vi] was focused on two main aspects: ecosystem services enhancement and tree farm management, targeting the Watershed Working Group and rural advisory (extension) officers respectively. Representatives from the oil palm plantation also joined these trainings.

## 5. Impacts of co-investment schemes on livelihoods

### 5.1. Human capital

The learning groups have empowered smallholders to be less dependent on support from the district government in managing their tree-based agricultural activities. Post-project interviews revealed that the majority of group members have applied tree nursery development and management techniques acquired in the learning groups on their own lands. Currently, the smallholders do not have to wait for seedlings or fertilizer support from the government. Acquired knowledge in producing organic fertilizer has encouraged learning group members to cage their livestock for fertilizer material, which has gradually changed the behaviours of villagers in the project sites that used to let their livestock roam free on public roads and agricultural land.

The participatory watershed monitoring only involved a limited number of villagers in conducting the monitoring. However, the initial results were conferred to a wider range of village communities through a role-playing game (Tanika et al. 2016). After the game was played, changes in watershed conditions were discussed and participants from the villages were asked to reflect on their experiences in the game and their daily activities. Thus, the participants were able to identify more risk and exposure to hydrological issues, and have wider mitigation options and coping strategies.

The trainings on ecosystem services have improved the understanding of government officers on the concept of ecosystem services derived from a production landscape, how to monitor the ecosystem services from the landscape, and methods for facilitating smallholder learning groups. The Watershed Working Group provided the arena for local policy-makers to improve multi-sectoral development coordination, engage in better-informed planning, and increase the synergy between economic development and environmental conservation in the district. Realizing the potential of the Smart Tree-Invest approach, the Working Group not only endorsed its replication within the district government, but also facilitated meetings with the private sector, such as the oil palm plantation, to replicate the project approach.

After joining in trainings on ecosystem services, representative of the oil palm company realized that they also can contribute to environmental conservation. Even though the oil palm company is not the direct beneficiary of the watershed services, representatives were willing to carry out environmental monitoring in their plantation area within the watershed. Facilitated by the Watershed Working Group, in March 2017, the company replicated hydrological and tree-growth monitoring as a part of the company's CSR.

The plantation will carry out the monitoring and periodically share the data with the Watershed Working Group. This initiative can be considered to be an initial co-investment from the company in environmental stewardship.

### 5.2. Natural capital

At the end of project, learning group members voluntarily planted approximately 4,500 cacao, durian and nutmeg tree seedlings on their private and degraded lands. Replication by the district government is expected to engage more stakeholders in tree-based farming and planting of more trees. Tree-planting will improve ecosystem services, such as carbon sequestration and watershed health, through the expansion of tree-based agricultural lands in the district. Watershed monitoring replication by the district government has gradually improved multi-sectoral development planning in the district. Better informed and integrated planning is expected to improve environmental conditions in the district, particularly on the watershed scale.

### 5.3. Financial capital

The results of tree farm learning groups could potentially increase smallholder income through better productivity based on improved tree farming management. Moreover, new skills in seedling and organic fertilizer production have brought additional income opportunities for learning group members. The learning groups from five villages were already requested by their neighbours to sell the seedlings and fertilizers they produced. In the project closing workshop held in April 2017, Buol District's Chief of Agricultural Office stated that he will allocate district funds in 2018 for buying seedlings from the learning group members if they can provide the required seedling quality. In the upland clusters, we observed an increase in the price of degraded lands (sale and rent), due to increasing demand to plant trees on the degraded lands from the learning group members.

Further impacts on financial capital are related to the public development fund. In 2017, the Buol government allocated 38,400 USD from the District Development Budget to replicate several Smart Tree-Invest activities (Table 5). Further, three village governments in the project sites stated that they have allocated village funds[vii] for agricultural activities, based on the knowledge acquired from the learning groups. These replications using public development funds indicate the awareness and willingness of the local government to co-invest in environmental stewardship.

Another potential impact that could enhance the livelihoods of smallholders is the provision of link between the commodities cultivated by the smallholders with the market, which would improve the benefits and sustainability of the smallholders' farming practices. Due to time limitation, this activity was not implemented during the project period.

### 5.4. Physical capital

The participatory watershed monitoring brought opportunities for smallholders and district officers to improve their understanding of the landscape. A better understanding of the landscape will enable stakeholders to make decisions on land-based solutions, such as tree planting, as a way to cope with environmental issues. Furthermore, their dependency on infrastructure construction to solve environmental issues will be reduced. However, consistency in conducting watershed monitoring is required from the stakeholders to generate reliable data for well-informed decision-making.

### 5.5. Social capital

The learning groups required smallholders to work together. At the end of project, four learning groups stated that they will continue to collaborate and work together as a group, indicating the growing bonds between the members. In applying the project approach, both for the learning groups and watershed monitoring, district officers must go to the field and interact with communities. This intensified interaction will potentially increase trust and collaboration between the government and the communities.

Table 5. Replication activities budget from the Buol District development fund in 2017

| No | Replication activities | Managing district office | Allocated budget (USD*) |
|---|---|---|---|
| 1 | Tree management learning group | Agricultural office | 6,800 |
| 2 | Participatory watershed monitoring | Environmental office | 12,300 |
| 3 | Tree diversity and growth monitoring | | |
| 4 | Coordination and supervision | Planning office | 19,200 |
| Total | | | 38,400 |

*1USD=IDR13,000

## 6. Conclusion

This study has presented the experience of the Smart Tree-Invest action research project on improving smallholder resilience and ecosystem services provision through co-investment schemes. Results show that a landscape diagnostic with a multi-disciplinary approach is a crucial phase in natural resource management. A comprehensive understanding of the vulnerability context in Buol, Indonesia, was built through the application of the CaSAVA research framework that combines scientific research (i.e. spatial analysis and assessment of ecosystem services) with a participatory approach to examine the local knowledge.

Building upon diagnostic results, specific on-the-ground interventions were designed to strengthen various types of livelihood capital to help improve the resilience of smallholders and ecosystem services in the landscapes. Tree farm management and watershed monitoring curricula were developed for the smallholders in the coastal and watershed clusters to improve their capacity in managing tree farms and watershed landscapes. At the district level, the project facilitated capacity building and advocacy targeted at local development actors, such as representatives of the local government and private sector. These activities further promoted the application of co-investment principles between public-private sectors with the smallholders to maintain and enhance ecosystem services.

Observations at the end of project revealed that initial improvements in the five types of livelihood capital have taken place. Replication and upscaling of the pilot funded by the district's budget at the end of the pilot project represent the key successes of the project and indicate raised awareness, ownership and trust, proving that this type of action research can improve the livelihood capital of communities.

## Acknowledgement

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i For the results, please see Rahayu et al. 2015 and Wijaya et al. 2015.

ii In Indonesia, it is common to find smallholders growing commodity tree crops in a mixed system called agroforestry. Agroforestry combines perennial cash crops with timber, fruit, food crops, building and handicraft material and medicinal plants, and has socio-cultural value for the local community (Joshi et al. 2002).

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iv See Hendrawan, DC 2016, 'Growing Hope with Trees' for further information about the learning groups.

v See Amaruzaman, S 2015, 'Stronger collaboration for co-investment in ecosystem services', for further information about the District Watershed Working Group.

vi See Tanika, L 2016, 'Training of trainers in monitoring and evaluating tree-growth and watershed functions in Buol, Indonesia', for further information about the training.

vii The Act No.6/2014 has given more authority to village governments, including management of village development funds. To appropriately utilize the funds, village governments' capacity in development planning needs to be improved, including in environmental conservation and local agricultural development.

Chapter 6

# Resin trees: A vital source of the Phnong people's livelihood in transition in Cambodia

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## Abstract

In the hilly landscape of Mondulkiri province in northeast Cambodia, the Phnong ethnic group accounts for up to 80% of the total population. The Phnongs depend on self-sufficient agriculture for their livelihoods. Their main product is upland rice for household consumption. However, they often suffer from shortages in its production. Thus, tree resin is very important to them as a major source of acquiring cash, especially during times of rice shortage. Holding rights over resin trees are transferred through generations, based on their system of customary tenure. Resin extracted from Dipterocarp trees (*Dipterocarpus* sp.) is collected and sold to middlemen for manufacturing paint, making boat sealant, making torches or varnish. However, expansion of economic land concession (ELC) for rubber and other agricultural crops in the province, along with illegal logging, have become threats to the Phnong's resin trees.

To understand the causes and effects of the decrease in resin trees upon the Phnong's livelihoods and ways in which they cope with this challenge, on-site observations, semi-structured interviews and focus group interviews were conducted with resin tappers, resin traders and community leaders in two villages in Mondulkiri between November 2014 and August 2016.

Results showed that the average number of resin trees per household varied from 30 to 250 trees. The number of resin trees owned was proportional to the amount of income generated from resin, varying largely from USD 125 to USD 1,620 annually. The main threats to resin trees were found to be the overlap of lands containing stands of resin trees with ELCs and illegal logging. As a result, some households that lost resin trees reported income decreases ranging from 20 to 60 percent compared to times before such threats arose. The solutions that have been recently attempted in tackling the challenges include expansion of farmland, finding labour work, bringing cases to authorities, and increasing the frequency of forest patrols. Some villagers even became illegal loggers themselves. Sustainable solutions proposed to support villagers in coping with these challenges include gaining legitimate rights and ownership over resin trees, building the capacity of community forestry members, involving stands of resin trees in REDD+ or carbon mitigation programmes and increasing agricultural productivity to enhance food security.

**Keywords:** Phnong; Resin trees; Economic land concession; Illegal logging; Livelihoods

## 1. Introduction

Mondulkiri province, located in the northeast of Cambodia, is 375 kilometres from Phnom Penh. The geographical character of the province is undulating uplands, mostly covered by forests with some lowland valleys. In the hilly landscape of the province, the Phnong ethnic people account for up to 80 percent of the total population. In 2009, the forest areas of the province covered 1,311,589 hectares, while cultivated land areas covered 117,211 hectares. Although rich in biodiversity, the province remains one of the poorest in the country (CDHS 2006). The government has taken steps to protect the valuable forests of Mondulkiri since the 1990s to conserve biodiversity. Forests in Mondulkiri comprise of a range of different forest types: deciduous dipterocarp forest, semi evergreen forest and bamboo forest (WWF-Cambodia 2016). These forests provide habitats for fauna and flora, together with economic benefits and ecosystem services such as habitat provision, carbon storage, pollution reduction and provision of non-timber forest products (NTFPs) (Watkins et al. 2016). Mondulkiri forests are not only a home for endangered and critically endangered and iconic megafauna such as the Asian elephant (*Elephas maximus*), tiger (*Panthera tigris*), leopard (*Panthera pardus*), Eld's deer (*Rucervus eldii*), Dhole (*Cuon alpinus*), and Siamese crocodile (*Crocodylus siamensis*), they also play a vital role as a safety net for the Phnong, who heavily depend on non-timber forest products for their livelihoods. However, despite their protected status and their importance for biodiversity in Cambodia, the forests of Mondulkiri have experienced massive losses due to logging, cash crop farming, agro-industrial plantations, and high immigration into the area, all of which have generated large-scale land clearing leading to deforestation (Kamnap & Sambat 2009).

The population of Mondulkiri is 56,443 people of 12,149 households (NCCD 2008), with 83 percent engaged in agricultural activities, mainly rice production. The Phnong depend on self-sufficient agriculture for their livelihoods. The main product is upland rice for household consumption. However, the Phnong often suffer from shortages in production due to low inputs and lack of irrigation systems. Thus, non-timber forest products, especially resin, are very important to them as a main source of cash during periods of rice shortage (Evan et al. 2003; Luu & Pinto 2007; Baird 2009; Tola 2009).

Besides providing the resin that supports the locals' livelihoods, the Dipterocarp tree contributes to ecosystem services in several ways. For example, its cauliflower-shaped crown lowers wind speed, its flowers produce nectar which is the food of pollinators, and its seeds are food for rodents and other terrestrial animals (Corlett & Primack 2005). Likewise, ectomycorrhizas association of the Dipterocarp not only increase the absorptive efficiency of the roots of the host plant but also increase soil nutrients that benefit the understory of the resin tree stands (Lee 1998) (Figure 1).

Figure 1. Farmland associated with resin trees (the trees at the right with high canopy)
(Photo: Institute of Environmental Rehabilitation and Conservation)

Figure 2. Left: Liquid resin from Dipterocarpus alatus; Right: Solid resin from dipterocarp trees (Photo: Institute of Environmental Rehabilitation and Conservation)

Traditional resin tapping practices are harmless for the forest as the resin tapper avoids causing fire during tapping activities, and tapping is conducted only for certain species (Luu & Pinto 2007). A resin tapper chops a tree's trunk making a backwards-sloping hole from 0.4 to 1.0 meter above the ground. Seven to ten days later, for the first time the tapper comes to harvest the oleoresin exudated from the woody vascular and stored in the hole. Then, the oleoresin remaining in the hole is used as fuel to burn the surface of the hole for two to three minutes to stimulate the exudation of oleoresin (Figure 2; Left). Tappers make sure to remove dried leaves, twigs and other ignitable debris found under or within close proximity of the trees to avoid causing forest fires. With proper care, this traditional practice is regarded as harmless to resin trees (Luu & Pinto 2007). The average annual production of oleoresin per tapped tree ranges from 23 to 31 litres depending on the size of resin trees (Samiano et al. 2014). Resins extracted from Dipterocarp trees (*Dipterocarpus* sp. or *Shorea* sp.) are collected and sold to middlemen for manufacturing paint or boat sealant, or making torches or varnish. Resins are classified as non-timber forest products class VI[i] (RGC 2005). According to Luu and Pinto (2007) resin from Dipterocarp trees can be divided into two groups: oleoresin (liquid resin or wood oil) and solid resin (Figure 2; Right).

The first person to find and mark a resin tree is considered by village custom to be the owner of that tree. The holding rights of resin trees transfer through generations based on the Phnong's customary tenure. For example, a father can give resin trees to children when they marry or when the father gets too old and faces difficulty in tapping resin. In cases where the father is too old to tap resin, the share of income from resin trees between children and father depends upon their agreement. Village members recognize resin trees as private property, which makes it possible to transfer ownership through sale, inheritance, and donation, or to sell the right to tap trees for specific periods of time (Evan et al. 2003; Tola 2009). Thus, resin trees are a vital source of livelihoods. However, the expansion of economic land concession (ELC) for rubber and other agricultural crops in the province, along with illegal logging, has threatened the resin trees and has tended to have adverse effects on the Phnong's livelihoods.

Economic land concession (ELC) is a system whereby beneficiaries are permitted to lease up to 10,000 hectares of state-owned land for industrial agricultural use for a maximum of 99 years. According to the Law on Economic Land Concessions, which regulates ELCs, all ELCs must meet certain criteria before being granted. These include the completion of environmental and social impact assessments, the provision of solutions for resettlement, and public consultations with stakeholders, including the affected communities. In practice, however, ELCs have been granted without the fulfilment of such criteria (Special Representative of the Secretary-General for Human Rights in Cambodia 2007). According to the Cambodian Center for Human Rights (2016) and Save Cambodia's Wildlife (2016), ELCs have little or no positive impacts on socio-cultural life, local livelihoods and economy, as perceived by villagers. Moreover, ELCs have severely impacted citizens' land rights in Cambodia, as in many cases ELC areas overlap with villagers' farmlands and stands of resin trees.

The objectives of this study were to understand the causes of the decrease in resin trees, the effects upon the Phnong's livelihoods and the ways in which they cope with the challenges. Moreover, the findings from this study are expected to serve as a solution and to support the communities in coping with the challenges they are facing.

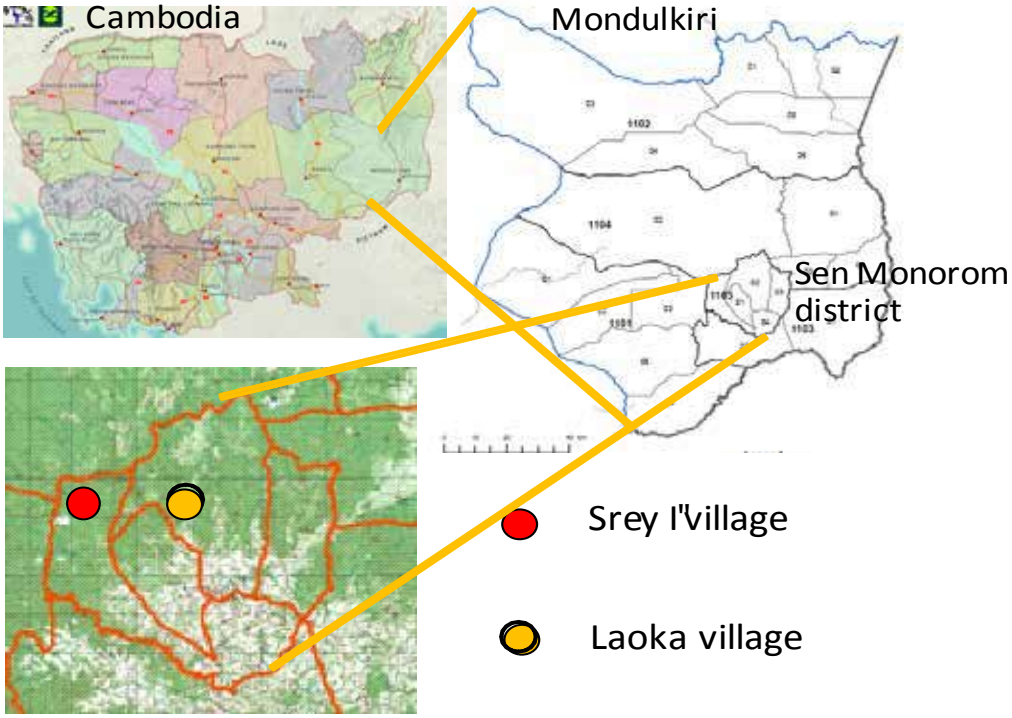


Figure 3. Location of the studied villages (Sources: Statistic Bureau 2009 and Cambodia Open Development 2014)

## 2. Methodology

### 2.1. Study area

The studied villages, Laoka and Srey I, are located 6 and 22 kilometres respectively from Sen Monorom, the provincial town of Mondulkiri (Figure 3). Both villages are located nearby the Phnom Prich Wildlife Sanctuary. In term of households and population, Laoka village consists of 273 households with 1,280 people, while Srey I village consists of 133 households with 570 people (Ministry of Planning 2014). The main occupation of villagers in both villages is agriculture, and their main products include rice (upland rice for Laoka village and paddy rice for Srey I village), cassava and vegetables.

### 2.2. Data collection

After consulting governmental and non-governmental organizations working on forest management and livelihoods in Mondulkiri, several villages were proposed to be studied. However, considering accessibility and time limitations on field trips, Srey I and Laoka villages were selected as the most accessible villages that produce a constant amount of resin for the market. Aside from practical reasons for conducting research, both villages are known as big producers of liquid resin in the Sen Monorom district. Semi-structured interviews and focus group interviews with resin tappers, resin traders and community leaders (including leading persons in community forestry), as well as on-site observations were conducted twice for each group in these two villages between November 2014 to August 2016 (Figure 4).

In order to understand the importance of resin trees for villagers' livelihoods, questions were prepared for each interview group. Questions for resin tappers included those on the number of resin trees per household, rights over resin trees, distance from village to resin tree stands, average amount of resin collected annually (Figure 5; Left), and average annual income from resin, as well as questions on perceived threats to resin trees and ways of coping with threats. Questions for resin traders included those on the amount of resin (liquid and hard resin) purchased and sold annually, price, customers and utilization of

Figure 4. Site observation with resin tappers (Photo: Institute of Environmental Rehabilitation and Conservation)

Table 1. Number of participants in each interviewed group

| Village | Group | Number of participants |
|---|---|---|
| Laoka village | Resin tappers | 23 |
| | Resin traders | 7 |
| | Community leaders | 6 |
| Srey I village | Resin tappers | 14 |
| | Resin traders | 4 |
| | Community leaders | 4 |

Figure 5. Left: Stockpile of liquid resin; Right: Middleman shop for buying resin (Photo: Institute of Environmental Rehabilitation and Conservation)

resin (Figure 5; Right). Questions for community leaders included general information on villages, forest resource utilization and management in the village. For cross-checking information, questions on perceived threats to resin trees and ways villagers cope with threats were asked to community leaders as well.

## 3. Results and discussion

The average annual income from agriculture of villagers in Laoka was 400 to 600 USD per household, and the average annual income from non-agricultural activities (hired labor, resin collection, collection of wild honey or other NTFPs) ranged from 600 to 1,000 USD per household. Meanwhile, in Srey I village, the average annual income from agriculture of villagers was 600 to 700 USD per household, and the average annual income from non-agricultural activities was around 1,000 to 1,200 USD per household.

Regarding the number of resin trees owned per family, in Laoka village, villagers reported that around 120 families in the village own resin trees. The number of resin trees own by each family varied from 30 to 250 trees. The reason for the difference in number was explained by villagers—the first person to spot a non-tapped resin tree and start to collect resin from the tree retains rights over it according to village custom. This custom is similar to the studies of Evan et al. (2003) and Cheetham (2014) that examined the rights over and ownership of resin trees in the Seima Protection Forest. Families that have lived in the village longer than others tend to own more resin trees than the ones that moved into the village later. The same reasons were also given by villagers in Srey I village, where the number of families owning resin trees was around 60, and the number of resin trees owned by each family varied from 30 to 150 trees.

The variation in number of resin trees owned by families was proportional to the amount of income generated from resin,

Table 2. Annual income and number of resin trees owned by villagers in studied villages (Source: Focus group interviews)

| Village | Average annual income | | Number of families owning resin trees (families) | Number of resin trees owned by each family (trees) |
|---|---|---|---|---|
| | From agricultural activities (USD) | From non-agricultural activities (USD) | | |
| Laoka | 400-600 | 600-1,000 | 120 | 30-250 |
| Srey I | 600-700 | 1,000-1,200 | 60 | 30-150 |

which varied greatly from USD 125 to 1,620 per year. Income was calculated from the amount of resin collected and sold for one year.

According to information gained in interviews, liquid resin is the most important source of cash for villagers in both villages. The proportion of income from resin in both villages contributed to between 20 to 60 percent of income from non-agricultural activities. In Laoka village, during the approximate four to five months each year that villagers face rice shortages, income from resin serves as their safety net. For Srey I village, the rice shortage period is around two to three months. This shorter period is explained by the fact that Srey I villagers grow paddy rice that has a higher yield than upland rice. Aside from buying supplementary rice, cash from the sale of resin is spent on farm machinery or vehicles for transportation, or added to savings.

Figure 6. Resin tree that was cut by an illegal logger (Source: Institute of Environmental Rehabilitation and Conservation)

### 3.1. Decrease in resin trees and effects upon the Phnong's livelihoods

As previously mentioned, the rights over and ownership of resin trees are transferred across generations by customary rights; however, these rights are not yet legitimated. Recently, the number of resin trees belonging to villagers in both villages has been decreasing. There are two main factors contributing to the decrease in resin trees as reported by villagers. One is the expansion of Economic Land Concession (ELC) and another is illegal logging.

There is a discrepancy in the data on the number of Economic Land Concessions granted in Mondulkiri. In 2012 the Ministry of Agriculture, Forestry and Fisheries, Cambodia reported that 14 companies received ELCs from the government with a total area of 101,036 hectares. However, data from Open Development Cambodia showed there to be 31 companies that received ELCs with a total area of 208,510 hectares (Lim & Theng 2015). Although the figures from these sources are different, data on land disputes in the province showed that out of 15 land disputes reported in 2013, 12 cases were caused by ELCs (Lim & Theng 2015). ELC areas have often overlapped with forest lands, agricultural lands, and village cemeteries, and have even overlapped with protected areas such as the Phom Prich Wildlife Sanctuary or other protected forests. Villagers reported that the ELC areas overlapped with some of their stands of resin trees. In many cases, companies cleared granted forest land that included resin trees, and similar incidents have also been found in areas of the Seima Protection Forest and other provinces (Cheetham 2014; Tola 2009). Since the rights over resin trees are not legitimated, villagers have found it difficult to get compensation for the resin trees that are felled by companies. In some cases, companies keep the stands of resin trees that belonged to villagers; however, to access the resin trees, villagers have to get permission from the company's security guards to enter the ELC area for collecting resin.

Aside from ELCs, illegal logging is one of the threats to resin trees. Many *Dipterocarpus alatus* trees, the main source of resin, were cut due to a high demand for construction material and furniture (Evan et al. 2003; Tola 2009). Superior quality trees such as rosewood (*Dalbergia cochinchinensis*), *Afzelia xylocarpa* or *Pterocarpus macrocarpus* have been illegally logged and exported to Vietnam under a timber trade network involving corrupted officials both in Cambodia and Vietnam (Environmental Investigation Agency 2017). Meanwhile, illegally logged resin trees, especially *Dipterocarpus alatus* which is regarded as inferior wood (Class II) (Forestry Administration and Wildlife Conservation Society 2008), have been used domestically to make furniture or for construction. Several villagers reported that their resin trees were cut by illegal loggers (Figure 6). One villager who owns 130 trees reported that between 2012 and 2017, he lost around 30 resin trees to illegal loggers. According to focus group interviews in both villages, over the past five years, the total number of resin trees lost by owners is over 200. The loggers were mentioned to be villagers from other villages, which are infamous for illegal logging, and workers at ELC companies.

The loss of resin trees has severely affected the livelihoods of villagers as resin is their main source of cash. In focus group interviews, villagers reported that between 20 to 60 percent of income was lost due to the loss of resin trees. When the main income of households is decreased, villagers struggle to find cash to buy rice during rice shortage periods. Moreover, there is less or no money to invest in agriculture, to go to the hospital or to save for their children's education.

### 3.2. Ways of coping with challenges

Due to limited alternative livelihoods, some villagers have decided to extend the area of their upland fields in order to gain more income. However, due to restrictions on protected areas nearby their villages—namely the Phnom Prich Wildlife Sanctuary—only a few villagers have succeeded in expanding their farmlands. Moreover, traditional agricultural practices have been linked to low productivity and low revenue. Some women reported that they tried to grow more vegetables to sell in the local market in order to gain more income; however, the income still could not compare with the amount of money they used to get from resin.

It was reported that some villagers looked for labour work in ELC companies, on large agricultural plantations or in Sen Monorom town, especially young males from Laoka village that is located only six kilometres from the town. However, finding work was not easy because most farm work is seasonal and construction work in Sen Monorom requires at least low-level construction skills that many of the villagers from the studied villages are lacking.

There were attempts to bring the cases of illegal resin tree logging to the attention of forestry administration officers or police. However, villagers reported that their complaints were rejected by the authorities. The villagers mentioned that the authorities ignored their cases due to lack of evidence and documentation of resin tree ownership. After cases were ignored, villagers reported that they felt it is pointless to bring cases to the authorities. These incidents made villagers lose their trust in law enforcement agencies and the forest management system.

Some stands of resin trees are located in areas of community forestry (CF). Villagers reported that they tried to increase the frequency of patrolling in community forest areas after the illegal logging of resin trees was reported. However, most illegal logging occurred in the rainy season when villagers were busy with their farmlands; hence, the patrolling team could not suppress the illegal logging activities as expected by villagers. Similar incidents were also reported by RECOFTC (2016), noting that CF members had limited capacity to involve forest law enforcement. Moreover, the average distance of resin trees from the villages is around 10 kilometres; thus, it was not easy for villagers to always keep watch over the resin trees.

Although not mentioned by villagers in individual interviews or focus group interviews, according to interviews with community leaders, some villagers who lost their income from resin became illegal loggers themselves. In order to cover household expenses, some villagers have engaged in illegal logging activity since it is easy to earn money through such activities, although they are risky and illegal.

## 4. Conclusions and recommendations

From the results of this study, it can be concluded that resin trees, a vital source of the Phnong people's livelihoods, are under threat (Figure 7). The decrease in resin trees has strongly affected the livelihoods of people who depend heavily on income from resin tapping. A lack of resin trees means a lack of a safety net for the Phnong. Their solutions to this challenge, as mentioned in the previous section, have been only short-term, and have proven ineffective and unsustainable. Some solutions chosen by villagers have created new problems, such as the expansion of farmland or villagers' engagement in illegal logging.

In order to support the villagers in coping with these challenges in a sustainable manner, collaboration among stakeholders is indispensable. Since the rights over and ownership of resin trees are yet to be legitimated, concerned authorities should support villagers in the legalization of their ownership. Legalized ownership would secure the Phnong's rights over resin trees and make it possible to bring cases to authorities with evidence of ownership. Community land titling, along with mapping of resin tree stands, are long-term solutions that authorities can provide to the locals to secure their rights over resin trees. With legitimated rights, local communities would be empowered to manage, protect and utilize their resources.

Capacity building for community forestry members, especially patrol teams, is also very important. As mentioned by villagers, patrol teams are able to report cases of illegal logging to the Forestry Administration (FA); however, in reality, villagers lack the ability to write complaint reports to submit to the local FA. With this constraint, illegal activities could be neglected.

Involving the stands of resin trees in REDD+ programmes is one idea to create income for villagers as well as promote sustainable forest management. Although REDD+ activity focuses on large forest cover areas such as the Seima Protection Forest, there is a successful model wherein smallholders or agro-forestry is joined with a carbon mitigation project (Samek et al. 2011). Moreover, resin trees have a high potential to store carbon, as studied by Khun et al. (2012). Therefore, resin trees could be utilized as a flagship for carbon mitigation initiatives for smallholders.

Another way to enhance the livelihoods of villagers is to increase farm productivity. Traditional agricultural practices,

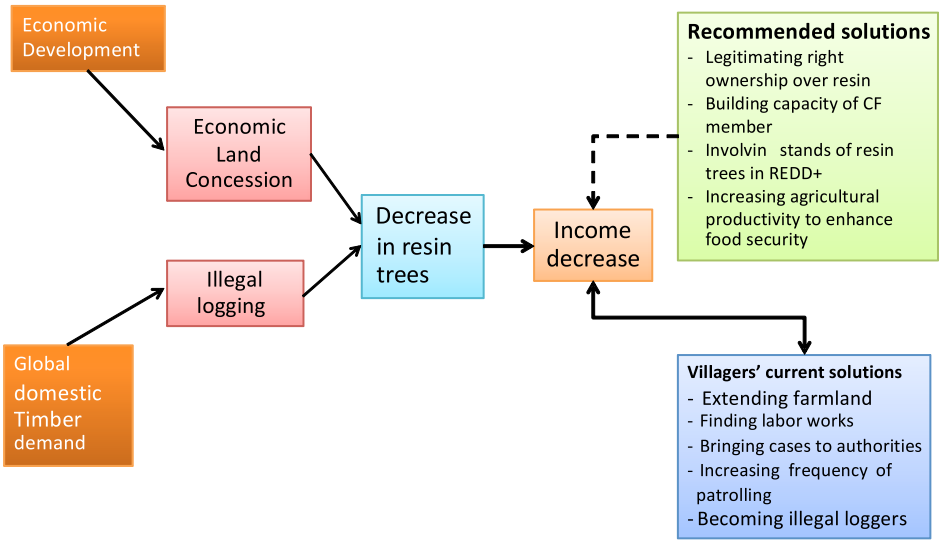


Figure 7. Diagram of causes, effects, current solutions and proposed solutions for tackling challenges

including slash and burn and rain-fed farming, are linked to low productivity and rice shortages. Multi-cropping or agro-forestry systems that enhance productivity and soil fertility should be introduced to villagers in the studied areas to enhance livelihoods and food security that have been damaged by the loss of resin trees.

Saving resin trees not only has implications for conservation of trees and nature, but also conserves and supports the livelihoods of indigenous people who depend heavily on the resin trees as their safety net. Without support from related organizations and authorities, the future of these vulnerable people in Mondulkiri is insecure.

## Acknowledgement

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i According to a proclamation on non-timber forest products by the Ministry of Agriculture, Forestry and Fisheries, Cambodia, non-timber forest products are classified for all forest resources that are not timber, including products from non-timber plants, wildlife, their processed products, and services from the forest. Resin is classified in class VI resin/gum.

Chapter 7

# Making landscapes work: A case of the Kakum Conservation Area in Ghana

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## Abstract

The Kakum National Park, considered to be Ghana's premier protected area, covers 350 km2 of moist tropical forest and represents one of the few remaining areas in West Africa's Upper Guinean Forest biodiversity hotspot with most of its plants and animals relatively intact. The park contains isolated populations of several globally endangered species, including the forest elephant, estimated to be 150-245 individuals. Kakum also contains the headwaters of four major rivers that supply water to over 500,000 people. Available data indicates there to be around 80 farming communities with an estimated 2,000 households within a five kilometre radius of the park, that typically maintain about four to eight acres of cocoa farms. The creation of the park restricted its use and limited the area available for crop production, thus adversely affecting the livelihoods of fringe communities. Traditional production practices that were deeply rooted in the culture of the communities were no longer entertained within the landscape because of the perceived threats to the park. During this period, Conservation Alliance, an environmental organization, implemented an initiative that demonstrated the livelihood benefits of integrating biological and cultural diversity within the landscape. Traditional practices including adherence to taboos and norms (dedication of forest to deities, protection of certain animals as totems and reverence of rivers as homes of gods) were integrated into the landscape management plan to strengthen the management of the park and thus enhance the health of the ecosystem. As a means of diversifying sources of incomes without compromising the resilience of the ecosystem, certified cocoa production that is compatible with nature was promoted. Additionally, the communities took advantage of the ecotourism development of the park to embark on economic ventures such as art and crafts production, catering services, tour guiding and performance in cultural troops. The park attracts more than 300,000 visitors to its canopy walkway annually and thus makes Kakum one of the iconic destinations for nature-culture lovers in Africa. Human-elephant conflict mitigation measures were integrated into the ecotourism program to provide additional revenue for impacted communities. Festivals are celebrated annually to deepen the cordial relationship between the people and their environment. The quantity and quality of biodiversity depends on the presence of cultural diversity.

**Keywords:** Livelihoods; Biodiversity; Socio-cultural; Ecosystem; Cocoa

## 1. Introduction

As a means of safeguarding their livelihoods against any potential threats, such as the escalating rate of biodiversity loss, rural communities have devised different mechanisms to protect the integrity of the natural resources. Traditional ethics (norms, precepts, principles and taboos) have been adopted to efficiently regulate the conduct and actions of community members towards the use and management of natural resources (Binlinla, Voinov & Oduro 2014; Udokang 2014; Harich et al. 2013; Ntiamoa-Baidu 1995). Tradition and customs defined the various aspects of human behaviour and social activities that were approved and those that were prohibited and forbidden. Nearly all the codes of morality were in the form of prohibitions, which were sanctioned by the deities and ancestral spirits (Udokang 2014). Adherence to these traditional practices was meant to ensure the long-term conservation of natural resources and safeguard economic security. These practices were later reinforced by the adoption of the protected area approach to natural resource management by offering enhanced protection to areas of exceptional socio-cultural, ecological and economic value (West, Igoe & Brockington 2006). This approach provided a landscape perspective to natural resource management and added benefits to landscapes with varying levels of human alterations (Wu 2013; Millenium Ecosystem Assessment 2010; Stolton & Dudley 2010).

As a way of providing additional goods and services to humans, some landscapes, such as agro-based ones, have been modified and managed to provide efficient services (Fahrig et al. 2011; Swinton et al. 2007; Robertson & Swinton 2005). The consequences of such management changes were alterations to land, forests and species distribution (Millenium Ecosystem Assessment 2010). Even though the resultant ecosystem may be conducive to a few species, the majority of these species, some rare and of higher conservation importance, may not have been able to withstand these alterations (Robertson & Swinton 2005; Swinton et al. 2007) and may have been lost eventually. Additionally, the intensification of agriculture had led to the degradation of a number of ecosystems goods and services, and thereby reducing the capacities of these goods and services to positively impact agriculture. (Wratten et al. 2013; Nelson et al. 2009; Tscharntke et al. 2005).

Agriculture is the most dominant land use within the forest landscape of Ghana and is likely to remain so as the country's population and food demand rise. As a managed ecosystem, agriculture requires some ecosystem services in order to be productive (Heal & Small 2002). The extent to which agro-landscapes are able to sustain production depends on the management practices that are implemented (Sabatier et al. 2014) and the relationship with the diversity, composition, and functioning of the remaining natural ecosystems in the landscape (Sabatier, Doyen & Tichit 2014; Karanth & DeFries 2010). This suggests that successful management of landscapes includes a human factor (Karanth & DeFries 2010), which should not be ignored in the determination of the sustainability of the landscapes (Bastian, Krönert & Lipský 2006; Estrada-Carmona et al. 2014).

Past interventions have yielded limited positive impacts. This is partly because these initiatives were driven by international policies that did not tie in with local values and processes, and thus became unsustainable. In the absence of sustainable management practices, numerous disservices could arise including pest infestation, habitat and species loss, and nutrient loading that may adversely affect farm productivity (Ma & Swinton 2011; Swinton et al. 2007; Zhang et al. 2007).

### 1.1. Study area

Cocoa production is a major land use and economic activity within the forest areas in Ghana. The Kakum Conservation Area (KCA) is one of the cocoa growing landscapes in Ghana (Marfo 2008). It includes the Kakum National Park (KNP), the Assin Attandanso Reserve (AAR) and an adjourning buffer zone all covering an area of about 420 km$^2$ (Figure 1). The area is part of the Upper Guinean Hotspot in West Africa described as one of the world's biodiversity hotspots (Barej et al. 2014). It contains isolated populations of several globally endangered species, including the forest elephant, estimated to total 150-245 individuals (Conservation International 1998). Designated a reserve in the 1930s (Eggert, Eggert & Woodruff 2003), the area is not only rich in biodiversity, but also exhibits climatic conditions (temperature range: 20.2 to 31.6 °C; two rainy seasons) that are an additional attraction for the migration of people into the area (Binlinla, Voinov & Oduro 2014). The park also contains the headwaters of four major rivers that supply water to over 500,000 people.

Four traditional areas border the conservation area. These are the Assin, Twifo-Hemang, Denkyira (5°20′- 5°40′ N), and Abura-Asebu Kwamankese (1°15′ – 1°30′) traditional areas (Amoah & Wiafe 2012; Binlinla, Voinov & Oduro 2014). Available data indicated that there were around 80 farming communities with an estimated 2,000 households within a five kilometre radius of the area. Each household typically maintains bout four to eight[i] acres of cocoa and two to three acres of food crops (Marfo 2008; Conservation International 1998). The entire landscape used to be part of the wildlife habitat until a portion of it was carved out for human settlements and agriculture. The traditional authorities

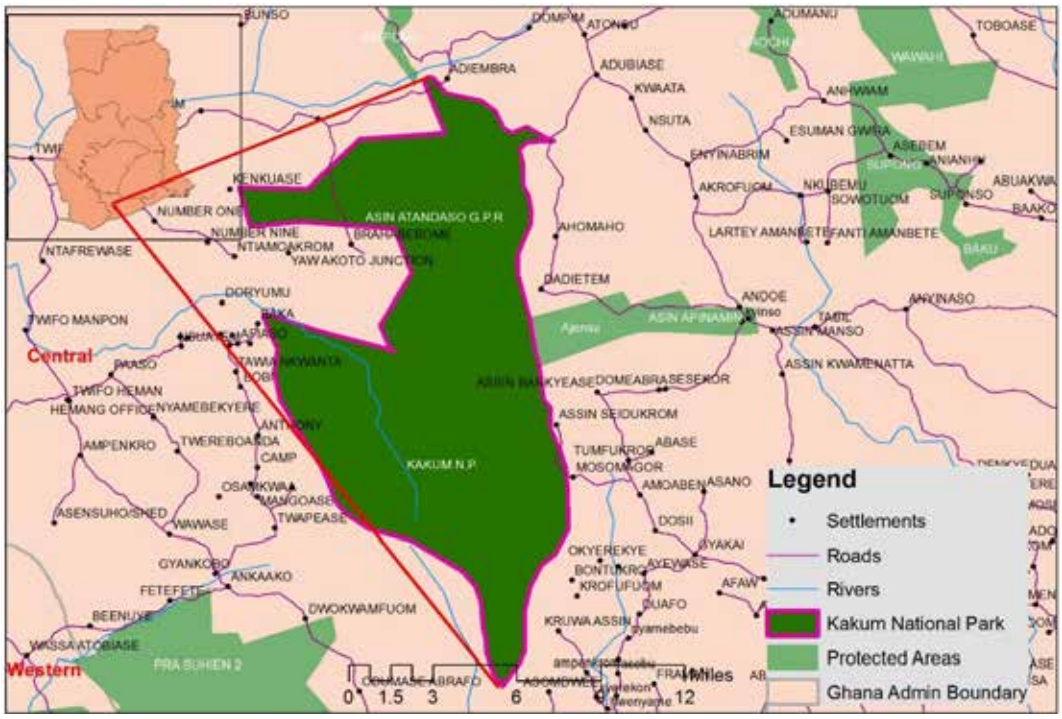


Figure 1. Kakum Conservation Area and surrounding areas

instituted certain norms and practices to regulate the use of natural resources and secure the long-term sustainability of agricultural production.

### 1.2. The problem

The designation of the Kakum Conservation Area sparked a number of socio-cultural, economic and environmental challenges. The traditional production practices that were deeply rooted in the culture of the communities were no longer entertained within the landscape because of perceived threats to the park. These restrictions came into effect after a change in the management regime of the Kakum Conservation Area in 1989 (Yeboah, Deikumah & Henaku-Owusu 2008) from the Forest Services Division to the Wildlife Division (Binlinla, Voinov & Oduro 2014; Fiagbomeh & Bürger-Arndt 2015). Until the change in management regime, the locals supplemented their livelihood needs with hunting (Amoah & Wiafe 2012) and harvesting of non-timber forest products (NTFPs) from the forests (Binlinla, Voinov & Oduro 2014). Restricted access to the forests thus adversely affected the livelihoods of the vast majority of the community members, especially women who depended on the harvesting of NTFPs. Even though the passage of the Wildlife Reserves Regulations (LI 1525) and the 2014 Wildlife Resources Management Bill gave limited user rights to communities, it was not enough to change their economic fortunes (Binlinla, Voinov & Oduro 2014).

Cocoa production, the major economic activity within the area, significantly declined due to a number of factors including unavailability of agricultural lands, poor soil, aged cocoa trees and an aging farming population (Cocoa Research Insitute of Ghana 2006; Zeitlin & Teal 2006). An estimated 80% of all youth within the fringe communities migrated to urban centres to look for new economic opportunities (Asamoah et al. 2013; Ghana Statistical Service & Ghana Demographic Health Survey 2008; Zeitlin & Teal 2006). With an increasing population, declining farm productivity and land degradation within the Kakum Conservation Area, a need arose to develop and implement an agricultural system that would enhance the livelihoods of fringe communities without compromising the environmental integrity of the area.

## 2. Description of activities (methods)

Conservation Alliance (CA) implemented a Satoyama Development Mechanism (SDM) funded project to enhance cocoa agroforestry in Ghana through an integrated GIS-based monitoring system. The project provided opportunity for integrating culture and nature into the management of the agricultural production landscape to enhance the livelihoods of the people without destroying the health of the environment. The funding support contributed significantly to achieving the four main strategic objectives of the International Partnership for the Satoyama Initiative (IPSI). In particular, it promoted increased knowledge and understanding of biodiversity and the production landscape (Objective 1*)* and addressed the causes of

loss of biodiversity and cultural diversity (Objective 2). Similarly, it improved benefits to communities from SEPLS (Objective 3) and enhanced the capacities of beneficiaries for implementing the Satoyama Initiative (Objective 4). The outcomes of the project were reflected in the health of the ecological landscape and the economic wellbeing of households within the landscape. The project was built around three main thematic areas including:

1. Development of ecological and farm database;
2. Use of community-based approaches to address production challenges;
3. Promotion of economic incentives for adoption of sustainable cocoa production practices.

### 2.1. Development of ecological and farm database

CA maintains a documentation system to monitor the ecological health of the agro-landscape and the livelihoods of people living in the fringe communities. This system is a web-based database system with offline capabilities for collecting, storing, and analyzing information in the Kakum Landscape Project. This system stores both socioeconomic and biophysical information from the farm level to the communal and landscape levels.

This information was used in assessing the impacts of the intervention. Additional data was collected and compared with the baseline. Since the data collection was a joint exercise between the technical team and the farmers, it offered both parties the opportunity to assess the performance of the project. To complement the biodiversity data analysis, the team also acquired images from the Global Forest Change website. Each dataset downloaded contained information on tree canopy cover, cover loss and gain, unusable data mask, year of gross forest cover loss event, and circa year data that are reference cloud-free Landsat® 7 composite images. All these datasets are offered for the years 2000-2014 and were used to develop a land cover map for the study area.

### 2.2. Use of community-based approaches to address production challenges

Interventions involved the promotion of best practices in cocoa agroforestry alongside the harmonious co-existence of humans and wildlife within the production landscape. With technical support from the Cocoa Research Institute of Ghana (CRIG), the project team established a modified form of Farmer Field School (FFS) to offer training to beneficiary farmers within the landscape. Braun et al. (2006) described FFS as experience learning aimed at empowering communities to build their capacity for informed decision-making. The training integrated best cultural practices such as the recognition of rivers as deities, as well as the scientific practice of leaving a buffer near rivers to prevent pollution and siltation. The reverence for some tree species within the landscape as "homes" of ancestral gods provided the opportunity to promote the integration of tree cultivation with cocoa production.

In collaboration with Ghana's Wildlife Division (Forestry Commission), the team also promoted the adoption of human-elephant conflict (HEC) mitigation measures to reduce the incidence of elephant crop raiding on farms and ensure peaceful co-existence. The community HEC scout provided technical support services to farmers whose farms were the target of rampaging elephants in exchange for monetary payments.

### 2.3. Promotion of economic incentives for adoption of sustainable cocoa production practices

As a means of improving farmer income and ensuring the long-term financial sustainability of the project, the team engaged a licenced cocoa buyer, *Olam Ghana Ltd*, and a certification body, *Rainforest Alliance*, to support the production and purchase of certified cocoa. Under certified cocoa production, farmers were required to comply with defined environmental, social and economic protocols to qualify for cash premiums.

Additionally, the communities have taken advantage of ecotourism development in the park to embark on economic ventures such as art and crafts production, catering services, tour guiding and cultural performance. The park attracts more than 300,000 visitors to its canopy walkway annually and thus makes Kakum one of the iconic destinations for nature-culture lovers in Africa. There is evidence to suggest that patronage of these various activities has improved the local economy substantially and increased the income levels of the participants by 30% (Marfo 2008). Festivals were celebrated annually to deepen the cordial relationship between the people and their environment. The improvement in the local economy has led to a significant reduction in the direct dependence on forest resources, resulting in marked improvement in the level of biodiversity within the landscape.

## 3. Results

### 3.1. State of landscape

Generally, the project recorded significant improvement in the ecological health of the landscape and the local economy. The landscape consisted of crop fields, fallow

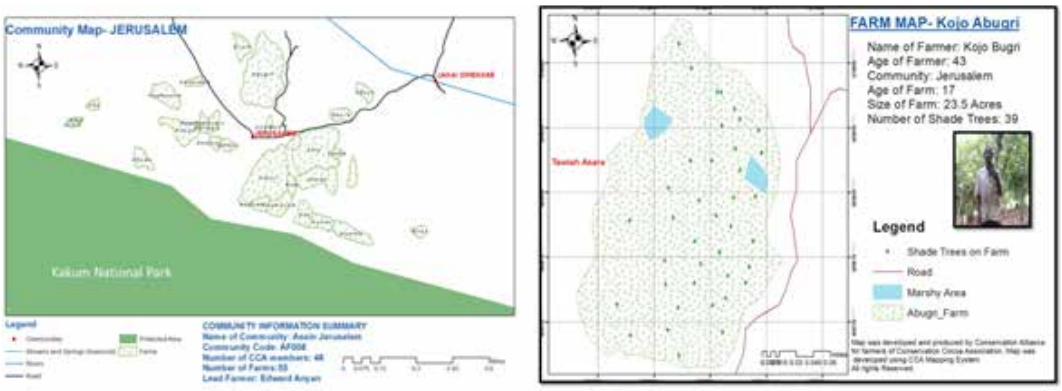


Figure 2. Community and farm maps generated from farmer database

lands, secondary (community) forests and sacred groves (Binlinla, Voinov & Oduro 2014). The tree species within the secondary forests were similar to that obtained from the park, although the diversity and distribution of trees were much lower than the park. The dominant tree species within the secondary forest were *Terminalia superba* (*Ofram*), *Terminalia ivoriensis* (*Emire*), *Pericopsis elata* (*Kokrodua*), *Albizia lebbeck* (*Lebbek tree*), *Mansonia altissima* (Mansonia), *Tectona grandis* (*Teak*) and *Cedrella ordorata* (*Cedrella*). Similar trends were observed for faunal species too. Wiafe and Sam (2014) reported increased activities of forest elephants, duikers, monkeys, reptiles, butterflies, ants and bees within the secondary forest and cultivated fields within the landscape. Except for the forest elephant, the secondary forests had similar species as those in the protected forest but with less diversity, density and distribution. While the biodiversity of the park was much higher than that of the neighbouring landscape dominated by cocoa, the complex agroforestry system provided a useful substitute for the natural forest. Some writers have revealed that "complex agroforestry systems may be a poor substitute for the natural forest but the heterogeneous mosaic landscape in which complex agroforestry forms part can be strategically managed to maximize the benefits of both sustainable agriculture production and conservation of plant diversity" (Asase & Tetteh 2010, p. 2). The implementation of the project activities sought to reduce the ecological imbalance between the forest and the neighbouring landscape.

### 3.2. Making production decisions at the farm level

The development of a database with information on farmers and farms provided a reliable means of decision-making based on production trends. The various outputs from the database gave farmers, their facilitators, and other stakeholders the opportunity to assess the impacts of the intervention at the landscape level.

- **Decision-making at the farm level**

Information in the database was made available to the farmers through the farm map, which is a visual spatial representation the farm (Figure 2). The farm map shows the configuration of the farm, its size, location in relation to other farms, existence of cocoa trees and native plant species that serve as shade for the cocoa trees, and other special features (e.g. animal activity on the farm, presence of sensitive habitats).

Production levels of farms were also recorded in the sales record book kept by the Purchasing Clerk. This record included information on cocoa beans (in kg) sold to the Purchasing Clerk over a period. By this, the trends in sales per farmer were established and the amount paid to the farmers was also monitored.

- **Decision-making at the landscape level**

Decisions at the landscape level were made based on land cover change analysis of data collected from secondary sources, spatial sources and primary data that was aggregated from the farm level to the landscape level. The buffer area around the KCA exhibited a variable land cover character, primarily because of the less regulated land use types common there. Three major non-forest types of use were identified. These were tree crop plantations that formed the majority (67%) of the cover type, food crop farms and built-up surfaces. The major tree crops grown in the area are cocoa, covering about 45% of the buffer area, oil palm (30%), citrus (15%), rubber and teak (10%). These figures correspond to the number of people engaged in various economic activities that were identified and documented (Figure 3). Change analysis of time series data indicated a conversion of oil palm and citrus plantations to cocoa due to the attractiveness of the crop and the attention given to it by the government. Also, there has been a decline in the local demand for citrus, which has left the crop to be purchased at low prices by brokers who feed the fruit to factories in neighbouring Cote d'Ivoire (Marfo 2008).

A mosaic of tree crop agroforests interspaced with fallow lands and food crop farms was observed in the adjourning

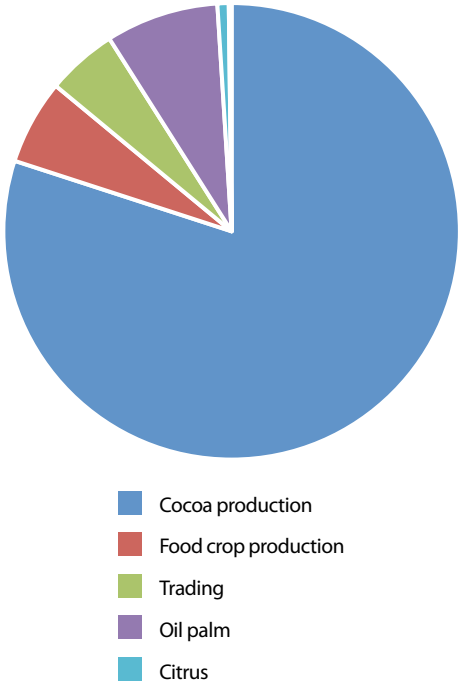


Figure 3. Number of people engaged in various economic activities in the area

buffer of KCA. This is a characteristic feature of most agro-landscapes in the High Forest Zone (HFZ) of Ghana (Aneani et al. 2011). Even though food crops are basically for subsistence, surplus food is sold to major cities and at roadside markets on the main Cape Coast-Accra and Cape Coast-Kumasi highways (Awotwe-Pratt & Osei-Owusu 2012). The distribution and extent of food crop farms are influenced by a number of factors (Osei-Owusu, Awotwe-Pratt & Osei-Owusu 2012). Analysis of monitoring data collected by CA (2008) indicated that the distribution and size of farms had reduced considerably over the years. Some farmers attributed this to land scarcity in the conservation area, which had compelled some farmers to reduce the size of their food crop farms and increase the size of their cocoa farms. Their argument was based on the fact that the output of a cocoa farm is higher than a comparable food crop farm. Also, farmers in communities around the northern portions of the area (Assin side) preferred to cultivate cocoa as compared to other crops (Danquah & Oppong 2007). Cocoa farms were less attractive to the elephants that raided farms compared to food crops like plantain and cassava. In the absence of food crops, however, the elephants had diverted their attention to cocoa pods.

### 3.3. Building the capacity of farmers

By promoting best practices in regenerative and resource-conserving technologies and practices that reduce over-dependence on agrochemicals, the project improved farmer income and the quality of the environment. To achieve this, CA together with CRIG and other partners developed a comprehensive curriculum on sustainable cocoa production in the area. The curriculum was organized into modules that depicted the whole lifecycle of cocoa production, from nursery establishment, care for young cocoa trees, shade management, integrated crop and pest management, and post-harvest quality assurance issues. Other modules on biodiversity conservation, financial literacy, and record keeping were added to give the training scheme a holistic view to cocoa production. About 350 lead farmers from 17 communities (Table 1) were enrolled in the modified farmer field school to build their capacity in sustainable cocoa production practices. They subsequently served as trainers for the rest of the farmers within the beneficiary communities.

Table 1. Number of male and female graduates of the Farmer Field School

| Farmer Field School Graduates | | |
|---|---|---|
| Description | Frequency | Percent |
| Males | 220 | 62.86 |
| Females | 130 | 37.14 |
| **TOTAL** | **350** | **100.00** |

The Farmer Field School model was used in other parts of the world for other crops but was first piloted in cocoa production in Ghana at the Kakum Conservation Area (Gockowski et al. 2010). A cascading approach was used to reach farmers within the KCA landscape.

Table 2. Number of community members trained by FFS graduates

| Community Level Training | | |
|---|---|---|
| Description | Frequency | Percent |
| Males | 1,634 | 65.36 |
| Females | 866 | 34.64 |
| **TOTAL** | **2,500** | **100.00** |

Each FFS-trained lead farmer was given the responsibility to set up a number of farmer field schools and conduct trainings for the farmers within his/her community. An average of seven other farmers were trained by each graduate of the FFS, despite an average of three being forecasted (Table 2). About 2,500 people have been reached with this cascading approach. There was a remarkable increase in farmers' knowledge in sustainable cocoa production, from an initial two out of ten farmers in 2002 to eight out of ten farmers in 2016 (Conservation Alliance 2016). This demonstrates the positive impacts of the project since its inception.

### 3.4. Livelihood enhancement in the KCA

Analysis of information collated from the field indicated that there was an increase in the number of trees per unit

area of cocoa farm. A change analysis using the Global Forest Change tool (Hansen et al. 2013) indicated that a contiguous secondary-like forest has been formed along the boundaries of the KCA where cocoa is cultivated. According to the farmers, there are growing incentives—both financial and socio-cultural—for them to propagate, nurture, and/or protect species in and around their farms. Some of the cultivated trees include *Terminalia superba* (*Ofram*), *Terminalia ivoriensis* (*Emire*), *Pericopsis elata (Kokrodua*), *Triplochiton scleroxylon* (*Wawa*), *Milicia excelsa* (*Odum*) and *Piptadenia africana* (*Dahoma*). This is mostly the case in areas where CA introduced cocoa certification projects that required farmers to have at least eight species of indigenous trees per acre of cocoa, including *Terminalia superba, Terminalia ivorensis, Newbouldia laevis, Milicia excelsa, Persea americana, Ficus exasperata, Antiaris toxicaria, Amphimas pterocarpoides, Albizia zygia* and *Morinda lucida*. Shade trees on the cocoa farms helped to regulate the incidence of pests such as capsids and improved the ecological health of the farms. The SDM initiative augmented past government efforts (the *CODAPEC and Cocoa Hi-Tech* schemes) and resulted in an approximate 30% increase in farm productivity. This initiative, implemented in 2016, contributed to a significant improvement in the health of the ecosystems and livelihoods of fringe communities, reflected in the yield per acre of the cocoa farms of beneficiary community members (Figure 4). In consultation with the farmer leadership, CA also assisted farmers in the adoption of UTZ Certified and Rainforest Alliance certification standards at various sections of the KCA. Farmers that were certified under these schemes witnessed an increase in their incomes from the sale of produce and from cash premiums paid for being certified.

The improved local economy (from sustainable cocoa production and ecotourism) contributed to a significant reduction in the direct dependence of the locals on forest resources especially the NTFPs (Marfo 2008). Similarly, the level of biodiversity within the landscape increased, evidenced by the increased number of wild animals that were sighted on farms. While the project succeeded in reducing the direct threats posed by agricultural encroachment, it could not completely eliminate illegal hunting within the landscape. Most of the illegal activities were carried out by non-residents and sometimes faciliated by residents.

## 4. Discussion and conclusion

The project recorded significant improvement in the health of the ecosystem and the income of households through the implementation of the different interventions. The farm database provided an excellent tool for farmers to accurately predict crop production trends. Estimates made by farmers were based on appropriate measurements of their farms allowing for the appropriate application of farm inputs and estimation of labor for farm activities. This reduced the cost of inputs that farmers needed to invest per year and also the amount of time the farmers used in the implementation of these practices. Farmers were therefore able to budget for ensuing years and also predict yields, ultimately determining the incomes that were available to farming families. Data was the key here, and the ability of farmers to turn data into information and apply it to their farms was enhanced.

For farmers to have optimal success in adopting best practices in cocoa production, training approaches and methodology should be built on the traditional knowledge systems that the farmers perceive as useful and easy to adopt. Training modules did not only look at the production systems but also covered aspects of financial literacy and management that gave farmers appropriate control of their production and investment. Farmers were then able to better plan farm activities resulting in increased yields and transformation of livelihoods.

The payment of cash premiums for sustainable production of cocoa did not only promote the improved ecological health of cocoa farms but was an incentive for adoption of sustainable practices. Farmers were motivated to adopt

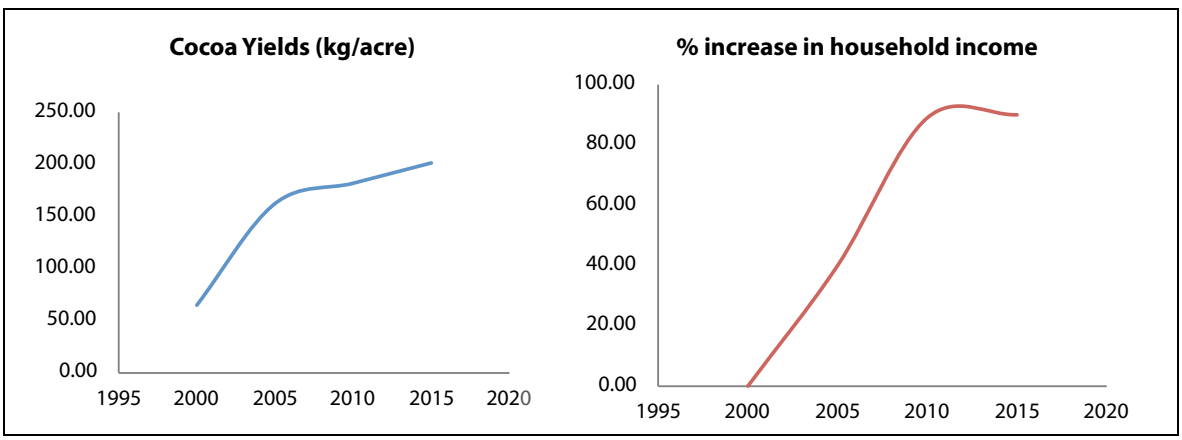


Figure 4. Cocoa yields of farmers (kg/acre) and percent increase in household income

improved practices to increase yield and earn higher cash premiums for their produce. This was a win-win situation for the environment and livelihoods of the farmers and their families.

The significant improvement in cocoa yield (about 30%) and the corresponding returns from certification (150-350 USD /ton) largely accounted for the wide-scale adoption of the recommended actions. The ease of accessing technical support from CA's field staff also motivated the farmers to sign on to the initiative. Some of the youth (about 12%) who had abandoned cocoa farming returned to take advantage of the opportunities that the initiative offered. While ecotourism was not the focus of the SDM initiative, the provision of services by community members to tourists accounted for about 11% of the household income in 2015 (Conservation Alliance 2016). Admittedly, this may appear low, but there was evidence to suggest that this figure will go up in the future due to the favourable political climate and the significant improvement of the level of biodiversity that attracts nature lovers to the site.

Cocoa production is undertaken by about 800,000 farmers and their families in Ghana. This makes cocoa production an important livelihood support pathway for most rural communities in the HFZ of Ghana. The Kakum Conservation Area project presented a good opportunity to support the argument that communities are willing to take part in conservation efforts if they understand the linkages between their livelihoods and the landscapes in which they live. Constant engagement with farmers and their families in the form of investments into the provision of improved and alternative livelihood options for fringe communities continued to sustain the local economy and promoted the sustainable use of natural resources in the area. Engagement was based on the fact that behavioral change is gradual and should be done without compromising the traditional knowledge system that exists in the area. There is an ongoing need for continuous engagement of farmers to sustain the gains made with the implementation of innovative activities that aimed at promoting farmer livelihoods and the ecological health of their farms.

## Acknowledgement

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i One acre is equivalent to 0.405 hectares.

Chapter 8

# Human-nature connection and well-being of the H're indigenous community in production landscapes of Kon Tum Province, Central Highlands of Vietnam

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## Abstract

This paper is designed to contribute to enhancing knowledge on the linkage between humans and nature in a socio-ecological production landscape and seascape (SEPLS) through providing analyses of the livelihood activities of the H're indigenous community in Kon Tum province, Central Highlands of Vietnam. We have documented the ways of life in the villages of ethnic H're communities that exhibit all the characteristics of livelihoods linked with a SEPLS. Their spiritual ecosystem includes how they perceive and interact with their land and mountains, forests and water, clean air and natural landscape. Cultural rituals and ceremonies involve organization within the community for diverse rituals throughout the year to pay respect and gratitude to many Nature Spirits. Community cohesion relies strongly on their customary laws, but there are certain changes due to context. Villages have already come into contact with external interventions; however, the communities continue to exhibit leadership and find alternative ways to defend their livelihood sovereignty and maintain their well-being and the sustainability of the SEPLS.

**Keywords:** Livelihoods; H're community; Spiritual ecosystem; Challenges; Well-being; SEPLS sustainability

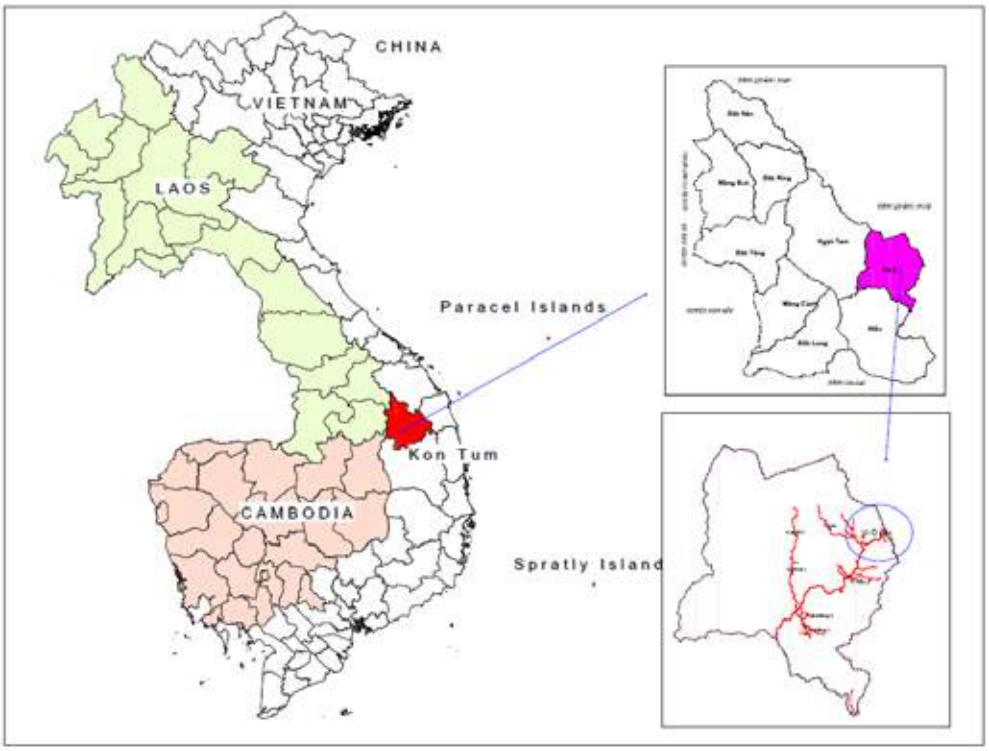


Figure 1. Map on the lower right shows the location of the site in Po E commune, Kon Plong district, Kon Tum province (Source: LISO 2016)

## 1. Context and challenges

This paper is designed to contribute to enhancing knowledge on the linkage between humans and nature of the H're people in an example of a SEPLS (socio-ecological production landscapes and seascapes), through describing the livelihood activities of this indigenous community in the Central Highlands of Vietnam. The community is located in the Po E commune of Kon Plong district in Kon Tum province, as illustrated in Figure 1. It is one of the most remote communes in the area. The commune has seven villages with a total land area of about 11,189.72 hectares (Po E Communal People's Committee 2013).

### 1.1. The H're community and their socio-ecological village landscape system

The Po E commune is home to 100 percent H're ethnic indigenous people. The living spaces of the H're villagers are surrounded by unique natural landscapes often composed of mountains and hills, river valleys, rice farming areas, gardening spaces and residential housing (CENDI 2015). The people are hard-working and often working conditions require them to be under the sun, up in the hills and in the forests.

A typical H're person has a small body form, with slightly dark-coloured skin, as shown in Figure 2. The people are

Figure 2. A H're family with two children in one village and a H're women's group in another village (Photo: Dang)

kind towards each other both in the same community and across communities. The H're speak their own language and show great pride in it. Generally, they enjoy their natural landscape and feel happy expressing their culture and identities that are closely linked with their landscape (CENDI 2015). For special events, they wear traditional H're clothes. The women are skilful in cultivation, forest use, and other resource management practices. The women's groups tend to stay together, going to the field or helping each other out at any events.

### 1.2. H're historical settlement and production activities

Historically, the H're community has settled in the mountainous areas of Quang Ngai province, with a minor group settled in Binh Dinh province (Hoang 2013). These areas were explored and settled by their ancestors. The origins of the H're are said to be attached to a mountain named *Mum* and a mountain named *Rin* from each specific locality (Hoang 2013; villagers' stories 2014-2016).

- **Traditional cropping and cultivation**

As the H're settled in areas between the high mountains and the valleys, often on flat agricultural fields with fertile soil along the river streams, they learned to use their ecological and topographical knowledge to form small rice terraces for farming (Hoang 2013). The rice cultivation of the H're can be grouped into two types: dry rice fields in upper zones and wet rice fields in lower areas. The H're are known to only farm one rice crop per year; however, occasionally there are places where people do farm two crops (villagers' stories 2014-2016). Villagers tend to prefer summer cultivation as this gives them higher yields (Hoang 2013). This once-a-year rice farming is well known due to the high quality of local rice varieties. According to an elder, "our H're people eat our local rice and can feel full; not like the white rice" (villagers' stories 2016). This knowledge and experience has gone through years of selection, and it is useful to learn that the H're have still saved their best local varieties today.

- **Raising livestock**

The H're raise their livestock in herds, including buffaloes, cows, chickens and ducks, and they also hunt wild animals (villagers' stories, 2014-2016). Large animals such as buffaloes are placed separately from other animals like pigs and chickens, which are often raised free-range around the house. Buffaloes are used as an alternative to manpower, for instance to help carry things to the rice fields in the upper hills. During cultural events, buffaloes are sacrificed as offerings to the Spirits (Hoang, 2013; villagers' stories, 2015). In special cases, they are also used as property to be exchanged for goods and services that villagers do not have internally. The H're raise a lot of pigs and chickens for both meat and spiritual offerings. In the day time, they free them into the wild, and in the late afternoon, they go into the forests to call their herds home (villagers' stories, 2014-2016).

### 1.3. The works of SPERI and the LISO Alliance

The Social Policy Ecology Research Institute (SPERI) and the Livelihood Sovereignty Alliance (LISO Alliance) are amongst the few NGOs currently working on site. The main objective of these NGOs is to work with local villagers and concerned stakeholders to contribute to the livelihood sovereignty of the villages through securing community land titles whilst also defending recognition of customary law-based resource governance to defend against numerous emerging challenges (SPERI/CENDI and the LISO Alliance, 2014-2018). Since 2014, activities at the site have successfully secured a total of 674.7 hectares of the community sacred forestlands, which have been legitimately put in the names of the four H're villages. Securing of these sacred forestlands has contributed to maintaining the spiritual ecosystem and also the beliefs and indigenous worldviews that the H're have long maintained, including interactions with the Mother Mountain, the Gifted Stream, the land and water and also the Gem Rice Field (CENDI, 2015) (see section 3.2.3 below). Through NGO activities, we also learned that despite villages having maintained the many aspects of their lives that are linked harmoniously and strongly to the natural landscapes, emerging challenges also exist. Conversion of forestland to cassava crops combined with promotion of herbicide use is one of the most critical. Many discussions have been raised by villagers and the LISO Alliance in order to search for lessons learned and solutions. Discussions have also been raised on the types of livelihoods needed to balance production, well-being and also SEPLS sustainability.

## 2. Methods

Information gathering and description of livelihoods for this thematic volume has built upon and been gathered with the obtained consensus of SPERI/CENDI and the LISO Alliance and from the ongoing work of these organizations.

### 2.1. Field work based on direct observation

Our activities have involved a great amount of field work conducted from 2014 to present. Direct observations took place at all times in the field, around the rice paddies and other cropping areas, over the entire landscape, at each household visited and also during community meetings. We witnessed the livelihood aspects of the H're by taking part in their daily activities to gain an understanding of their lives; including how and why they do things in their own ways, using customs and local knowledge (SPERI, 2016).

### 2.2. Community discussions and in-depth hearings with villagers

Based on field work, discussions and notes were compiled. Direct and in-depth interviews were also conducted with most members of the villages, including women's groups, elders' groups, youth groups and farmers' groups. For example, the most recent trip aimed to study how the H're community harvests its rice crop and how it organizes the traditional ceremony to thank the Rice Spirits. Interviews occurred with all groups at the rice fields (e.g. area for harvesting, area for drying rice, place for storing rice). After intense listening, oral consultation was also undertaken with participants on local knowledge, such as with the women on local rice varieties for documentation and acknowledgement (SPERI, 2016). Elders were mainly men and were consulted on knowledge of sacred or spiritual attachments. Youths were consulted on future plans for the village and for themselves.

### 2.3. Participatory mapping and documentation of indigenous knowledge

Initially, community meetings were held with villagers to discuss the identification of local terms for places of significance in their village lands. Both locations and names were documented and their meanings carefully recorded. The subsequent field work by groups of villagers also included a cultural officer from the district Department of Culture, a legal officer from the district Department of Justice, a Forestry officer and a Natural Resources officer. These officers also attended earlier meetings when possible. The field work was completed over three or four visits (or sometimes more) to ensure that the documentation was thorough. The inclusion of all participants ensured engagement, agreement and ownership of the mapping by everyone. The entirety of information gathered via field work was processed and mapped onto a formal Natural Resources map (SPERI/CENDI and the LISO Alliance, 2014-2017).

Documentation came in various forms: written notes, photos, video and other materials recording the information obtained from the villagers with their oral permission. Final production of documentation acknowledged contributions from all. For certain activities, selected photos were printed and returned to communities. Villagers and local stakeholders were informed of video productions and release (SPERI/CENDI and the LISO Alliance, 2014-2017).

### 2.4. Limitations of this paper

The results presented herein describe the livelihoods of the H're and largely come from field observations and experiential learning from the villagers. Certain literature is integrated but to a large extent, primary information is provided. Our interpretation is dependent on what members saw and witnessed concerning how villagers practice their ways of life as well as information provided by the people. Our writing and description of results also respects another reality, that is that our usual history in Vietnam has often focused upon major events and milestone activities, and often pays little attention to the details of the smaller marginal groups such as the H're ethnic group. We thought it necessary to make the effort to directly document knowledge and practices from villagers themselves so that their stories and ways of life can be acknowledged.

### 2.5. Peer review

This paper received comments and inputs from peers during a case study workshop held in Japan as well as other independent inputs. There was a list of 29 comments (or viewpoints) for exchange and contribution into the current draft version used for its improvement. A process was undertaken by the corresponding author to include and respond to those comments and inputs.

Figure 3. H're cultivate maize by natural farming methods. Pigs and chicken are free-range (Photo: Dang)

## 3. Results

### 3.1. The H're people's current practices

- **Cropping and cultivation**

Given that the soil type in the Central Highlands region is of high quality, 'dark red-brown basalt soil', there should be no need for additional fertilisers (villagers' stories, 2014). The H're people in all villages continue practicing natural farming and production, e.g. putting seeds into the soil and just letting them grow by themselves (villagers' stories, 2014-2017). About 80 to 90 percent of families practice natural farming as illustrated in Figure 3. Livestock continue to be raised freely and food sources are natural. Local cropping and breeding varieties are continuously saved and replanted.

The H're community uses local varieties for subsistence and home consumption in both livestock and farming. Local cropping and breeding varieties are strongly connected to ritual ceremonies and the cultural lives of the people (CENDI, 2015). New varieties, such as cash-crop cassava, corn and hybrid acacia, are not used by the H're for any cultural or spiritual reasons. The villagers have also adopted different systems of labour exchange for local varieties versus new varieties. For traditional crops such as rice, the H're people exchange or give help without any cash and with no concern for winning or losing amongst the families (CENDI, 2015). For cash crops such as cassava and hybrid acacia, the villagers join in exchanges but members are paid either by cash or by labour.

Production and harvests have remained largely traditional, but the recent presence of some mechanical intervention has been witnessed. In one village, out of all families, there were just one or two families that recently could afford to buy a machine that helps during the rice harvest. Groups of families borrow or hire this machine, and then when finished rotate the machine to another group of families for use. The machine helps to separate the rice seeds from the rice plants, as shown in Figure 4. In other villages, an arrangement of community rotational help for families during rice harvesting still in large part remains, as illustrated in Figure 5.

Little is yet known about whether the introduction of a rice harvesting machine into the community will have any effect upon social relationships, i.e. become a source of tension. Nevertheless, to date, the H're have continued their usual social workforce arrangement, exhibited by labour exchanges and help-groups during rice harvests (CENDI, 2015). Harvesting takes place yearly during the month

Figure 4. H're people using a machine to separate rice seeds from the rice plants (Photo: Dang)

Figure 5. The community helping a specific family during rice harvesting. The red circle highlights the *cái hái*—a tiny traditional knife that is placed within the palm to cut each of the rice plants by hand and then wrap them in bunches (Photo: Dang)

Figure 6. H're family starting their first rice cultivation (Photo: Dang)

of October. For all the steps involved in rice harvesting, the H're work for one another without any cash payment requirements. On average, each family needs 20 people to come and help. Men are often in charge of the harvesting (in some cases now able to use a machine), women gather rice bunches from the rice field bringing them to the banks, and young people help to carry the rice bunches by hand from the banks to the machine. Youths also engage in rice separation from the plants whilst the women continue gathering rice into the rice bags and young people further help by carrying these rice bags to their homes. For all other community works such as house-building, building rice storehouses, and firewood harvesting, the H're people help one another equally regardless of clan, age, status of the household, or social position, and no cash is involved (CENDI, 2015).

In their lives today, the H're villagers still maintain many traditions during production activities (CENDI, 2015).

Two photos (Figure 6 above) tell the story of a couple who walked for half an hour from home to this location for the best clean water. They settled on these two plots and started their first rice seeding. The husband prepared and cleared the two plots for flattening, mixed soft soil and water, firmed all the banks and edges, and followed up with the protective measures of laying wild pineapples leaves (meant to scare off bad luck from these new seeding plots). The wife silently greeted the Spirits, including all nature surrounding spirits, and spread the basket full of good rice seeds. They prayed for a good year with a good crop, good weather and a good harvest. These two plots are just used for the younger shoots to come up, after which the shoots can be transplanted in bigger plots. Even in their lives today, cultural and spiritual attachments during the production activities of the H're appear fundamental (SPERI/CENDI and the LISO Alliance, 2014-2017).

During other field work, we followed another group of women. In the morning, they called out to each other to go into the forest together. At a certain point in the wild, they divided into different groups searching in various directions. They searched for and collected leaves, roots and small tree branches of special types for their special ritual ceremony. Some women looked for roots whilst the younger ones climbed up trees to collect the youngest shoots in the uppermost parts (Figure 7, red circle).

The activity took them a whole day, searching for bunches of leaves to bring home to present to the Spirits. While practicing these activities, the women silently greeted the Nature Spirits, acknowledging them for everything they do.

Figure 7. H're women searching for and collecting leaves and roots for the final bunch to present to Nature Spirits. The red circles highlight the villagers climbing trees (Photo: Dang)

Figure 8. An area of storehouses for the rice of the villagers (Photo: Le)

- **Houses for rice and houses for buffaloes**

Another interesting finding concerns the H're rice storehouses. Rice storehouses are built and made carefully of good structure, often located out near the rice fields, and separated from the residential areas. Rice and their bags are brought into the storehouses. The storehouses are framed with traditional bricks for roofing material, surrounded by wooden walls, often made with good timber. Each rice storehouse stands firmly upon sometimes four, sometimes six wooden poles, depending on each family. The H're practice many ritual steps in building and using the rice storehouses (CENDI, 2015). An example is painting each pole with certain pungent oils from some special trees in the forest to deter rats and animals from climbing up to the storehouse. The entire design was created by the H're (Figure 8). All bags of rice must be included in rituals before entering storehouses.

Another interesting finding concerns houses for buffaloes. As shown in Figure 9, the H're spend a lot of time and resources on making safe and warm houses for animals. They are located further from home. The H're have carefully made the roofing from a metal-based material to avoid damage by strong winds during the winter time. Pieces of wood are placed standing side-by-side to form the four walls. There is a little door big enough for the biggest buffalo to go through. None of the houses for buffaloes have locks; the H're do not have a concept of locking doors (CENDI, 2015). At the beginning of the year, there is a ceremony to greet the house for buffaloes as well, often happening in February. There are some hanging plants and a wooden bowl also hung in front of the entrance. These symbols signify the family's asking the Spirits for good health for the buffaloes and wish to avoid bad luck for the herds of the family (CENDI, 2015). Rice and buffaloes are not only important livelihood sources but also the cultural assets of the H're.

- **Forest use and management and customary norms**

Two important sources of livelihood also derived in this SEPLS landscape are the forests and rivers and streams. In the forests, the H're people collect forest vegetables, wild fruits, natural honey, birds, or wild animals, wood, rattan and bamboo, forest mushrooms, and much more. Rivers and streams are important sources of crabs, fish, snails, shrimps and other small freshwater fish, as shown in Figure 10. Collecting from nature in these ways has contributed to the daily lives of the people. The H're always teaching and train their community members to protect these important sources of livelihood and not to pollute them, that they may continue to enjoy the natural foods they have to offer (CENDI, 2015).

Each village has an area for common use and another area for family use. Individual family land area is the land used by a family, having long cultivated rice fields on it, including uphill cultivation areas, residences and houses for animals. The common land area is known as community forestland that has had little external intervention. It is commonly used and accessed by all villagers. Likewise, everyone follows village rules and customs for resource use and management. Each village has its own customary norms identifying what can and cannot be done in the forests, as illustrated in Figure 11. Most of the families can collect non-timber forest products, raise animals free-range in certain plots, and have

Figure 9. H're houses for buffaloes. The red circle indicates some hanging plants and a wooden bowl intended to ward off bad luck (Photo: Le)

Figure 10. Crabs, fish, snails, shrimps and other small freshwater fish found in the stream (Photo: Le)

access to some logs for making houses with permission (SPERI/CENDI and the LISO Alliance, 2014-2017).

Each village publishes its own customary norms. Through our activities we helped to both formally register and obtain recognition by formal government agencies of each village's customary norms. We also assisted in setting up wooden boards placed at the front of each village with hand-written rules and norms to inform community members and outsiders of what they can and cannot do to the community forests. Each of the four villages has different wooden boards (SPERI/CENDI and the LISO Alliance, 2014-2017).

The differences between villages in their customary norms are found largely in their descriptions of each separate mountain and landscape that each village rests within. The entire H're community shares a common God or Nature Spirit, or the equivalent. But for eachmountain or forest area, a different local name and local history are associated with the place (CENDI, 2015). Members of each community gather to discuss their particular norms for use and management of the area. The establishment and practice of these norms play an important role in the maintenance and conservation of biodiversity. If a need to change these norms arises, community members sit under the guidance of traditional elders and respected village leaders to discuss and also vote upon the changes. The creation of boards listing customary norms is a new innovation for the H're (SPERI/CENDI and the LISO Alliance, 2014-2017).

Figure 11. Our activities helped to set up wooden boards with hand-written customary norms in the villages (Photo: Le)

### 3.2. H're socio-ecological practices linked to well-being

- **Social settings of the H're community**

The H're live in small groups in a village, often called *plấy* in the H're language (Hoang, 2013). In one village, there may be three to four clan families and the associated daughters and sons, granddaughters and grandsons. During the daytime, they call out to each other to go into the forests or the fields together. During the evenings, they gather to drink rice-wine and sing, sharing the details of their lives and work in the fields. Many families still do not have access to electricity. They sit around the fireplace and drink until falling asleep.

- **Community-based institutions and the role of esteemed men**

In both traditional and present day H're society, the village, its residential areas forming the core part, are voluntarily self-governed (Hoang, 2013; SPERI/CENDI and the LISO Alliance, 2014-2017). The self-governing mechanism means that the H're people pay high respect to the role of traditional leaders and elders—villagers listen to them. Figure 12 depicts an example of a spiritual ceremony where an elder was asked to help convey a family's message to the Spirit. Each village also has its own headman, in the H're language called *kra plây* (Hoang, 2013; CENDI, 2015). The villagers, whenever facing difficulties including conflicts requiring resolution, seek advice from elders and headmen, who are knowledgeable in the H're culture, identity, and local wisdom (SPERI/CENDI and the LISO Alliance, 2014-2017).

Figure 12. H're man preparing offerings for a ceremony for cultivating the new rice. An elder man in the community helping the family talk to the Spirit during the ceremony (Photo: Dang)

- **Perceptions of values and practical norms concerning the natural landscape**

The H're villagers, through their daily and yearly cycles, pay respect to nature as they conduct their spiritual and material lives (CENDI, 2015). Figure 13 depicts a traditional mapping of the different spiritual ecosystems in which the H're practice ritual ceremonies throughout the year (LISO, 2015). Embedded in these customs is a deep commitment to nature and cultural identity preservation. This mapping documentation is a new innovation resulting from our research activities (SPERI/CENDI and the LISO Alliance, 2014-2017).

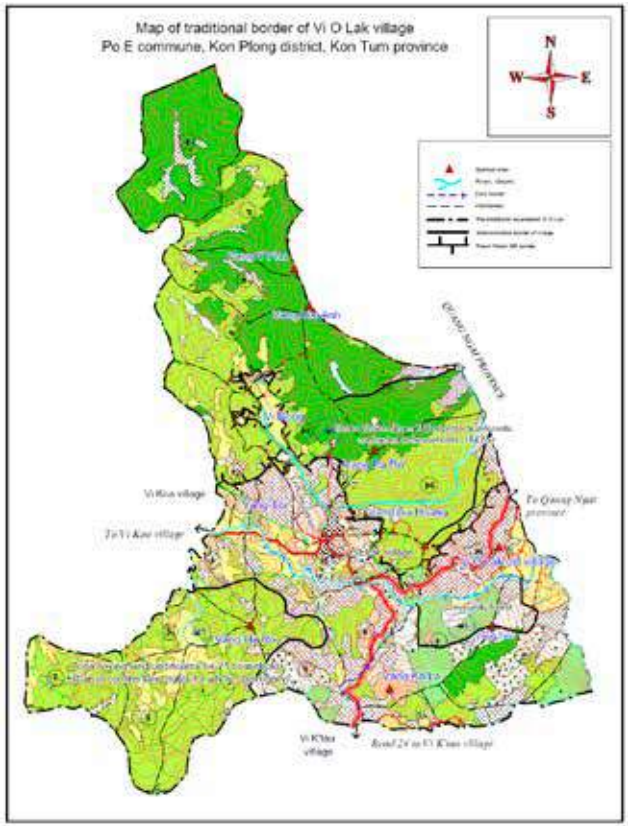


Figure 13. Newly created documentation of the map of traditional borders of one village (Source: LISO, 2015)

The *Spirit of Vang Y Phu – Mother Mountain:* With a height of 1,150 meters, *Vang Y Phu* is the place the H're believe the most powerful Mountain Spirit resides. *Vang Y Phu* is considered to be the spiritual cradle of the entire ecosystem of the village. In the H're language *Vang Y Phu* means "Mother Mountain" (CENDI, 2015). According to the H're belief in the Mother Mountain, the Spirit resides in two big old trees (in H're language *Loong Chi Ri* and *Loong Preo*) (CENDI, 2015). The *Inta* bird sings from these trees and its beautiful voice can be heard beyond the mountain. According to customary norms, the H're can only listen to the *Inta* bird but are not allowed to sing along (CENDI, 2015). Every year, the H're villagers make a pilgrimage to *Vang Y Phu* in their traditional clothes bringing offerings. During the pilgrimage, the villagers worship the Mother Mountain spirit and express their admiration, praying for a peaceful, healthy and happy life for all community members.

The Spirit of *Vang Ha Lenh* – Gifted Stream: *Vang Ha Lenh* is the second highest hill at 1,070 meters. The combination of *Vang Y Phu* and *Vang Ha Lenh* creates the unique scenery and landscape that has inspired generation after generation of the H're. The villagers described the *Ha Lenh* stream as a gift from the Mother Mountain, *Vang Y Phu* (CENDI, 2015). Every year in spring, all the villagers go together to the "Gifted Stream" to hold a ceremony for collecting water, shown in Figure 14, with the women's group collecting water for their special ceremony.

This ceremony is an important event for every family in all villages. Both husbands and wives go into the forest to prepare materials for the ceremony. A ritual ceremony to welcome the Water Spirit from *Ha Lenh* stream into the sacred room of the house is also held at home by each family (CENDI, 2015).

The Spirit of *Vi Nong* rice field – Gem Rice given by *"Yang"*: The *Vi Nong* rice fields produce local sticky rice varieties such as *H'Roa* and *Mao Nu*. There is also a non-sticky rice

Figure 14. H're women collecting water for the special ceremony (Photo: Dang)

species called *Jring.* All rice species are combined and used for making the special local *ghe* wine, used as offerings to the Spirits in all rituals and for home consumption (CENDI, 2015). As the villagers worship the Spirit of *Vi Nong*, the rice fields, they also worship the Spirit of the *Vang Ha Lenh* that provides water to the fields, as well as the Spirit of the Mother Mountain, *Vang Y Phu* (CENDI, 2015). Like the Elder A Xi shared, "rice is a gem given by *Yang*". The H're villagers show their deep gratitude through practicing this annual ritual. The special local *ghe* wine is hung on the sacred pillar in the sacred room of the house as an offering all year round in the worship of *Yang* (CENDI, 2015).

### 3.3. The local economic system of the H're community

Up to the present day, most of the livelihood activities of the H're remain traditional and are primarily a subsistence system based on both livestock and farming. Livelihoods are closely connected to the natural resources provided by the SEPLS. People cultivate and harvest crops including rice production and upper hill cultivation, collect and hunt in forests, rivers and streams, and also utilize other natural resources.

In the upper hills, agricultural crops such as cassava, corn, coffee, certain fruit trees, and some annual plants can be found. Villagers practice mixed planting—in some families they plant sweet potato, taro, yam, sugar cane and banana in separate areas. Production activities are diverse. For forestry species, crops such as cinnamon, hybrid acacia, bamboo, *Litsea glutinosa*, and also chinaberry (*Melia azedarach*) are currently grown. There are many local plants and trees of native varieties specific to the local ecosystem that have not yet been fully studied and documented. Agricultural crops and forest species are a mixture of both local varieties and new varieties (SPERI/CENDI and the LISO Alliance, 2014-2017).

New varieties are more frequently found for cassava, corn and coffee. Hybrid acacia is exceptional in terms of its extensive planting, up to 145 hectares. According to a report in 2014, only 22.5 hectares were planted with local varieties for all the crops types, whilst 224.4 hectares were planted with new varieties also for all crop types (Po E Communal People's Committee, 2014). According to interviews, new varieties for cassava were introduced in 2014 by the government. Areas for planting the new cassava have increased rapidly in recent years. New varieties of cassava are often planted in the upper hills; the furthest distance would be about a 20 minute walk. All the products from new cassava varieties are sold directly to buyers by villagers (SPERI/CENDI and the LISO Alliance, 2014-2017).

For hybrid acacia, cultivation began in 1999 and also came from government introduction. According to interviews, the villagers started planting these crops only from 2004. On average, each family has about 5,000 square meters; with the largest area a family can plant being up to two hectares. Depending on each mountain area and the soil type, villagers may plant acacia on the upper field for the first year, then mix planting with some cassava. Until the acacia fully grow, villagers do not plant cassava. On average, each family has already harvested and sold over two acacia cycles. The manner of harvesting, as well as the ways in which villagers sell their produce, really depends on each separate family. Some harvest first then find their own ways to sell. Some choose to sell acacia right in the forests (SPERI/CENDI and the LISO Alliance, 2014-2017).

### 3.4. Major external pressures on the landscape and livelihoods

Despite local efforts to culturally and socially maintain the socio-ecological landscapes, there are emerging challenges of great concern. Challenges have largely arisen due to market development associated with policy schemes. Commercial cassava cropping has accelerated due to market demand associated with a policy scheme for E5 bio-fuel development (Viet Nam News, 2017), as well as due to the

Table 1. Changes over the three types of land use from 2014-2016 in the Po E commune (Po E Communal People's Committee, 2016)

| Land types and areas | 2014 | 2015 | 2016 (early first 6 months) | 2016 (planning for entire year) |
|---|---|---|---|---|
| Hilly areas (largely cassava and corn) | 384 ha | 442 ha | 419 ha | 405 ha |
| Forestland areas (largely production forests such as hybrid acacia, cinnamon, bamboo) | 644.6 ha | 655.6 ha | 655.6 ha | 698 ha |

demand for sources of animal feed from small and medium-sized businesses. Areas of production forest cleared to make way for cassava crops were of particular concern in 2016 (SPERI/CENDI and the LISO Alliance, 2014-2017). Table 1 shows that more areas in the Po E commune are now used for cassava and corn compared to the years 2014 and 2015. In the first six months of 2016, the total land area for cassava and corn had already reached 419 hectares, well above the annual planned limit of only 405 hectares (Po E Communal People's Committee, 2016).

Commercial cassava varieties, shown in Figure 15, that were introduced along with the use of herbicides, as illustrated in Figure 16, in the earlier years claimed a higher yield. However, in subsequent years these varieties have cost the villagers more whilst health issues have already been observed (SPERI/CENDI and the LISO Alliance, 2014-2017). Much is not yet documented, and a more detailed investigation into these issues and impacts is needed.

## 4. Discussion

Findings have demonstrated that the H're people continue to perform ritual ceremonies expressing their gratitude towards Nature Spirits and their belief that everything they need to live has been offered to them. Embedded in these beliefs is a unique sense of well-being and inner happiness (CENDI, 2015). Their practice of showing respect towards nature may sound merely spiritual, but nevertheless reflects an entire holistic indigenous knowledge system and lifestyle based on the coexistence of both the concrete and the spiritual. The

Figure 15. Clearing of production forests for planting cassava (Photo: Dang)


Figure 16. Herbicides found in one of the villages. These observations are recent. (Photo: Le)

H're's continued belief in sacred trees, the Mother Mountain, the Gifted Stream, and also the Gem Rice Fields, illustrates the interconnectedness of their knowledge system and implies the non-opposition of the secular to the spiritual, as well as the non-separation of the empirical and objective from the sacred and intuitive (Nakashima & Roué, 2002). These are further reinforced by their wish to protect their natural capital for the long run. Documentation and publication of the H're people's practices and links to spiritual entities and the SEPLS are currently insufficient. The need remains to inform the public and concerned stakeholders of the significance of the indigenous knowledge system and its contribution to biodiversity conservation. This is important to the implementation of Article 8(j) of the Convention on Biological Diversity (developed at the Rio Earth Summit in 1992).

Our activities on site aimed to strengthen the livelihood sovereignty of the villages through securing community land titles whilst defending the recognition of customary laws based on resource governance to address emerging challenges (SPERI/CENDI and the LISO Alliance, 2014-2018). It is essential for the villages to get land titles for their sacred forests given the following rationale. Vietnam has ambitions of becoming a more developed nation. It is interconnected to the global market and is inevitably affected by the processes of globalization and industrialization. The legal framework has been reworked to give favour to privatization and extraction of local resources. The presence of more firms and businesses in the areas of indigenous ethnic minorities threatens the maintenance of community structures and traditional practices, including spiritual dimensions which are, by nature, the indigenous knowledge system of the H're people (SPERI/CENDI and the LISO Alliance, 2014-2018). Agricultural policies geared towards modernization with hybrid and high-yielding crops and use of chemical fertilizers and pesticides threaten local communities with the loss of local knowledge and know-how and the extinction of local native species. Our work on the legitimate claims to sacred forests of indigenous communities aims to contribute to the conservation of cultural and spiritual uses of species, genetic resources and natural biodiversity (SPERI/CENDI and the LISO Alliance, 2014-2018). The underlying spiritual and cultural dimensions expressed in the daily lives of the H're display the essence of their indigenous knowledge system by which they govern and use resources to the benefit of their own well-being (CENDI, 2015). Changes have been observed and mostly are increased awareness and realization by the communities of the value and need for protection of the land and forests against external forces, such as reducing cases of logging. The gradual recognition of their indigenous knowledge and practices is a key part of cultural identity preservation, and self-determination contributes to the overall sustainable management of their natural resources and SEPLS.

Land use change has put pressure on villages, and expansion of commercial cassava cropping at the landscape level is one of the key factors implicated in forest loss (SPERI/CENDI and the LISO Alliance, 2016-2018). Whilst protection and support from the government is often very limited (To, Mahanty & Dressler, 2016), the expansion of cassava may continue not only to meet increased global demand but also domestic need for E5 bio-fuel. Herbicide use associated with cassava production has already raised concerns both from ecological and social perspectives, although our research activities were not yet able to look into this issue in detail. Community cohesion experienced certain changes as some families have been approached to plant cassava crops, while a few still have not. Other social relationships involved in the cassava production chain also revealed a complexity and degree of dependence (To, Mahanty & Dressler, 2016), which could potentially effect a loss of autonomy and self-determination on the part of villagers, as well as a loss of identity and culture. If commercial cassava crops increased to become a dominant landscape, it is not clear how the H're would tackle this changing socio-ecological landscape (SEPLS) and what role customary law would play in addressing increasing market demand, i.e. more land conversion and increased use of herbicides and complex social relations. For each forest cut down, the multiple values trees have to offer are lost, including ecosystem value. Thus, when trees are cleared to make way for commercial cassava crops, we are turning from the multiple-choice forest ecosystem landscape into an area of no biological or no higher value agricultural land. How can customary laws cope with increased changing landscapes and tackle complex forms of social relationships? A future study to investigate these questions in-depth and compare information with that available for other communities undergoing similar pressures and changes is needed.

## 5. Conclusion

The above descriptions have illustrated that the cultural beliefs of the H're people, practiced regularly and well maintained, are embedded within their own natural landscapes. The socio-ecological connections within the H're society, whether at the individual or collective level, are both cultural and spiritual connections with the surrounding nature. Our activities to date have added to our knowledge on the human-nature linkage of the H're people, and given insight into their perspectives as evident in their daily living practices and livelihoods.

Most of the H're production activities are strongly linked to their socio-ecological production landscape (SEPLS). Likewise, their rituals to express thanks to Nature Spirits imply respectful practices towards nature. Throughout

the year, the cultural and spiritual meanings inherently conveyed through all production activities of the H're are also very significant to the inner happiness and well-being of each individual and the entire community.

Our activities have resulted in the display of customary norms on boards at the entrance of each village and the documentation of traditional mapping. This enhances the ability of the H're to strengthen their management of the forest and landscape resources (SEPLS), and reinforces their livelihood sovereignty. Most importantly, the H're indigenous knowledge system and traditional ways of life that go hand in hand with the maintenance of local ecological systems and the conservation of biodiversity have been highlighted.

To cope with ongoing environmental challenges, we together with community members continue to raise these issues and report them to officials at varied levels. Community activities and discussions on the impacts of herbicide use were conducted late 2016. Likewise, more awareness raising and trainings are being conducted in 2017. Empowerment and skills enhancement for young H're people and intergenerational knowledge exchanges will be conducted in the hope that these young H're and the entire community will recognize their internal strengths and the unique culture generated from their traditional landscapes (SEPLS). It is hoped that this recognition will be the foundation for their continued well-being and livelihoods. The many valuable insights of the H're people's linkage between humans and nature, as expressed through cultural activities and ritual ceremonies associated with such landscapes, should not be further damaged by increased market demand and harmful environmental practices.

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Chapter 9

# FairWild certification: An approach for linking biodiversity conservation with sustainable livelihoods in the northern Western Ghats, India

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## Abstract

Biodiversity conservation is a key global sustainability issue. Land use change due to expansion of agriculture, tourism, and development projects is contributing to loss of habitat and species at an alarming rate. Moreover, indiscriminate logging of forests for immediate monetary need is further degrading forests and habitats. This is particularly true for biodiversity areas and ecosystems in the forest landscapes of northern Western Ghats - a global biodiversity hotspot. The situation is exacerbated by a sparse protected area network, the predominantly community ownership of large tracts of biodiversity rich forests, a lack of awareness on the importance of biodiversity in human well-being, and low economic returns from sustainable utilization of biodiversity. Sacred groves - traditionally managed old growth forest fragments that exist in good numbers across the region – offer some hope for the conservation of threatened plants and animals. Yet these areas are facing the consequences of the loss of faith in tradition among the local community. There is thus a growing threat to the ecological integrity of landscape, together with a need to develop a strategy that fulfils monetary expectations of local communities whilst ensuring conservation of key biodiversity areas. With this in mind, AERF implemented the international FairWild certification scheme for the sustainable collection of non-timber forest products from community managed forests in the North Western Ghats. FairWild articulates stringent protocols and requirements with respect to biodiversity conservation, sustainable harvesting methods, monetary benefits to resource owners, ownership of and access to target resources, and the equitable sharing of benefits.

*Terminalia bellirica* and *Terminalia chebula* were the selected target species based on established demand for their fruits in traditional medicines in India and abroad, the potential for sustainable harvesting, the opportunity for improving economic returns, and the associated conservation benefits. AERF conducted a resource assessment of the trees, cost-benefit analyses and a social feasibility study to understand the potential of this certification scheme. Twenty-five villages were selected for

a resource assessment of *T. bellirica*, while the assessment of *T. chebula* was carried out in four villages from Sangameshwar and Bhimashankar. Selecting collectors and conducting trainings to build their capacity in sustainable collection and processing of fruits were necessary parts of compliance for FairWild certification. Successful implementation of FairWild certification has provided direct economic benefits to 100 households while protecting up to 600 large trees of *Terminalia bellirica* and nearly 1,000 old trees of *Terminalia chebula* in the North Western Ghats.

**Keywords:** Biodiversity conservation; FairWild certification; Sustainable livelihoods

## 1. Background

The conservation of biodiversity in human-dominated landscapes is substantially influenced by the extent to which particular values - cultural, spiritual, and economic - attached to the resource, are respected. In India the forces of globalization have led to severe deterioration in cultural values associated with natural resources, and efforts have been made to substitute these intangible values with monetary ones. On one hand this has precipitated exploitation of natural resources in a rampant and unsustainable manner, posing serious threats to the stability of ecologically important and irreplaceable places such as the forest ecosystems of the Western Ghats—a global biodiversity hotspot. On the other hand, there are opportunities to save biodiversity through sensible and careful use of economic instruments. The medicinal plants sector, though highly promising in terms of providing opportunities for economic development alongside biodiversity conservation at the landscape level, has seldom delivered on these expectations. Unfair market practices and near complete disregard for the ecological sustainability of the resource are two key reasons behind the failure of this sector. Local extinctions and declines in healthy populations of many economically important medicinal plants provide sufficient evidence for these unsustainable practices. Management practices which are ethical, inclusive and economically viable can likely provide a sustainable alternative for biodiversity conservation and livelihoods. In this regard, the principles and criteria of FairWild certification valuably address these critical issues in the medicinal plants sector and therefore may have the potential to generate success stories in conservation whilst promoting economic growth based on the use of natural resources.

The importance of certification schemes in addressing environmental and development issues is now widely accepted, although just how successful they are in achieving their objectives and meeting their aims has long been an issue of contention. Indeed, it is difficult to envisage a situation in which such schemes will avoid disadvantaging some people or precipitating unintended negative consequences. However, it is also true that many schemes have been successful from the consumers' point of view. For instance, products bearing the Fairtrade label have now become the purchase of choice for many consumers around the world who are willing to pay the additional premium cost these products bear.

FairWild is a relatively recent certification scheme of this type, having been founded in 2008 and based on the International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP), itself rooted in the Good Agricultural and Collection Practices (GACP) framework. Its development was supported by the German Federal Agency for Nature Conservation (BfN), TRAFFIC, WWF and IUCN, who were driven by a recognition that the increasing demand for wild plants - as ingredients for food, cosmetics, well-being and medicinal products - poses major ecological and social challenges. Pressure on potentially vulnerable plant species was recognized as endangering local ecosystems and the livelihoods of collectors - people who often belong to the poorest social groups in the countries of origin. In response to these concerns the FairWild Foundation was set up to promote the FairWild Standard and establish a certification system for the sustainable management and collection of wild plants. These institutions aim to provide a worldwide framework for implementing a sustainable, fair and value-adding management and trading system for wild-collected natural ingredients and products thereof. The foundation's mission is to "…enable transformation of resource management and business practices to be ecologically, socially economically sustainable throughout the supply chain of wild-collected products" through the provision of "…a worldwide framework for implementing a sustainable, fair and value-added management and trading system for wild-collected natural ingredients and products thereof" (FairWild.org 2018). FairWild certification seeks to ensure that buyers know they are supporting fair trading, with the products being legally and sustainably sourced, and the benefits being felt by all those involved right down to the local communities harvesting the wild plants.

With the scheme still in its infancy, the number of FairWild certificates awarded remains small. The latest published

information records some 30 implementation projects around the world, but just 34 live certificates (they are renewable each year) that cover 18 plant species at different locations (FairWild Feb. 2017). Of these projects, 27 are in six, predominantly eastern, European countries, of which 14 are in three Balkan states (8 in Bosnia-Herzegovina, 5 in Bulgaria). Of the rest, four are in former Soviet republics, and only three are operating further afield - one in Zimbabwe and the two in India that are the subject reported here.

This paper presents an ongoing project implemented in the North Western Ghats of India, where an approach articulated through the FairWild certification scheme is being employed as a mechanism for promoting biodiversity conservation, the sustainable collection of target species, and economic growth. The North Western Ghats is a recognized Global Biodiversity Hotspot, yet has a rather sparse protected area network, largely because the great majority of the forest landscapes that comprise it are privately owned. According to the study carried out by Pune-based NGO WRCS in 2013, in the five districts of the northern Western Ghats including Satara, Sangli, Kolhapur, Ratnagiri and Sindhudurg, of the total forest area of 17, 699 $km^2$, 12,043 $km^2$ are owned and managed privately, while 5,656 $km^2$ of forest area (less than 50% of privately managed land area) is owned and managed by the government (Kulkarni & Mehta 2013). In the absence of a sound, comprehensive policy for the sustainable management of biodiversity on these private lands, subsidy-driven monoculture plantations, coupled with a lack of knowledge on economically viable sustainable management alternatives, is resulting in mass-scale deforestation and degradation.

The Applied Environmental Research Foundation (AERF), a conservation NGO based out of Pune, is the implementing partner in a FairWild project focused on the protection and sustainable exploitation of medical plant resources in the North Western Ghats. AERF set up the "My Forest" initiative in 2007 to address the issue of deforestation in this region. Under this program, AERF decided to offer a financial incentive to the marginal and economically weak farmers, those most in need of gathering firewood and timber, for not logging the forests. A "conservation agreement" is signed between the farmers and AERF for this purpose and lasts for a minimum period of five years. The progress of this approach was slow in the initial years as it was a completely new way of looking at forests, and was therefore somewhat confusing for the farmers. However, more and more farmers joined this initiative once they began to think about resources in a more holistic and long-term way. Through this initiative, AERF has secured long-term protection for 2,000 hectares of forests until 2022. However, although this is a small but significant step forward in halting deforestation, it is also necessary to create a revenue model based on sustainable use of this vast resource in order to create the financial self-sufficiency necessary to sustain this conservation initiative in the long term.

In pursuing this objective, AERF identified the FairWild certification program as offering a potentially valuable tool for addressing important sustainability issues of biodiversity conservation, and in 2012 conducted a feasibility study, short-listing two districts for possible implementation of FairWild certification. Crucial motivation for this feasibility study was provided by active involvement of Pukka Herbs Ltd. - Europe's leading manufacturer of Ayurvedic products. Pukka Herbs expressed interest in purchasing FairWild certified primary processed fruits of *Terminalia bellirica* and *Terminalia chebula* trees, two of three ingredients that comprise a key Ayurvedic preparation - Triphala. This led to the selection of two areas in which to explore the possibility of implementing FairWild certification. The first, the Bhimashankar Wildlife Sanctuary in the North Western Ghats, is traditionally known for collection and sale of *T. chebula* by the tribal community, the Mahadev Koli. The second area, the forest landscapes from Sangameshwar block in Ratnagiri district, is rich in populations of *Terminalia bellirica* trees, many of which are located in sacred groves. These sacred groves are old growth "oases" protected by their religious significance that are critical in maintaining biodiversity by providing reservoirs of biodiversity colonizing capacity and "stepping stones" for species moving through the landscape. By July 2012, AERF had taken steps towards making a stronger business case for biodiversity conservation through setting up some demonstration projects, and established a private limited company, Nature Connect India Pvt., Ltd. (NCIPL). NCIPL came in very handy as vehicle for implementing FairWild certification in years to come.

Following a preliminary assessment of the potential impacts for conservation and rural livelihoods, in partnership with academics from the Durrell Institute for Conservation and Ecology (DICE) in the School of Anthropology and Conservation at the University of Kent, in June 2013 AERF secured three years of financial support through the UK Government's Darwin Initiative programme. This was supplemented by a small support grant from the Keidanran Nature Conservation Fund (KNCF) to specifically promote the FairWild approach. This funding enabled AERF to conduct situation analyses, run capacity building training sessions with the local communities, carry out trial collection exercises, and purchase and install equipment for primary processing (drying and pulverizing) of the collected fruits.

In presenting this project, this paper reports the project approach and process, the benefits, problems and issues

Figure 1. Left: Traditional drying method for *T. chebula* fruits; Right: Drying method for FairWild certified *T. chebula* fruits (Photo: Jayant Sarnaik)

that it has generated. Likewise, the paper considers the potential of this approach for fostering long-term, ecologically sustainable livelihoods based on the harvesting of non-timber forest products (NTFPs).

## 2. Project implementation

For a product to be sold as "FairWild Certified" all those directly involved in the national and international supply chain need to be assessed and approved. This includes: collectors, collector associations/co-operatives, manufacturers/NGOs contracting collectors, manufacturers/processors in the country of origin, traders and exporters in the country of origin, importers, processors and even marketing companies in the consumer countries (who can become certified on a voluntary basis). The certification award is based upon: a detailed resource assessment, a viable management plan, sustainable collecting practices, cost calculations along the full supply chain, the traceability of goods and finances, and documented fair trading practices. In addition, no producer organization can become certified without an on-site inspection. Since organizations can have many, sometimes hundreds of, collectors, not all can be individually visited. Thus, the purchasing company and collectors are certified as a group and therefore need to operate an internal quality assurance system.

FairWild Certification enables companies to show and communicate to the end consumers that their products are sourced and produced in a socially and ecologically sound

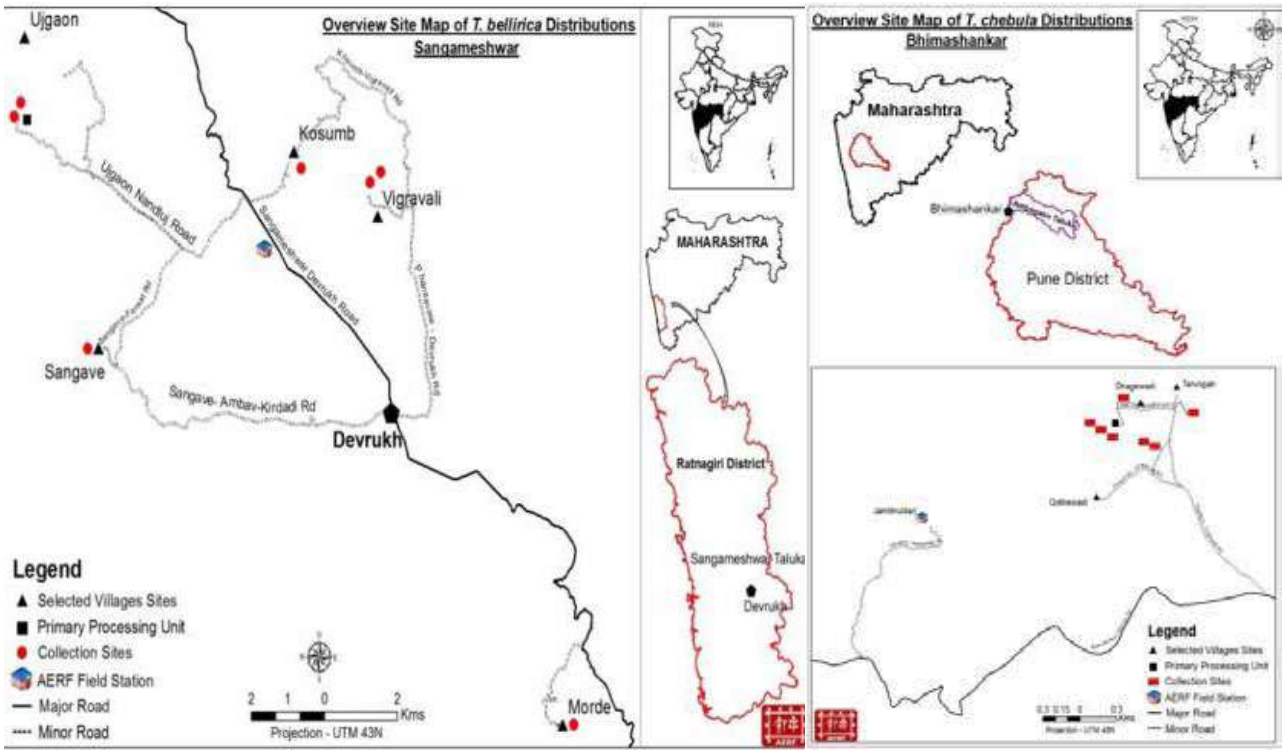


Figure 2. Map showing locations of FAIRWILD certified collection sites in the northern Western Ghats (Source: FAIRWILD operator profile AERF/ Nature Connect 2016)

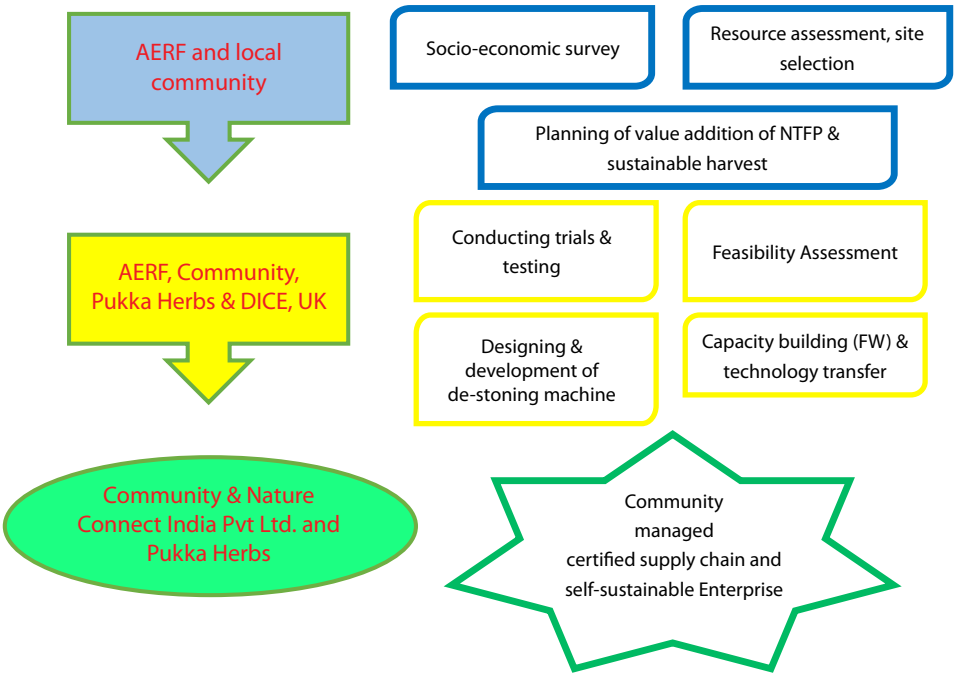


Figure 3: Process flow chart of FAIRWILD certified supply chain of wild plants

way, so that benefits are felt by all those involved right down to the local communities harvesting the wild plants.

Following a broad resource assessment, AERF identified specific collection sites in the two districts selected for FairWild implementation activities. Additionally, organic certification has also been undertaken at both the locations for all the resource areas. The organic certification guarantees that the collected material is not contaminated by pesticides or other harmful chemicals, qualifying the produce as acceptable for human consumption in the UK.

The two principle project sites are around the villages of Dhagewadi, Bhimashanker and several villages in the vicinity of Sangameshwar, both located in the North Western Ghats, Maharashtra, India. The figures show the location of these sites and the main nearby distributions of *T. bellirica* and *T. chebula*.

Within the Bhimashankar Wildlife Sanctuary, the Mahadev Koli village of Kondhwal, which is dependent on the surrounding forest area for a large part of its subsistence, was chosen. This community collects firewood and *T. chebula* ("*haritaki*") fruits from the forest lands under their ownership, with the *haritaki* being sold to meet immediate cash needs.

In conducting a FairWild project feasibility study, AERF recognized that if the *haritaki* fruits received FairWild certification, the collectors could get an increased price for their harvest and this would encourage conservation of the resource, which is mainly comprised of large groves of *T. chebula* with a richly diverse floral understory. The FairWild premium, a percentage of the export value of the product returned to the community for its own development purposes, could then be used for projects such building a bio-gas plant and/or improving sanitation.


Figure 4. Community engaging in processing activities at the FairWild processing facility in Bhimashankar (Photo: Jayant Sarnaik)

Figure 5. Left: Wild population of *Terminalia chebula* trees; Right: Great pied hornbill nesting on certified tree of *Terminalia bellirica* (Photo: Jayant Sarnaik)

AERF had already conducted conservation projects in this region at a local level, enabling their field experts to have built an excellent rapport with the locals and become familiar with the key biodiversity, socioeconomic and geographic factors and issues. This was invaluable for the successful conduct of a socioeconomic survey of the village and resource assessment with the support of the villagers, as well as in communicating the benefits of the FairWild certification to the local collectors. Kondhwal village in Bhimashankar Wildlife Sanctuary is comprised of four separated settlements ("*wadis*") made up of varying numbers of households: namely Gavandewadi (65), Kondhwal and Dhagewadi (33 each), and Shindewadi (6). The survey addressed the populations of all four *wadis*, with the data collected from nearly 150 families including: family size/ no. of dependents, area of land owned and uses to which it is put, crop yields, location and number of *haritaki* trees owned and harvest data, and annual household income and sources and details thereof. As predicted, the villagers' livelihoods are predominantly focused on rice cultivation to ensure their survival. However, they were also found to depend on income generated from other sources, of which *haritaki*, primarily in the form of the young fruits ("*hirda*"), accounted for nearly 50%, wage labour about a third, milk from cattle another 10%, and rice and honey sales another 8% and 3% respectively. It is also true that some young people are employed in small towns or cities. However, they repatriate little of their income.

The steady rise in income from collecting and selling of certified fruits of *Terminalia chebula* has started attracting local unemployed youth to this initiative for potential employment. While the project engaged about five young members of the community in collecting and processing in the year 2015, there are a total of 15 young men and women who participate in the project activities at different levels of the supply chain in the Bhimashankar Wildlife Sanctuary.

Similar data sets were gathered from the other study site, a collection of villages close to sacred groves in the Sangameshwar block in Ratnagiri district hosting mature specimens of *Terminalia bellirica*. Here the objective was to build a picture that included the specific role of *T. bellirica* and the sacred groves in conservation, and also to develop a means of enhancing the livelihoods of marginal/subsistence farmers—members of the local community with little or no cash income.

The process flow chart (Figure 3) shows various activities carried out in establishing the FairWild certified supply chain, along with the role of each stakeholder group in the northern Western Ghats.

With the setting up of processing equipment and facilities at both sites, together with the training of selected locals and articulation of the project within the framework of the FairWild standard and protocol, a pilot exercise conducted by TRAFFIC International, Japan in 2013 was followed by the official FairWild assessment visit and award of the certificate for the fruits of both *Terminalia* species, first in 2015 and then again in 2016. In 2015, 3.6 tonnes of *T. chebula* fruits and 2.6 tonnes of *T. bellirica* fruits were collected under the FairWild standard, and 4.9 tonnes of *T. chebula* and 4.6 tonnes of *T. bellirica* in 2016. Complete supply chains were also established and substantial volumes of semi-processed fruits (husks) were delivered to Pukka Herbs Ltd. in the UK (3.2 tonnes in 2015; 4.4 tonnes in 2016) through the Indian export company Phalada Agrosciences, Bangalore. Most importantly, the certification process under the project established a significant income source for 10 collectors in the Sangameshwar block, nearly 100 individual collectors in the Bhimashakar Wildlife Sanctuary, and three marginal farmers at each site who were trained and employed in the maintenance and operation of the processing equipment and record keeping. As the demand for the FairWild certified fruits increased, additional sites were brought under

FairWild certification in the year 2016. This has resulted in a substantial increase in collection of certified fruits in 2017. For example, a total of 7,200 kilograms of *Terminalia chebula* fruits have been collected and processed in Bhimashankar, while in Sangameshwar, a total of 5,200 kilograms *Terminalia bellirica* have been collected and processed. Ultimately, a total of 5,500 kilograms of certified processed fruits of both species were supplied to Pukka Herbs, UK in 2017.

When compared with local market prices for uncertified fruits, a significant rise in income for the farmers supplying certified fruits to processing centres is evident. In 2015, the local market price for high quality *Terminalia chebula* fruits was INR 6/kg, while certified *Terminalia chebula* fruits brought in INR 12/kg, an increase of 100%.

Moreover, this price is paid to the farmer at the processing centre which is set up in the village, thus saving the cost of transporting the material. Additionally, the farmers are paid the total compensation on delivery of the certified material on spot, while in the local market they have to wait up to one month to get the money from the sale of materials.

In terms of biodiversity benefits, the establishment of sustainable collection practices under the FairWild protocol has contributed to the conservation of 27 groves of *T. chebula* spread over 26 hectares. Meanwhile up to 750 large *T. bellirica* trees and their habitats, spread over 32 hectares across 11 villages, have been conserved in the Sangameshwar block, of which up to 400 have achieved FairWild certification. The ecological importance of *T. bellirica* is particularly noteworthy because many of the individual trees in question are large mature specimens that provide nesting sites for important seed dispersers. Thus, this project ensured the protection of 28 nesting sites of the Malabar pied hornbill (*Anthracoceros coronatus*) and five nesting sites of the great pied hornbill (*Buceros bicornis*).

India is one of the signatory countries to the Nagoya Protocol, which was ratified by the Ministry of Environment and Forest (CBD nodal agency) on 14 July 2014. Thus, it is now imperative that suitable institutional mechanisms are put in place for implementation of Access and Benefit Sharing (ABS). The National Biodiversity Authority and respective state biodiversity boards were given the mandate for implementation of ABS in India. The state biodiversity board of Maharashtra where the FairWild project is being implemented invited AERF to become the nodal organization for setting up biodiversity management committees – village level institutions vested with governing authority for sustainably managing biodiversity within villages. While this was a welcome and important step towards collaboration with the local government for implementation of ABS, it turned out that implementation through the government route was marred with impractical regulations, and thus the process came to a halt. As per regulations, the company sourcing raw material for manufacture and/or trading is supposed to pay a certain percentage (1.5% to 5%) of turnover as a royalty to the state biodiversity board, which in turn is to pay the respective biodiversity management committees about 85% of the royalty for conservation management of the village resources. While this is fine as a regulation, many doubt the intention and ability of the government to share the royalty with the village committees. On the other hand, through FairWild certification, the buyer pays between 10 and 30 percent of the total value of the purchased material from the respective village to the village collector committee as a premium fund every year. This fund can be used for any social work that the village committee finds appropriate. In this manner, the FairWild premium has significant overlap with ABS regulations. Thus with the FairWild certification scheme, distribution of benefits is more transparent, practical and easy to implement.

## 3. Discussion

To date this project has had major positive effects on the individuals and communities it has targeted, both human and non-human. However, it has also generated significant additional benefits beyond the pragmatic economic and ecological ones already described. In particular, the FairWild demand for documentary evidence of ownership of the resources being exploited, together with the intensive capacity-building sessions and other documentary requirements of FairWild and Organic certification, has helped these communities recognize and act upon the need to put their land records in order so that they can officially claim the ownership of the trees standing on their land. Similarly, they have come to a much better understanding of the nature of markets and the means by which consumer demands for good quality products can be more effectively met by changing their harvesting and processing practices, as well as how additional income can be generated by adding value at the beginning of the value chain. There was also the realization that these markets are not just local or regional, but extend across the planet, thereby connecting what is happening on the ground with global processes and understanding - thinking globally whilst acting locally.

A qualitative study by Sardeshpande (2016) of key informants along the value chains of the project provided valuable further insights into the impacts of this FairWild approach. Sardeshpande conducted semi-structured interviews with collectors (2), facility managers (2), project partner at AERF (1), DICE (3), TRAFFIC (2), and Pukka Herbs, Ltd. (1), as well as representatives of other firms also engaged in biodiversity value chains (2). These interviews

examined the pros and cons of certification, its challenges and prospects, market dynamics, and economies. The resulting data was illuminated with those from an online consumer survey (81 respondents) which explored product labelling, willingness to pay for FairWild certified products, the demand for certification in different product categories, and the perceived impacts of certified collection on forests and communities.

The evidence thereby generated supported the view that certification in general was unanimously regarded as making a very positive contribution to the marketing of NTPFs, although, at the same time, not seen as a panacea. More specifically, the implementation of FairWild principles in the context of this project was recognized as precipitating good management practices, equitable trading, and significant capacity building. It was seen to have provided vital monitoring of the resource, together with a degree of transparency that encouraged trust between the participants, which in turn would allow for long-term strategic planning. At the same time, the FairWild certification was believed to have acted as an important vehicle for integrating and promulgating socioeconomic and environmental ethics. Consumer respondents, though mostly (70-90%) found to be unaware of FairWild by name, overwhelmingly declared support for such schemes and indicated a willingness to pay a 15% premium for FairWild certified products once the schemes had been explained to them.

Interestingly, the range of perspectives differed between the different stakeholders. Whereas collectors and managers tended to emphasize aspects of landscape conservation and community participation, project partner representatives emphasized livelihood benefits and those associated with certification. Likewise, the buyers highlighted the investments required to achieve long-term sustainable returns. Collectors and source managers also perceived the certification scheme as an important means of incentivizing the conservation of otherwise undervalued and overexploited ecosystems, emphasizing the need to develop many more value supply chains of this type and to involve communities in adopting more sustainable use of the land. Further development was envisioned to make NTFP collection resilient to seasonality and market dynamics, to allow the practice to be extended to other forest fragments, and, through planting interventions, enable degraded habitat to be restored whilst providing sustainable livelihoods.

India's Biological Diversity Act of 2002 (BDA) calls for the formation of Biodiversity Management Committees (BMCs) which catalogue their local biodiversity in detailed Peoples' Biodiversity Registers (PBRs). BMCs and PBRs have already been successful in a few states, notably Karnataka, Kerala and Madhya Pradesh, but only sparsely adopted in most other states (NBA 2016). In this context certification-related inventorying may help bolster PBR efforts, particularly if the premium fund model proves to be an efficient mode of distributing benefits to the community. The certification implementation process can thereby act as a means of making the community as a whole accountable for and a stakeholder in forest conservation. However, the magnitude of the impact of the fund on communities is debatable because the amounts raised in the context of small volumes of product only afford the purchase of small household or public utility items such as pillows, detergent, and waste bins. This reiterates the need for larger product volumes and/or multiple supply chains.

Botanical medicines are used by a majority of the Indian population. Thus, incorporating certified products is likely to generate multiple benefits for biopharmaceutical companies to consider, particularly given the growing middle-class constituency whose values are progressively aligning with those that underpin the FairWild certification. However, it cannot be over-emphasized that despite all the positive aspects that this certification exercise has produced, it has been very expensive from a financial point of view. The cost of achieving FairWild certification was in the region of USD 15,000 in pure monetary terms, not including the value of the time and other resources contributed by the individuals and organizations involved. Without the funding and support provided by the Darwin Initiative, the Keidanran Nature Conservation Fund, AERF, DICE-SAC, Pukka Herbs, and TRAFFIC, it is highly unlikely that FairWild certification would have been achieved. Accordingly, the resource requirements must be effectively addressed if the successes identified in this project are to be duplicated elsewhere.

Finally, on a more positive note, it is worth highlighting the fact that this project was also innovative in bringing together stakeholder groups with quite different agendas - communities, NGOs, a private business, and an academic institution - in order to pursue a single cause: combining good practices and economic incentives to simultaneously benefit community development and biodiversity conservation. All participants reported that although they had been challenged at times by certain aspects of this institutional diversity, they had learnt a considerable amount in the process and were eager take the project forward in further collaborations.

## Appendix 1. Conservation outcomes achieved through FAIRWILD certification

The following list of plants, birds and butterflies documented from a single FAIRWILD certified site in Sangameshwar provides a glimpse into how much of the regional biodiversity can be conserved by providing positive economic incentives and skill building.

Appendix 1a. Diversity of plants documented at FW certified site in Village Devade, Sangameshwar block, northern Western Ghats

| Sr.no | Name of species | Common name | Family | Remark |
|---|---|---|---|---|
| **Tree** | | | | |
| 1 | *Acacia auriculiformis* | Australian acacia | *Leguminosae* | |
| 2 | *Artocarpus heterophyllus* | Fanas | *Moraceae* | |
| 3 | *Atalantia racemosa* | Makad limbu | *Rutaceae* | Fru/R/O |
| 4 | *Beilschmiedia dalzellii* | | *Lauraceae* | |
| 5 | *Bombax ceiba* | Sawar | *Malvaceae* | |
| 6 | *Bridelia hamiltoniana* | Jungli asana | *Euphorbiaceae* | |
| 7 | *Careya arborea* | Kumbha | *Barringtoniacee* | |
| 8 | *Casearia graveolens* | Bokhada | *Flacourtiaceae* | Fru |
| 9 | *Catunaregam spinosa* | Gela | *Rubiaceae* | |
| 10 | *Celtis cinnamomea* | | *Ulmaceae* | |
| 11 | *Dysoxylum binectariferum* | | *Meliaceae* | |
| 12 | *Erythrina stricta* | Pangara | *Leguminosae* | |
| 13 | *Ficus amplissima* | | *Moraceae* | L/O |
| 14 | *Ficus callosa* | | *Moraceae* | |
| 15 | *Ficus tinctoria* | | *Moraceae* | |
| 16 | *Flacourtia indica* | Atak | *Flacourtiaceae* | |
| 17 | *Garcinia indica* | Kokam | *Clusiaceae* | |
| 18 | *Garcinia talbotii* | | *Clusiaceae* | |
| 19 | *Garuga pinnata* | Kudak | *Burseraceae* | |
| 20 | *Grewia nervosa* | Asal | *Tiliaceae* | |
| 21 | *Holoptelea integrifolia* | Vavala | *Ulmaceae* | O/L |
| 22 | *Lagerstroemia microcarpa* | Nanya | *Lythraceae* | O/L |
| 23 | *Lepisanthes tetraphylla* | | *Sapindaceae* | |
| 24 | *Mangifera indica* | Amba | *Anacardiaceae* | O/L |
| 25 | *Memecylon umbellatum* | Anjani | *Melastomataceae* | |
| 26 | *Meyna laxiflora* | Alu | *Rubiaceae* | |
| 27 | *Nothopodytes nimmoniana* | | *Icacinaceae* | |
| 28 | *Pongamia pinnata* | Karanj | *Leguminosae* | R/O/D |
| 29 | *Sageraea laurifolia* | | *Annonaceae* | R/O/D |
| 30 | *Strychnos nux-vomica* | Kajara | *Loganiaceae* | |
| 31 | *Syzygium cumini* | Jambhool | *Myrtaceae* | |

| | | | | |
|---|---|---|---|---|
| 32 | *Terminalia bellirica* | Behada | *Combretaceae* | D |
| 33 | *Terminalia elliptica* | Ain | *Combretaceae* | |
| 34 | *Trewia polycarpa* | Ambani | *Euphorbiaceae* | |
| 35 | *Vitex altissima* | Tipani | *Verbenaceae* | |
| 36 | *Wrightia tinctoria* | Kala kudha | *Apocynaceae* | |
| 37 | *Xantolis tomentosa* | Katekumbhal | *Sapotaceae* | |
| **Palm** | | | | |
| 38 | *Caryota urens* | Bherli-mad | *Arecaceae* | R |
| **Shrub** | | | | |
| 39 | *Carissa conjesta* | Karavand | *Apocynaceae* | Fru |
| 40 | *Pavetta indica* | | *Rubiaceae* | |
| 41 | *Vitex negundo* | Nirgudi | *Lamiaceae* | |
| 42 | *Pogostemon benghalensis* | | *Lamiaceae* | |
| **Climber** | | | | |
| 43 | *Combretum latifolium* | | *Combretaceae* | |
| 44 | *Cyclea peltata* | | *Menispermaceae* | |
| 45 | *Dalbergia horrida* | Pedgul | *Leguminosae* | |
| 46 | *Diploclisia glaucescens* | Vatoli | *Menispernaceae* | |
| 47 | *Getonia floribunda* | Ukshi | *Combretaceae* | |
| 48 | *Gnetum scandens* | | *Gentaceae* | |
| 49 | *Hippocratea grahamii* | | *Celastraceae* | |
| 50 | *Hoya wightii* | | *Apocynaceae* | |
| 51 | *Jasminum malabaricum* | Kusar | *Oleaceae* | |
| 52 | *Moullava spicata* | Wakeri | *Leguminosae* | |
| 53 | *Mucuna pruriens* | Khaj khujli | *Leguminosae* | |
| 54 | *Olax imrbricata* | Kotluk | *Olacaceae* | |

| | |
|---|---|
| O | Old growth |
| R | Regeneration |
| Fru | Fruiting |
| Flr | Flowering |
| D | Dominant |
| C | Common |
| Unc | Uncommon |
| L | Large |

Appendix 1b. Diversity of birds conserved at FW certified site in village Devade, Sangameshwar, northern Western Ghats.

| Sr. no Birds | Scientific name | Common name | Endemic to WGs | Habitat specialist bird |
|---|---|---|---|---|
| 1 | *Perdicula asiatica* | Jungle Bush Quail | | Forest |
| 2 | *Nisaetus cirrhatus* | Crested Hawk Eagle | | Forest |
| 3 | *Stigmatopelia chinensis* | Spotted Dove | | |
| 4 | *Centropus parroti* | Southern Coucal | | |
| 5 | *Hemiprocne coronata* | Crested Treeswift | | Forest |
| 6 | *Megalaima viridis* | White-cheeked Barbet | Yes | Forest |
| 7 | *Megalaima haemacephala* | Coppersmith Barbet | | |
| 8 | *Aegithina tiphia* | Common Iora | | |
| 9 | *Lanius schach* | Long-tailed Shrike | | |
| 10 | *Dicrurus macrocercus* | Black Drongo | | |
| 11 | *Pycnonotus jocosus* | Red-whiskered Bulbul | | |
| 12 | *Pycnonotus cafer* | Red-vented Bulbul | | |
| 13 | *Prinia sylvatica* | Jungle Prinia | | |
| 14 | *Orthotomus sutorius* | Common Tailorbird | | |
| 15 | *Acrocephalus dumetorum* | Blyth's Reed Warbler | | |
| 16 | *Turdoides striata* | Jungle Babbler | | |
| 17 | *Alcippe poioicephala* | Brown-cheeked Fulvetta | | Forest |
| 18 | *Zosterops palpebrosus* | Oriental White-eye | | |
| 19 | *Zoothera citrina* | Orange-headed Thrush | | Forest |
| 20 | *Turdus simillimus* | Indian Blackbird | | Forest |
| 21 | *Copsychus saularis* | Oriental Magpie Robin | | |
| 22 | *Copsychus malabaricus* | White-rumped Shama | | Forest |
| 23 | *Cyornis tickelliae* | Tickell's Blue Flycatcher | | |
| 24 | *Chloropsis jerdoni* | Jerdon's Leafbird | | Forest |
| 25 | *Cinnyris asiaticus* | Purple Sunbird | | |

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Chapter 10

# Coastal communities and livelihoods in a changing world: A comparison of the fisheries and aquaculture sector in Matsushima Bay, Japan and the Salish Sea, Canada / USA

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## Abstract

The fisheries and aquaculture sector provides a broad range of nutritional and economic benefits that support the well-being of millions around the world. Many small-scale communities involved in fisheries and aquaculture are well-described by the concept of socio-ecological production landscapes and seascapes (SEPLS), where rich cultural traditions are inextricably linked with production activities and the management of surrounding ecosystems. Livelihoods in the sector are in a state of rapid change, as illustrated here by a study of coastal communities in the Matsushima Bay of Japan and the Salish Sea in Western Canada and the USA. In both regions, communities involved in this sector are rapidly shrinking and aging, and new entrants face similar barriers to getting started. Ecological and economic uncertainty, and the opportunities available in urban centers have caused many to leave the sector. Still others have sought to minimize risk through diversifying into other fisheries or other sectors, such as tourism. Depending on the priorities of local governments, communities and industry actors, a number of practical steps seem to be available to encourage new entrants into the sector, including through support mechanisms to lower initial entry costs. According to several respondents, however, people will follow their own impulses, and efforts to bind them or entice them into unpredictable livelihoods will falter. A cultural sense of obligation to continue the family business, or to maintain long-standing community traditions that are a source of local pride have also proven effective in some cases at sustaining communities.

**Keywords:** Coastal communities; Livelihoods; New entrants; Uncertainty; Diversification

> *People are attracted to a very romantic way of life. Being on the water. It's very independent. Dependent on your knowledge and ability to learn […] and living with and working with a variety of similar independent-minded folks. Fishermen here are – like in most places where I've met them – generally pretty independent minds. They're not all cut from the same cookie cutter.*

## 1. Introduction: Global trends in livelihoods within the aquaculture and fisheries sector

The fisheries and aquaculture sector exists at the nexus of food security, livelihoods and human well-being, while in many areas constituting a crucial element of cultural heritage and community cohesion (Coulthard, Johnson & McGregor 2011; CBD 2011; Minohara & Blasiak 2015). In 2014, some 167.2 million tonnes of capture fisheries (inland and marine) and aquaculture products were produced globally (FAO 2016). More than 87% of this was directly used for human consumption, constituting 17% of the global population's intake of animal protein (FAO 2016). Moreover, fish is a crucial source of micronutrients that provide rural populations in low-income food-deficit countries (LIFDCs) with key amino acids and fats needed for early-child development, and impacting lifelong health outcomes (Golden et al. 2016).

Globally, nearly 60 million people are engaged in capture fisheries and aquaculture activities, and an additional estimated 200 million people are employed in the processing, shipping and sale of associated products (FAO 2016 Teh & Sumaila 2013). Employment in the primary sector of capture fisheries and aquaculture, however, has followed starkly divergent trends in recent decades (Teh & Sumaila 2013). While employment in the aquaculture sector has roughly doubled in the 25 years from 1990 to 2014, employment in capture fisheries has been slowly rising in some parts of the world, while dropping in many of the world's most industrialized countries (FAO 2016). From 2000-2014, for instance, the United States and Canada have seen a collective 6% decrease in fishers, while Asia has seen an 8% increase (FAO 2016).

Such trends reflect a number of broader global dynamics: increasing industrialization and efficiency within fishing fleets in highly industrialized countries, the demographic shift of people from rural to urban communities, depletion of some fish stocks, and increasingly risk-averse fishery management regimes in some parts of world (Costello et al. 2016 UN DESA 2014 Worm 2016). At the same time, aquaculture production has grown dramatically, particularly in East Asia, and is on track to soon outpace capture fisheries in terms of global production volumes, although the long-term sustainability of such trends is unclear (Naylor et al. 2000).

These global dynamics are having a substantial impact at the local level, and on socio-ecological production landscapes and seascapes (SEPLS), where communities share an inextricable cultural connection with the surrounding ecosystems upon which they depend for their livelihoods and well-being (Ichikawa, Blasiak & Takatsuki 2012). Yet monitoring, assessment and future projections of ecological changes have outpaced corresponding attention to changes in social and cultural systems (Blasiak et al. 2017). This study considers changing livelihoods and communities at the local level by comparing the fisheries and aquaculture sector in two areas: Matsushima Bay in northeastern Japan, and the Salish Sea, which extends across the Canadian and United States border on the western coast of North America. Drawing on in-depth interviews with people involved in the fisheries and aquaculture sector in both areas, a portrait is drawn of how communities have been evolving within a changing world. While the scope of this study is limited and it does not seek to catalogue all socio-ecological changes occurring in the two regions, it is indicative of how rapidly conditions are changing for these communities, and the potential for transnational sharing of innovations to common challenges.

## 2. Methods

This study primarily draws on the results of a series of in-depth interviews with stakeholders engaged in the fisheries and aquaculture sector in two areas: Matsushima Bay in Japan (see Section 3) and the Salish Sea, which extends across the western coast of Canada and the United States (see Section 4). Additional secondary material was collected from relevant publications of the governments of Canada and Japan, the research community, and United Nations agencies.

### 2.1 Selecting interview partners

The selection of respondents for this research was heavily dependent on previous personal connections by members of the research team with communities in each location. In the case of Matsushima Bay, members of the research team had previously been involved as participants and researchers in community dialogue sessions aimed at facilitating multi-stakeholder dialogue among residents and other external actors (Minohara & Blasiak 2015). Field visits from 2011-2017 provided a deep knowledge of community structures and potential respondents. A member of the research team also grew up in a small fishing community along the Salish Sea, and was able to draw on a network of contacts in the region. Following discussion within the research team about the research objective (identifying changes in livelihoods and communities in fishing communities), an initial set of individuals were contacted to seek interviews. A snowballing method was subsequently followed in which interview respondents suggested further relevant respondents, who were in turn contacted.

### 2.2. Conducting the interviews

Prior to conducting interviews, the research team prepared a template of broad questions and themes to address with respondents (Appendix 1). This template provided the basis for semi-structured interviews that would enable the identification of commonalities and differences among respondents and communities. In line with the principles of informed consent, all respondents were first informed of the purpose of the research, and the intended use of the collected information. Respondents were furthermore offered anonymity and the opportunity to read and comment on the draft manuscript prior to publication. Interviews were conducted by Skype and telephone by members of the research team. Due to a tight research timeframe, a total of nine interviews were conducted – four with respondents in the Salish Sea, and five with respondents in Matsushima Bay.

### 2.3. Assessment of interviews

After conducting interviews, the research team discussed the results and compiled a list of four primary themes that repeatedly emerged over the course of the interviews as representing crucial factors in shaping changes in livelihoods and communities in the two locations. This resulting typology encompassed: (1) incentives and barriers influencing movement into and out of the fisheries and aquaculture sector; (2) role of production activities in shaping community structures; (3) sources of uncertainty in fisheries and aquaculture sector; and (4) role of governance and regulations in shaping livelihoods within the fisheries and aquaculture sector. Interview transcripts were reviewed, and key quotes and insights from the respondents were classified according to this typology (see Section 5).

## 3. The aquaculture and fisheries sector in Matsushima Bay (Japan)

Matsushima Bay is located in Miyagi Prefecture, in northeastern Japan's Tohoku region (Figure 1). As the name *Matsushima* (*matsu* = pine tree, *shima* = islands) implies, Matsushima Bay has long been famous for its scenic views, with 260 pine-clad islands of various sizes and shapes. Four of these islands are inhabited by a total of just over 350 residents (as of February 2017), and are known as the Urato Islands. Matsushima is known as one of the three most scenic spots in Japan ("*nihon-sankei*"), and also became the first bay in Japan to be designated as one of the "Most Beautiful Bays in the World" in 2013. The landscapes and seascapes forming Matsushima Bay have nurtured unique cultures and livelihoods since ancient times, and the area is protected by the Act on Protection of Cultural Properties.


Figure 1. Map of Matsushima Bay (Source: Google Map)

While tourism is a leading industry in the region, drawing nearly 8.4 million tourists from Japan and abroad in 2014 (Miyagi Prefecture 2016), the fisheries and aquaculture sector has played a key role in forming the socio-ecological production landscapes and seascapes (SEPLS) around Matsushima Bay for thousands of years. Archaeological excavations have uncovered about 70 shell mounds, and a number of pottery shards from the early Jomon period (around 4,000 B.C.) were excavated around the bay. This suggests that some 6,000 years ago the region was already home to *satoumi* communities, where people caught available fish and shellfish, many of which are still commonly consumed in the region, including oysters and clams (Okumatsushima Jomon-mura History Museum 2002). Some of the pottery demonstrated that a salt-making culture had been developed at this point as well.

The shallow and calm waters of Matsushima Bay have allowed people to make their livelihoods from farming oysters and seaweed, and this has played a considerable role in shaping the SEPLS of the bay. Oyster farming in Matsushima Bay began in pre-modern times, and its history can be traced back as far as the late 17th century (Miyagi Prefecture 1994). Seaweed (*nori* and *wakame*) aquaculture started more recently after World War II (Miyagi Prefecture 1993 and 1995). Oysters and seaweed (*nori*) produced in this region are both considered among the highest quality in Japan. While products from Matsushima Bay are currently sold in the domestic market, the bay was once tightly connected with international markets. In the mid-20th century, large quantities of seed oysters were exported to the US and France, until the oil shock of the late 1970s caused these exports to end (Miyagi Prefecture 1994).

A variety of fish are caught in the bay by small-scale fishers. Matsushima Bay also provides rich grounds for eelgrass (*amamo*), which is often referred to as "a cradle of the sea" as it provides spawning grounds as well as habitats for juvenile fish. The Great East Japan Earthquake and Tsunami of March 2011 severely affected the ecosystems of Matsushima Bay. The unprecedented tsunami not only washed away houses, aquaculture facilities and boats, but also uprooted eelgrass, resulting in ecological changes to the marine environment. Yet, continued efforts by local people and a variety of stakeholders, combined with the resilience of nature, have resulted in the fisheries and aquaculture sector rebounding, leading one oyster farmer to proudly state that "since Matsushima Bay contains a lot of high quality seaweed and makes a good 'soup', oysters grown inside the bay (*naiwan*) are so tasty!"

Figure 2. *Satoumi* landscape in Matsushima Bay (Photo: Akane Minohara)

## 4. The aquaculture and fisheries sector in the Salish Sea (Canada/USA)

Named in honor of the region's first inhabitants, the Salish Sea encompasses the bi-national marine waters of British Columbia's Strait of Georgia and Washington's Puget Sound and Strait of Juan de Fuca. The region is dotted with islands encompassing a complex ecological system of coastal waterways. It is among the largest and most biodiverse inland seas and fisheries in the world (PBI 2017). The nutrient-rich marine system has supported First Nations peoples for thousands of years, resulting in these aboriginal coastal communities forming close cultural connections with the SEPLS of the Salish Sea. For post-settlement communities, socio-cultural connections extend back over 150 years and have helped define the economic well-being and social fabric of the entire region. Today, on both sides of the international border, nearly eight million people live in the mainland watersheds and islands that sustain the Salish Sea.

The Pacific Northwest coastal fishery is known around the world for its legendary salmon runs, as well as for herring, halibut, hake, sea urchin, crab and shellfish. These fisheries have been an extremely important and valuable resource for coastal communities whose economies are partially dependent on fishing and whose identity and culture are directly linked to fishing. Today, the national government is almost entirely responsible for fisheries access and allocation in British Columbia, and recent years have seen many changes that are impacting local fishing communities and fundamentally altering the nature of the fisheries and associated livelihoods, particularly among the smaller coastal communities in the Georgia Strait (Figure 3).


Figure 3. Map of Salish Sea (Source: Google Map)

In the Strait of Georgia, salmon, the traditional economic driver of the fisheries, has seen significant decreases in catch rates, particularly among the Chinook and Coho. A variety of factors have been suggested as contributing to the drop in return rates of wild Pacific salmon, including impacts of climate change, ecosystem mismanagement (Evenden 2004) and the rapid growth of aquaculture along the north coast. The economic and social impacts of the introduction of individual transferable quota systems, a form of privatization of the fisheries in the 1990s, also affected the maritime cultural landscape of the region, making it more difficult for small subsistence fishers to survive. The consolidation of quotas and licenses, along with their soaring value, made entry into the fisheries sector an increasingly capital-intensive proposition, and encouraged the movement and consolidation of activities from rural coastal communities to urban centers; vessel ownership has likewise shifted from individuals to large companies. As one respondent explained, "In the mid-1980s, there were around 21,000 fishermen along our coast – there's now close to 6,000 fishermen. The number who are viable is probably closer to 2,000."

The region's fisheries are now increasingly functioning in an integrated globalized business environment, strongly influenced by international market forces. Some sectors of the fisheries have benefited from tighter regulation and international markets, particularly the well-managed geoduck and prawn fisheries. Prawn fishing in particular still retains strong family connections. While sustainable management is an important achievement, concerns remain in some cases about the sharing of benefits from resource exploitation, particularly for proximate communities.

The cultural and economic connection of coastal communities to the sea has shaped the region, but it is unclear whether fisheries will remain a meaningful and sustainable source of employment in the region over the longer term, or which cultural connections will endure. As one respondent emphasized:

> *The average age of fishermen across British Columbia is 62. The average age of skippers is 68. And we have people doing commercial fishing into their 90s in the communities here. It's certainly an aging fleet that we have. The number of youths who are getting into it is very small. The future of those communities and the culture and way of life associated with fishing is vastly shrinking.*

Or as another respondent explained, when asked to give a prediction of what the next 50 years hold for fisheries and aquaculture in British Columbia: "Oh, that's impossible to say…"

Figure 4. Commercial fishing boats along the British Columbia coast (Photo: Chris Cooling)

## 5. Results and Discussion

### 5.1. Incentives and barriers influencing movement into and out of the fisheries and aquaculture sector

Considerable overlap seems to exist in both of the regions with regard to the drivers of people leaving the fisheries and aquaculture sector as well as the barriers facing new entrants. One common aspect was perhaps best summarized by a respondent from Canada: "Young people, young people… well they have other things to do!" Indeed, both Canadian and Japanese fishing communities are characterized by a rapidly aging and shrinking population of people engaged in fisheries and aquaculture activities. Age and health concerns are causing many older participants to ultimately leave the industry, while a range of barriers face new entrants.

Across Japan, entry into fisheries is limited by the allocation of fishery rights and fishery licenses by national and local governments. In the case of coastal fisheries, fishery rights are managed by fishery cooperatives, and only those who meet certain conditions, such as being local residents and engaging in fishing for a minimum number of working days, can be considered for membership to participate in fisheries and aquaculture activities in the respective coastal waters. In this sense, after entering the sector, the individual becomes *de facto* bound to one landscape/seascape (SEPLS) for as long as they continue such activities. This explains why – aside from a few new entrants – the vast majority of people engaged in this sector in Japan have been engaged in fisheries and aquaculture for generations. Likewise, limitations exist for Canadian fisheries, and a finite number of licenses exists for certain fisheries. This challenge of securing a license in attractive or saturated fisheries constitutes one of the first challenges facing new entrants seeking to join the groups. Acquiring annual lease rights is also not cheap, and some new entrants pay up to 80% of the value of their landings just to cover this cost.

In addition, high initial investment costs set the bar high for those who wish to become fishers. A respondent who moved to an island in Matsushima Bay in 2016 explained that it would have been impossible for him to start seaweed farming if the company had not provided him with a boat and other necessary equipment and facilities. Such barriers were clear across both regions, with some groups facing particular challenges, as one respondent from Canada explained:

> *It's not easy for aboriginal people to borrow money. [In the past] banks didn't [consider] fishermen as good sources to invest in. It's only been in the last couple of years that banks actually have really stepped up to the plate to fund fishermen in acquiring licenses. You had to have cash to buy licenses before.*

While such dynamics limit people's movement into the industry, some people are drawn to the idea of a life by the sea, and to a closer connection with nature. This connection with nature, however, was perceived by respondents in Japan and Canada as a source of uncertainty and a source of bounty. One respondent from Canada, for instance, explained that, "People are attracted to a very romantic way of life. Being on the water. It's very independent." While another noted that life in such areas is not for everyone: "Fishing is a hard life and the millennial age is not necessarily geared for being away from home and the hard work that it takes to be a fisherman […] the comforts of home are not there." A Japanese respondent noted that "dealing with nature" involves certain risks and uncertainty, and, "Even you invest 100, you don't always get 100 back. You are dealing with nature, so it doesn't always result in production, but you always learn from it." Another respondent from one of the Urato Islands in Matsushima Bay, who realized a childhood dream of becoming a seaweed farmer, explained how he likes "the rhythm of the island". Despite the hard work, especially during the cold winter time, he emphasized the sense of accomplishment in living as a seaweed farmer.

Entry into the sector has been eased by some formal types of assistance that have contributed to changing the landscape of fishing communities. In British Columbia, for example, initiatives have been taken to bring young fishers together to discuss and share their experiences, and to identify barriers and seek pathways to addressing them. In Japan, a government-led initiative was launched with the aim of

Figure 5. Stay Station: The building was previously an elementary school and was used as the main evacuation center following the tsunami in 2011 (Photo: Akane Minohara)

making it possible for young people to transition from urban to rural areas to help revitalize communities. This initiative was used by the young seaweed farmer mentioned above, who was able to move to an island in Matsushima Bay and begin training as a seaweed farmer. In addition, all of the Japanese respondents emphasized the importance of a newly established "Stay Station" for islanders (Figure 5). This accommodation allows outsiders to actually "live" on the island, which would otherwise be a substantial challenge due to the ban on people not already living on the island buying land or building new houses (as the islands are protected by the Act on Protection of Cultural Properties). A local NGO consisting of young people who became involved in the reconstruction activities soon after the 2011 tsunami played a significant role in this case, acting as a mediator between local people and local governments. Without their efforts, it would have been difficult to deliver the local voice to the city government and identify local needs.

### 5.2. Role of production activities in shaping community structures

Although the communities in both Canada and Japan have undergone considerable change in recent decades, these changes have taken different forms. In Canada, all of the respondents could recall a time when fisheries along the coast were characterized by larger fleet sizes, higher fishing volumes, and a greater range of associated processing activities.

> *You would see a harbour full of fishermen, but now you see a handful of boats. In every community it's like that, the fleet is becoming smaller and smaller [...] some of it is industrialization, bigger boats, packer freezer boats out doing larger scale dragging but for the most part it's been about access and entry.*

Industry consolidation has likewise reshaped many of the small communities along the coast that had previously been predominantly dependent on fisheries. As one respondent noted: "In our outlying communities, there's very few people left for the fishing industry. It's more or less centralized itself in Vancouver." At the same time that the fishing industry has become more consolidated, coastal communities have grown more diverse:

> *The communities on the coast are very small. They've now all gone to tourism and recreational fishing and everything else. The competition for the fish is a good part of some of its problem. Places that were in the fishing industry – they've now gone to […] they can't fish on the coast anymore. […] Those days have gone with the dinosaur.*

Even for those who have remained in the fishery sector, fishing has become more of a "*business*" and less of a "*community-oriented thing*". At the same time, respondents felt that the ethnic and cultural dynamics within the sector had been changing with "new immigrants [replacing] generational Canadians", although noting that Canada's national history has long been characterized by successive waves of immigration. Moreover, some parts of the sector in Canada have grown increasingly connected to markets and economies outside the region, including the geoduck fisheries, which export primarily to markets in East Asia.

In Japan, due to the fishery right system for coastal fisheries and aquaculture, fishers' movement is more restricted and place-bound, with Matsushima Bay being no exception. Traditionally, the eldest son was expected to take over the family business, with fishery rights being passed down through generations. Shared connections fostered by fisheries and aquaculture activities have generated a strong sense of community that extends between the islanders themselves and to the surrounding landscapes and seascapes. During one field visit, a member of the research team encountered an old lady standing at a port waiting for her husband, who is over 80, to return from the sea with some breakfast. Similarly, a group of elderly men on Nonoshima Island still continue to farm oysters, proudly nurturing a tradition dating back to the 17$^{th}$ century in a place known as the regional origin of oyster farming. A strong historical and spiritual linkage also exists, extending from the mountain to the sea. Fishers from islands in Matsushima Bay would embark on pilgrimages to sacred mountains in Yamagata Prefecture to express gratitude for the year's good harvest, and their hopes of bounty in the coming year. Although this tradition is no longer practiced, stone monuments in a local shrine still serve as a record of past pilgrimages (Figure 6).

Figure 6. Stone monument showing a record of pilgrimage to Mt. Yudono (Photo: Akane Minohara)

Although many strong cultural linkages have been maintained with surrounding landscapes and seascapes, there have also been changes in the social system in Matsushima Bay's Urato Islands, especially since the Great East Japan Earthquake and Tsunami of 2011. Traditionally, seaweed farming was operated in family units. Husband-and-wife teams frequently worked in tandem on a boat ("*meoto-bune*"), and received support from their children when they landed. However, the seaweed farming and production facilities were washed away by the tsunami in 2011, and the only way to receive government support to rebuild the industry was to form a group and work collaboratively. They decided to establish a company and restart their operations, but some struggled to change their traditional way of doing things, feeling uncomfortable with a situation that was "like having a lot of CEOs in one company". Another respondent explained that working individually was much harder, and he used to "wear out [his] body", while working in a group is "wearing out [his] mind".

Respondents from both regions noted a growing "professionalization" within the fisheries and aquaculture sector. In the islands of Matsushima Bay, for instance, seaweed farmers and oyster farmers are referred to as *nori-yasan* and *kaki-yasan* (i.e. "*-yasan*" indicates pop-and-mom business" in an affectionate way) respectively, but now seaweed farmers have turned into "*salary-men*". While some have struggled to adjust to these changing conditions, the group-based seaweed farming has proven somewhat more accessible to new entrants, with one respondent emphasizing that he could not have started seaweed farming if there had not been a platform providing all the necessary support to get started.

### 5.3. Sources of uncertainty in the fisheries and aquaculture sector

High levels of uncertainty are one aspect of fisheries that renders management and planning decisions more challenging than other types of production activities. When it comes to the ocean, even fishers with a great depth of local experiences never gain control over nature. During the interviews, a variety of challenges related to ecological, social and regulatory uncertainty were raised by respondents in both countries.

Environmental changes, including degradation of ocean ecosystems, ocean acidification, rising sea temperatures and climate change were mentioned by several respondents as long-term changes creating uncertainty that influences their planning and management decisions. One respondent from Matsushima Bay, who is now in his late 50s, described how when he was a child, there used to be rich tuna stocks "just around the corner". At that time, he explained, the tuna fishery, without any sophisticated boats or equipment, brought a great deal of wealth to the island (Figure 7). However, when a large industrial port was constructed nearby in the late 1960s, the stock disappeared.

In Canada, fears of similar stock collapses have generated highly risk-averse management strategies and quotas:

Figure 7. Abundant tuna stocks around Matsushima Bay in the 1960s (Photo: Mrs. Takeyo Utsumi)

> *When you're fishing salmon years ago, you used to harvest those fish runs up to around 75 or 80 percent. Now you're down around 20 […] because the fish stocks aren't in good shape.*

Some changes have occurred on a much shorter time scale. Aquaculture and certain types of fisheries like set-net fisheries are particularly vulnerable to natural disasters, such as tsunamis and typhoons, as they cannot be easily moved on short notice. Some respondents pointed to fluctuations in catch and harvest levels driving the decisions of some people to leave the sector. Those who remain have frequently developed coping strategies to deal with uncertainty. For example, in Matsushima Bay, it is common for people to switch their primary livelihoods. Over the last few decades, for example, production activities have changed dramatically from traditional oyster farming combined with a seasonal tuna fishery. This was followed by a subsequent transition to seaweed farming when this grew more lucrative, and then to a partial return to oyster farming due to a spread of disease and increase in oil prices and mechanization in the 1970s.

A key strategy for coping with uncertainty in both regions has been the diversification of livelihoods. One respondent from an island in Matsushima Bay stressed that "diversification of risk […] changing your mindset […] not sticking to conventional ways and thoughts" are the keys to adapting to a changing environment and increasing resilience. Throughout his life, he has been involved in a variety of activities, including small-scale fisheries, harvesting clams and providing tourists with marine recreation opportunities. Today, he owns a guesthouse and works as an oyster famer. He also continues exploring better ways and techniques for fishing, which are not costly but "utilizing what they have" (Figure 8). On the Canadian side, First Nations communities have found success with operating traditional lodges that focus on cultural practices related to the sea. Visitors can participate in spiritual ceremonies connected to the Salish Sea and build stronger emotional ties to the region.

The speed and scale of changes impacting the fisheries and aquaculture sector proved to be a rich topic for discussion among respondents. Yet regardless of the uncertainty caused by changes in the natural, economic and social conditions, one factor remained constant, as captured by one respondent:

> *The ecosystem needs to be in balance [..] our ocean health has got to be our number one priority, it isn't an ocean we have total control over.*

Figure 8. A handmade floating lamp to attract more Icefish *(Salangidae)*, using empty coffee can and battery (Photo: Akane Minohara)

Figure 9. Salmon stocks have proven particularly challenging to manage due to high year-to-year variability in return rates (Photo: Chris Cooling)

### 5.4. Role of governance and regulations in shaping livelihoods within the fisheries and aquaculture sector

*Over the last 20 years, we've had both ecological changes and policy changes that have divorced people from the industry.*

The management of a public resource, like the Salish Sea, involves a complex and constantly evolving dialogue due to the wide variety of stakeholders, including First Nations communities, industrial fishing, and small-scale coastal fishers. One key change came primarily in the 1990s with the introduction of catch shares by the Department of Fisheries and Oceans Canada (DFO). While one hope of the policy was that it would not only result in more sustainable fisheries management, but would also benefit small-scale fishers and communities, respondents noted that the consolidation of the quota system had largely divorced the fishing fleet from a direct geographic connection to the resource, with management decisions being made in urban centers like Vancouver. In some cases, local communities were seeing few benefits from rich fisheries resources in their immediate vicinity, and had little role in stewardship of these resources. One result of increased consolidation within the industry was that it raised barriers to new entrants. The high cost of quotas as well as initial start-up costs have made it very difficult for (young) people to enter the industry, and have contributed along with other social factors listed in the previous sections to an aging population of fishers.

Many fishers who acquired quota when the system was introduced have continued to retain their quotas in retirement and now lease them to the highest bidder. Some fishing enterprises have sought to purchase these, reduce operating costs by "stacking" the quotas onto a few vessels and pressuring fishermen to supply them with fish at low cost. This in turn places additional pressure on small–scale fishers, who are already struggling to remain profitable.

Regulatory limitations on licenses, however, can also provide a foundation for sustainable practices. Two of the respondents, for instance, are currently employed in the geoduck fishery and have benefited from the limited licensing. This fishery has succeeded, in part, due to a shift to new global markets in China and efforts to add value to the product (developing processes to sell live geoduck as opposed to processed).

*It's an export market orientated fishery, and it was limited entry for a long time, only 55 licenses, so it's a small very well-managed fishery.*

The geoduck fishery is also characterized by concerted efforts to invest in market research and strictly monitor its environmental impact. Part of the fishery's success is also attributable to an agreement among the fishers to accept identical quotas, making it possible to shift focus from competition among fishermen to competition in the market place. This approach is the result of progressive thinking within the industry combined with effective co-management policies in the association.

In 2007, the DFO launched the Pacific Integrated Commercial Fisheries Initiative (PICFI) with a focus on environmentally sustainable and economically viable commercial fisheries with First Nations. Conservation is one of the main priorities under the initiative, but its success remains difficult to assess. Another key component of this policy is the retirement of existing quotas and allocation of this access to native communities to increase participation in the commercial fishery. There is also an attempt to improve transparency within the fishery all the way from harvest to consumer and to add value to the product along this chain. One respondent pointed to the recent acquisition of St. Jean's cannery in the Nanaimo area of Georgia Strait as a good example of a sustainable community-owned and operated enterprise. Stronger co-management practices with industry and government, and First Nations, are also crucial for the long-term success of this policy.

In Japan, it is common for small-scale coastal fishers to pass "rights to fish" from generation to generation, yet Japanese respondents also emphasized that financial issues have become a significant barrier for new entrants, and that government as well as community support is essential. They stressed how the "Stay Station" (see Section 5.1) and financial support provided by the local government for those who wish to become fishers or oyster/seaweed farmers in the Urato Islands have opened up new opportunities for the future of the island and new energy to break through various problems such as an aging and declining population, and lack of young successors. If a person wants to settle in a SEPLS, as one respondent put it:

*There must be something which keeps you there, giving you a sense of satisfaction, while at the same time, it must also give you enough to support yourself.*

A clear commonality throughout the interviews was that respondents felt the government can, and indeed must, play an active role in supporting the management of marine resources as well as the people working in this sector. The range of economic and financial pressures as well as the inherent uncertainty linked to livelihoods directly dependent on natural systems means that a continued role for small coastal communities in the fisheries and aquaculture sector in highly-industrialized countries like Japan and Canada is tied not only to somewhat intangible social factors (e.g.

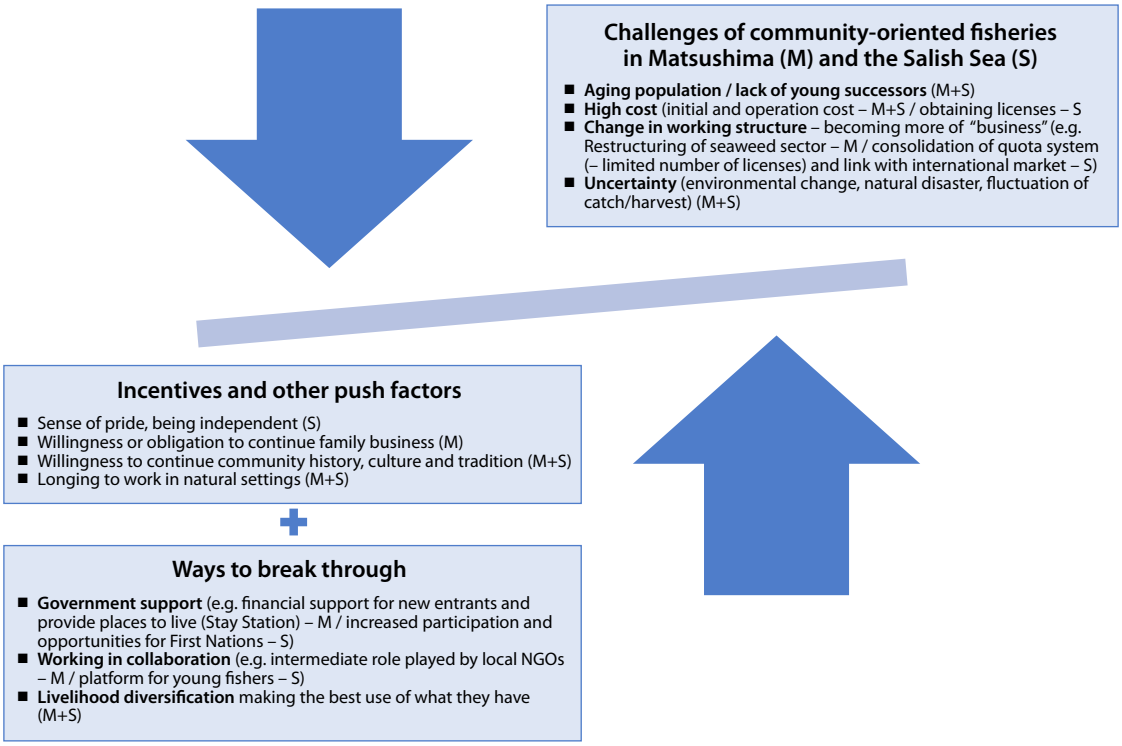


Figure 10. Factors (re-)shaping the fisheries sectors in Matsushima Bay and the Salish Sea

sense of pride, familial obligation, longing to work in more natural settings), but also to a range of highly tangible factors (e.g. availability of licenses, equipment costs, market access) (Figure 10). While a government or community may struggle to influence these social factors, a variety of actions can be taken to ease movement into the sector, and to reduce the vulnerability of traditional or small-scale actors.

## 6. Conclusion

> *Even in the age of technology you are isolated and kids don't want to be out of range of their cell tower.*

> *Our social systems are in as much change – if not more – as our ecological systems. […] Our knowledge and data on both are changing. We have much more data now on our ecosystems than we had 10 years ago.*

Livelihoods and social systems dependent on the fisheries and aquaculture sector are inextricably linked with marine ecosystems. Although extensive monitoring and data collection as well as the application of precautionary approaches to management decisions are key elements to ensuring that livelihoods are sustainable, nature remains unpredictable. People and their driving impulses also remain unpredictable in many cases. As one respondent noted, "Most [young people] can't wait to get out of rural places!" Yet for others, an emotional longing for a stronger connection to nature or for a more independent lifestyle drives them to enter the sector. Still others feel an obligation or desire to continue the family business or maintain proud cultural traditions.

Across both of the regions considered in this study, such dynamics were apparent. Additionally, small communities that were once largely self-sufficient are now culturally and economically linked with surrounding areas, and international markets, creating new opportunities and challenges. A common theme throughout the research, however, was that these external pressures and the inherent uncertainty of natural and social systems can be mitigated in a variety of practical manners. Barriers to new entrants can be eased through community, industry, or government support; ecosystem monitoring and participatory decision-making processes can contribute to effective management practices; and specialization in high-risk production or harvesting activities can be mitigated through diversification. Communities in both study locations are in a state of rapid change. But recognizing that communities are the result of constantly shifting social, ecological and economic dynamics, change is to be expected.

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## Appendix 1: Guiding questions/themes for semi-structured interviews

Introductory statement:

1) Who we are (fisheries researchers based in Yokohama and at the University of Tokyo)
2) What we're doing (research on dynamics of livelihoods in fishing communities).
3) Why we are doing this research (contribute to a United Nations University publication on livelihoods in "socio-ecological production landscapes and seascapes" – i.e. places where people share strong cultural linkages with their surrounding landscapes/seascapes through sustainably managing their resources)
4) How we will use interview data (can be anonymous or attributed depending on their preference – will be used for open-source research publication by the United Nations University)

Guiding questions/themes:

1) General introductory question: Tell us about how you became involved in the fishing industry and your current work/job.
2) How has the fishing community changed since you starting working in it?
3) Based on your experience, has the number of young people engaged in the sector been generally increasing or decreasing?
4) What are the main reasons for (young) people to leave the fisheries sector or decide not to enter it?
5) What are the most attractive aspects of the fisheries sector? (i.e. what draws people in?)
6) What forms of support exist for people who want to become fishers / aquaculturalists in your community?
7) What barriers exist to people who want to become fishers / aquaculturalists in your community?
8) What do you see as the long-term future of the fisheries/ aquaculture in your community?
9) About family (whether his/her parents were/still are involved in fisheries/aquaculture)
10) If born into a fisher's family, whether he/she had other choices than becoming fishers
11) Whether they have successors (his/her own child or other young people)
12) If they have children, whether they want them to become fishers/aquaculturalists too
13) What changes have you seen in the local fisheries with regards to licensing, government regulations, environmental change, catch volume, markets, etc.?
14) As a fisher or aquaculturalist, what changes have you witnessed regarding young people entering the industry, economic viability, relationships with the community and others in the sector?

Chapter 11

# Enhancing livelihoods of Lake Victoria fisher folk through control of the predator Nile perch in Uganda

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## Abstract

Lake Victoria Basin has a population of 40 million, with a population density of 250 people per square kilometre. Lake Victoria is bordered by Uganda, Tanzania and Kenya. It is the main source of food and livelihoods for riparian communities. The predator Nile perch, which was transplanted in the lake in 1950 by the British colonial administration, decimated the population of smaller fish, which were traditionally a source of food and livelihoods for lakeside communities. The Nile perch fishery produces one million metric tons of fish for export per year, but economic benefits flow almost exclusively to foreign companies.

Due to high demand for Nile perch in the international market, prices have soared beyond the common man's reach. Expansion of capital intensive, industrial level operations in Nile perch harvesting, processing and marketing has resulted in massive transfers of protein supplies away from food deficit areas to serve the lucrative export markets. The involvement of large firms in capture operations has marginalized artisanal fisher folk, forcing them to engage in subsistence agriculture, burning charcoal for sale and selling wood fuel. With the disappearance of significant native fish numbers that feed on algae and detritus, the organic material is left to decay and sink to the lake floor, where its decomposition absorbs the oxygen available for fish living in deeper layers of the lake.

In spite of extensive research on Lake Victoria, no action has been taken to restore the native fishery in order to sustain the livelihoods of 40 million people that depend directly or indirectly on the lake. To a large extent research work is externally conceived and financed, and is silent about the plight of riparian communities and the dying lake that serves as their life support system.

Towards this end, EPIC, together with its partners, is developing responses that seek to raise awareness on biodiversity and the humanitarian crisis in the Lake Victoria region. These responses aim to promote recovery of threatened endemic fish species and to support local communities in rebuilding their fishing villages by applying both traditional knowledge and modern science. They are also designed to enable farmers in the surrounding watershed to adopt the Vetiver Grass Hedgerows System to control nutrient-loaded runoff, and also to develop skills in innovative entrepreneurship. Activities are expected to contribute to restoration of biological diversity and ecosystem function as well as recovery of the native fishery, hence enhancing the livelihoods of lakeside communities. The project will also expand livelihood options to reduce pressure on the fish stock.

**Keywords:** Lake Victoria; Livelihoods; Native fishery; Nile perch; Uganda


Figure 1. Map of Lake Victoria basin
(Source: https://practicalconservationmanagementwikispaces.com/lake+victoria+basin, accessed September 2017)

## Background information

The Lake Victoria Basin (LVB) has a population of 40 million with a population density of 250 people per square kilometre. The lake is shared by Uganda, Tanzania and Kenya, and prior to the 1980s, was the main source of food and livelihoods for riparian communities. According to a lake-wide trawl survey at the end of the 1960s, haplochromine species (cichlids) endemic to Lake Victoria comprised 80 percent of the demersal fish biomass of Lake Victoria (Kudhongania & Cordone 1974, cited in Njiru et al. 2005). Following the introduction and establishment of the predator Nile perch (*Lates niloticus*), the contribution of haplochromine cichlids to fish biomass decreased rapidly, from 83 percent during the 1970s to less than one percent by the mid-1980s (Njiru et al. 2005). The ecology of the lake has been turned upside down causing a total collapse of the native fishery. Introducing Nile perch and tilapia to Lake Victoria traded the lake's biodiversity and an important a source of local food for a significant, although unsustainable, source of export earnings.

Prior to the introduction of Nile perch, people enjoyed a diversity of fish species, and the native fishery was dominated by the cichlids, which contributed significantly to household incomes and served as a source of affordable protein for a large section of the wider society. Pringle (2005) asserts that haplochromine cichlids were widely utilized by local fishermen, but the British disdained them, labelling them "trash fish".

In those old good times, of the 1930s, when the fisheries were predominantly native, a kilogram of fish cost UGX 10 (Ugandan Shillings) and demand arose from the local markets.

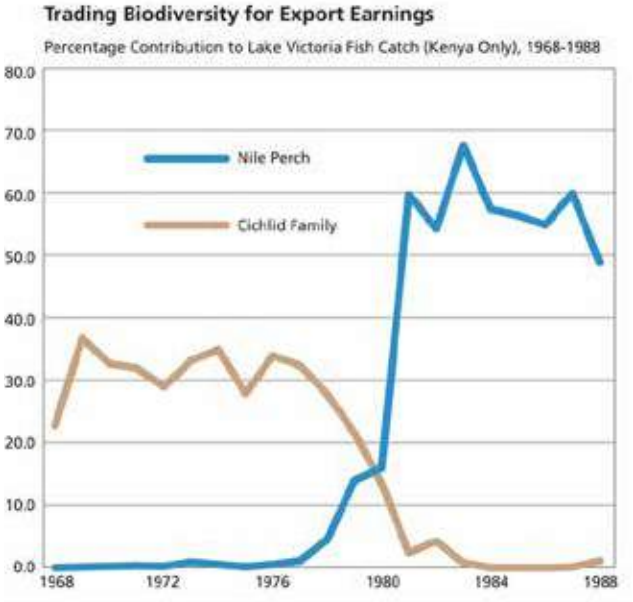


Figure 2. Changing contributions to Lake Victoria fish catch
(Source: A Guide to World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life, World Resources Institute 2000)

Figure 3. Photo of Haplochromine cichlid (Source: http://www.pinterest.com304978205992886134)

Economic activities in the fisheries were structured around the family unit, which facilitated the distribution of economic benefits at the nucleus of society. The roles of men and their sons included boat construction, repairing broken fishing nets and capture of fish, whereas women and their daughters processed and sold fish in the local markets. Women also sold *mukene* (*Rastrineobola argentea*), a tiny fish used as a sauce, to the poor who could not afford to buy bigger fish. Likewise, women prepared food and sold it in local markets. Trust and a sense of ownership were the drivers of a flourishing sustainable native fishery that secured benefits for biological diversity and human well-being. Partners in ownership were more decentralized, and income from fish catches was fairly and evenly distributed (Kayiso 2009). Household income was high and therefore people faced fewer hardships in paying family expenses, e.g. paying school fees for their children or buying basic necessities. Steady income was a factor in stabilizing marriages according to local beliefs.

Around 1900 large scale sugar works and tea estates were established in the surrounding watershed to take advantage of fertile soils and frequent rains. They attracted immigrant workers seeking employment who settled in the lake basin, hence increasing population and demand for lake resources. The influx of immigrants had social, economic, ecological and cultural impacts on the fishing villages. For instance, the locals learnt new fishing methods from immigrants such as *pokoto* from Lake Kyoga. Jaluo women from Kenya brought knowledge of medicinal properties found in the *enkeje* (cichlids) fish species.

Population explosion increased the demand for fish and resulted in hikes in fish prices. However, at the same time, it was possible for artisanal fisher folk to retain profitability in fisheries based on their effort to work in a cost effective manner within the ecological limits of the fish stock in the lake. Native fisheries harvests used small manually propelled rafts and simple dugout canoes and other affordable local materials such as papyrus seine nets, basket traps, harpoons and hooks. These crafts could not go long distances from shore, and therefore had little or no impact on fish stocks. Traditional fish capture methods provided employment opportunities for young men. The supply deficit was a blessing in disguise because it created room for participation by more local fishermen in the capture of fish to supply the growing fish market. It also offered opportunities for innovation to cope with increasing demand. At that time, small scale operators dominated the fish processing and trading subsectors, according to Abila (2000, cited in Njuri et al. 2005). These were mainly women; they sold fresh fish and processed the surplus using simple technologies such as smoking, salting and sun drying for later sale. The traditional fish harvesting methods were therefore economically viable, environmentally sound and socially acceptable in that they supported the livelihoods of the locals in terms of employment creation and generating income for households. Both men and women were fully employed in the capture, processing and marketing of fish. The elders we talked to claim that their livelihoods were far better than they are today following liberalization of Lake Victoria fishery.

Notwithstanding the above social trends and economic performance, around 1900 the British colonial administration established a large fisheries industry in Lake Victoria, purportedly to meet the high demand for fish by the growing population and to take advantage of the arrival of the new railway line from the East African coast. The move was also designed to allow entry of the colonialists in the fish trade, to secure their dominance and control of resource use to the detriment of the livelihoods of riparian communities. Poverty was one of the tools used by colonialists to subdue their subjects. It can be inferred, therefore, that the plight of livelihoods in the Lake Victoria SEPLS was deliberate and a result of hostile policies of colonial rule. The colonialists introduced nylon gillnets and outboard engines which allowed large numbers of fish, particularly the cichlids, to be caught, leading to a sharp decline in the native fishery. Hence, the livelihoods of lakeside communities started to deteriorate. In 1950, the British colonialists illegally introduced the predator Nile perch (*Lates niloticus*) and tilapia to Lake Victoria, amidst protests from scientists and the media. Moreover, Pringle (2005) shows that, in 1950, the East African High Commission implemented the Lake Victoria Fisheries Act. The act initiated several conservation measures, one of which was the stricture that "any person, who introduces, puts or places into Lake Victoria any fish, or the spawn thereof, of a species other than that in Lake Victoria...shall be guilty of an offense against this Act." This

Act was disregarded by colonialists and their agents, the first transplants were branded and locals were asked to throw them back in the lake when found in their nets.

The introduction of Nile perch in Lake Victoria was first proposed by Graham (1929), to feed on what was termed "trash fish" and convert the population of fish in the lake into larger fish of greater commercial and recreational value, reports Anderson (1961, cited in Taabu 2004). The eventual move to introduce the alien species did not give due consideration to the locals who depended on the fish in the lake for their livelihoods and as a source of protein and medicine. The decision deprived the natives of their livelihoods and concentrated economic benefits derived from the newly established fishery among a few foreign companies. The colonialists being exploiters and plunderers of natural resources had projected the inability of the poor artisanal fisher folk to access the capital required for investment in Nile perch fishery due to lack of collateral, which gave the foreign companies the exclusive monopoly in the Nile perch fishery today. This deliberate attack on riparian communities and their resources, has resulted in acute poverty and misery up to the present day, is tantamount to a crime against humanity and contradicts the United Nations Sustainable Development Goals: 1) End poverty in all its forms everywhere, and 2) End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

The following section will examine the threats and challenges emanating from the loss of native fish species diversity and how these threats and challenges have affected the livelihoods of riparian communities in the Lake Victoria Basin. Examination is based on our many years of engagements with different stakeholders in the Lake Victoria SEPLS, existing reviews and first-hand information gathered from both men and women that participated in the native fishery prior to the introduction of Nile perch.

## 2. Threats and challenges

Today poverty and degradation are inextricably linked around the lake where they both occur on a vast scale. The Nile perch boom starting from the 1980s had far-reaching social, economic and ecological repercussions on the livelihoods of lakeside communities, but this paper will discuss only the first two. The growth of commercial fisheries, especially Nile perch export, resulted in reductions in fish stocks and availability of fish to local communities in the Lake Victoria region. This decline in fish has not only threatened the livelihoods of artisanal fisher folk and processors but also threatened the nutrition and food security of populations in the region, as suggested by the

Figure 4. Photo of the predator Nile perch (Source: https://www.pintrest.com/fishfanatics/perch)

study of Kabahenda and Hüsken (2009). The export oriented fishery has further led to marginalization of women in the post-harvest sector. This dealt a big blow to the level of nutrition and fish food security within fishing households since women are responsible for producing and preparing food in the African family setup.

Indeed, bigger turned out not to be better for the local population, Nile perch are found too far out in the open water for small fishing boats, and are too big to be caught with unsophisticated gear. They are hauled by the ton from the open lake by large commercial boats and sold to nearby foreign-owned processing plants where they are rapidly cleaned, filleted, boxed and frozen. From there, they are sent off to the delicacy freezers of food stores in the Middle East, USA and Europe, leaving lakeside communities starved, physically weak and unable to carry out any meaningful work to earn a living. Only factory rejects and bones are left behind for local markets.

The collapse of the cichlids fishery, which was also the engine of the local economy, was caused primarily by the introduction of two exotic species, the Nile perch and tilapia. The Nile perch fed on the cichlids and outcompeted them for food. A voracious predator, the Nile perch has virtually eaten its way through all its potential prey species, destroying the diversity of the lake's fish species and the related livelihoods of the indigenous people.

Furthermore involvement of large firms in capture operations marginalized artisanal fisher folk leading to unemployment and decline in household income. This has forced them to engage in subsistence agriculture on fragile landscapes causing severe soil erosion. They also burn charcoal and sell wood fuel which is directly related to deforestation. The few jobs created by the processing

Figure 5: Photo of the local council chairman of Kikondo fishing village talking to Mr. Imran Ahimbisibwe of EPIC on how the decline of native fishery has affected the livelihoods of local people (Photo: EPIC)

Figure 6. Photo of the fish market at Masese landing site. Decline in native fishery has left traders idle in fish markets (Photo: EPIC 2017)

plants, bearing in mind that most of the work is done by machines, do not necessarily benefit the lakeside communities, but rather are taken up by other people from a different section of society. Anonymous sources informed us that labour gangs hired by the companies in the fishery are not necessarily from among those who lost their livelihoods, and that they can be from anywhere inside or outside the country. This leaves the indigenous people as the victims of extreme poverty, sometimes forcing them to immigrate to urban centres in search of hard-to-get jobs. As currently more capital is needed to engage in fishery, those who do work as fishermen are often not the boat or net owners, but the employees. This has led to a situation whereby the owners of the resource have become slaves on their own property, earning far less than what they used to earn when they were fish traders. This situation raises the issue of equity in relation to access to productive resources and distribution of benefits. The growing involvement of wealthier entrepreneurs, politicians and industrial firms in the Nile perch fishery jeopardizes every effort aimed at enhancing the livelihoods of the poor through the revitalization of the native fisheries, simply because the former influence the steering of policy processes and measures to their advantage. Large-scale trawling, processing and export marketing operations have caused shortages in the supply of fish for local markets, thereby undermining the growth of local economies and worsening poverty levels.

Fishermen are now away from home for extended periods and their wives and other members of the family are no longer involved in their activities, typical unemployment of the highest order. Due to the relatively high price of fish, managers do not like fish to be taken home by crew members, who happen to be the true owners of the resource. The controversial Nile perch fishery is characterized by deprivation, denial and daylight robbery of the weak by the powerful. The increased value of the nets and the fish has led to the increased incidence of net and fish thefts, according to U.S. Fish and Wildlife Service (2014). Fishermen now do not earn enough to meet all their basic needs because they are underpaid as casual labourers in lieu of making profits in fish trade. "In those good old days we took all our catch back home to our wives, but now we take the fish to the factory leaving our families with nothing at all to eat" explained Mr. Mulongo, the Local Council Chairman (Figure 5).

Due to high demand for fish on the international market, prices have soared beyond the common man's reach. The current cost of one kilogram of fish is UGX 30,000 (USD 10) according to local sources. The effects of the changed fishery, characterized by loss of livelihoods and economic exclusion, are unacceptable with respect to the societal norms of riparian communities, and constitute a serious environmental problem with an international dimension. The locals have forfeited their lake-dependant livelihoods in the name of liberalization, but at the same time they cannot afford the price of fish in the market. Parents can no longer afford to put their children through school and the numbers of street kids have increased, as have the levels of social crimes. Women in the lakeside communities prostitute themselves to survive, one lady respondent at Ripon landing site claimed. This is backed up by the fact that reports of the first victims of HIV/AIDS, a deadly sexually transmitted disease, came from Kyotera in Masaka on the shores of Lake Victoria in the late 1980s. Women in the Masese fish market have switched to tomatoes (Figure 6), explained Deborah Kwebiha of the Masese landing site market. Meanwhile others work as house maids. Likewise, *mukene* trade is also declining due to changes in the mixture of chick feed where soya is now the main ingredient, according to local sources in the Kikondo fishing village. Locals have also complained

that climate change has reduced the productivity of wetland rice schemes, leading to loss of jobs.

When the colonial administration introduced the Nile perch, they altered the balance of goods and services the lake produced and redistributed the economic benefits flowing from them. Lake Victoria supports the largest freshwater fishery in the world, producing one million tons of fish per year; however, riparian nations are among the poorest in the world, reports the African Great Lakes Conference (2016). In spite of the general economic boom, the changed Lake Victoria fishery has concentrated income among a smaller proportion of participants in the fishery, leaving the majority poor. Local people have progressively been edged out of this production by the pricing, marketing and processing advantages of the factories, as reported by Abila (2000, cited in Njuri et al. 2005). The liberalization of fish trade around the Lake Victoria Basin has resulted in negative social and economic trends in form of food insecurity, loss of jobs and livelihoods and reduced household income. Kabahenda and Hüsken (2009) indicate that although it is often argued that an increase in returns from the sale of value-added products improves national income and food security, evidence from the Nile perch boom shows that commercialization of fish products does not have direct benefits for local communities that depend on these products for food. For example, the report on high levels of malnutrition among children in the Suba district (Abila 2006a, cited in Kabahenda & Hüsken 2009) which is a major fish exporting district on the Kenyan side of Lake Victoria, is not an isolated case of malnutrition resulting from insufficient regulation of exportation of fishery resources. This is well echoed in "Big Fish, Small Fry", a documentary on the effects of globalization of Lake Victoria fisheries on food security, employment, and incomes of local communities (Jansen & Boye 2001, cited in Kabahenda and Husken). One respondent to EPIC's survey from Kikondo fishing village reported that some families can hardly afford to eat one meal in a day. He appealed to donors and the government to provide food aid to the starving lakeside communities.

The affected communities believe that other livelihood options need to be explored. They call upon the government to regulate the Nile perch industry in order to allow more participation of local fishermen in the capture and sale of fish in local markets. Others want to see the Nile perch eradicated from the lake in totality to enable restoration of the native fishery and enhancement of their livelihoods. The majority of respondents agree that, as the ecology of the lake is being restored, it is time to switch to other income generating activities, such as poultry or bee farming, goat rearing and handicrafts, but they lack skills and capital.

## 3. Responses: Existing and proposed interventions

In terms of existing interventions by different stakeholders seeking to address the many threats facing the Lake Victoria SEPLS, a number of actions can be highlighted.

### 3.1. The Lake Victoria Environmental Management Project (Phase 1)

The Lake Victoria Environmental Management Project, Phase 1 (LVEMP-1), covering Kenya, Uganda and Tanzania and funded partly by the World Bank, was a multi-stakeholder initiative in which the three riparian states participated and contributed funds. It supported many knowledge-building activities that advanced understanding of the lake's ecosystem, particularly in the areas of biodiversity of fish (establishing a baseline), levels and sources of pollution, fish stocks, and hydrology. Significant work by the fish quality laboratory resulted in the lifting of the temporary ban by the European Union (EU). Needless to say, the project did not address the direct cause of the decline of native fishery and livelihoods, namely the predator Nile perch. It failed to make, as its starting point, comparison between the merits of native fishery and those of the exotic Nile perch for local economies and ecosystem function, thereby missing the significance of traditional management systems and sound biological diversity that preserved the lake for centuries, while at the same time generating benefits for human well-being. Instead the project promoted and supported development and expansion of the Nile perch fishery at the expense of biological diversity and livelihoods of locals.

### 3.2. Lake Victoria Environmental Management Project (Phase 2)

The Lake Victoria Environmental Management Project, Phase 2 (LVEMP-2) is a regional project implemented by five East African partner states: Uganda, Kenya, Rwanda, Tanzania and Burundi. Its objectives are achieved through four broad project components: (a) strengthening institutional capacity for managing shared water and fishery resources, (b) point source pollution control and prevention, (c) watershed management, and (d) project coordination and management. It is however imperative to state that under component (c) watershed management, eight kilometres of terraces have been excavated and bunds maintained as an on-farm measure for soil and moisture conservation on the Uganda side. However, the terraces get filled with silt while the bunds get washed away by runoff. Hence, the Environmental Protection Information Centre (EPIC) is proposing the Vetiver Grass Hedgerows System, a vegetative technology that creates permanent terraces. LVEMP-2 also

does not address the direct causes of decline of livelihoods, emanating from introduction of Nile perch in the lake.

### 3.3. Lake Victoria Fisheries Research Project

The Lake Victoria Fisheries Research Project (LVFRP) was established in 1997, by the three East African states of Uganda, Kenya and Tanzania, with financial support from European Union. Its principal objective was assisting the Lake Victoria Fisheries Organization in the development of a framework for the rational management of the lake's fisheries. This research project too arrived at a time when the Nile perch had already damaged the lake's native fish stock and established itself. The project did not perceive the introduced exotic Nile perch as a pertinent issue deserving thorough study to ascertain its socioeconomic impact on riparian communities. One of the areas LVFRP has addressed was an attempt to involve fishing communities in managing the lake's fisheries through Beach Management Units (BMUs). However, BMUs are regarded as ineffective by the fisher folk because they do not guarantee the flow and fair sharing of benefits from the new fishery. They also complain that BMUs are created politically and as such do not represent the interests of impoverished lakeside communities, reports EPIC (2016, pp. 35&39). Furthermore, this research project did not contribute to solving contemporary environmental problems associated with the biological diversity crisis and the controversial Nile perch fishery, which are central to the cause of decline of livelihoods of riparian communities. On the contrary, emphasis was put on stabilizing Nile perch in the lake at the expense of the native fish stock that is supportive of local economy and livelihoods.

Figure 7. In the center of the red colored arc, the photo shows the water hyacinth weed growing on Lake Victoria adjacent to unprotected cultivated land in Kikondo fishing village, from where soil nutrients wash down into the lake through runoff (Photo: EPIC 2017)

### 3.4. Environmental Protection Information Center (EPIC)

The Environmental Protection Information Center (EPIC) is a non-governmental and not-for-profit organization which was conceived and registered in Uganda in 1998 to address environmental issues in the region. EPIC aims at informing minds, reforming lives and protecting biodiversity for human well-being. Our work has resulted in the improved quality of life in several marginalized and poor communities through protection, conservation and sustainable use of natural resources. Our multidisciplinary orientation provides a strong platform for discussing rural policy issues and increasing awareness on why investment in natural resources management and rural development is critical in reducing poverty, improving food security and enhancing biodiversity conservation. EPIC organized a workshop on Socio-Ecological Production Landscapes and Seascapes (SEPLS) from 7-10 August 2017, in Jinja, Uganda with financial support from the Satoyama Development Mechanism (SDM). The workshop took participants to the three fishing villages of Masese, Wanyange and Ripon landing sites on Lake Victoria, to test the three-fold approach of the Satoyama Initiative, and to assess the situation of the livelihoods of lakeside communities. Community members were given a chance to express their concerns. Ones of their complaints was that they are not consulted by government on lake management related issues. The workshop created a shared understanding on issues related to the lake resource management, loss of biodiversity and decline of livelihoods, among other things.

EPIC is working with local authorities in Kikondo, Tongolo, Wanyage, Masese and Ripon, to support 10,077 smallholder farmers from the above fishing villages in the adoption of the Vetiver Grass Hedgerow System for soil and moisture conservation, in order to increase soil nutrient retention levels in their crop fields, and improve yields. The hedgerows will also prevent nutrient-loaded runoff from washing down into the lake causing eutrophication (Figure 7). Local authorities in the Kikondo fishing village have requested EPIC to setup a vetiver grass nursery for the community to serve as a source of planting material. They have offered two hectares of land for this purpose.

After consultations with the National Environment Management Authority (NEMA) and the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) of Uganda on promoting the recovery of threatened endemic fish species of high economic and ecological value (particularly those that are preyed on by the predator Nile perch in Lake Victoria), the MAAIF has most recently approved EPIC's proposed intervention that seeks to utilize sand pits in Katonga swamp in the Lake Victoria Basin for conserving

and breeding diverse native fish species. Targeted species include *Alestes* (*Nsoga*), *Bagrus* (*Semutundu*), *Barbus* (*Nkisanja*), *Haplochromis* (*Kenjje*), *Labeo* (*Ningu*), *Mormyrus* (*Kasulabane*), *Synodontis* (*Nkolongo*), and Tilapia (*Ngege*), among others.

EPIC intends to bring on board various stakeholders to create linkages particularly between private investors in Lake Victoria fisheries and upland famers in the surrounding watershed with a view towards initiating incentive schemes such as Payment for Ecosystem Services (PES) to motivate farmers engaged in sustainable conservation livelihood activities to address socioeconomic and ecological challenges, as a win-win for the two sides and ecological restoration.

A number of activities are being proposed by EPIC in full recognition of the interdependence of the socio-ecological and economic factors responsible for the plight of local communities and their livelihoods. Enhancing the livelihoods of affected communities must therefore go alongside restoration of the biodiversity and ecological stability of the lake to enable a sustainable, sound native fishery to flourish on the lake again. This can be achieved through ensuring integration of both social and ecological aspects in the management of Lake Victoria fisheries. The intervention proposed by EPIC has five (5) key activities, summarized below.

## 4. Key activities of intervention

- **Training workshops**

National, regional and local training workshops will be organized by EPIC to raise public awareness on the biological diversity crisis in the Lake Victoria Basin (LVB) and the resulting plight of livelihoods of riparian communities, among others. At the local level skills will be imparted in innovative entrepreneurship to reduce pressure on fish stocks.

- **In-situ conservation sites**

Establishment of in-situ conservation sites is planned. Threatened and depleted fish species of high economic and ecological value will be bred and conserved near to their natural habitats.

- **Vetiver grass nurseries**

Large-scale vetiver grass nurseries will be setup by the project, one in each country for Uganda, Kenya and Tanzania. These will serve as sources of planting material for upland farmers and the entire community in the SEPLS. The application of Vetiver Grass Hedgerows Technology by farmers in the surrounding watershed will control eutrophication in the lake and stop the growth of the water hyacinth weed caused by excess soil nutrients. These efforts will contribute to the achievement of Aichi Biodiversity Target 7 (By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity) and 8 (By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity).

- **On-going research**

Research will be carried out by EPIC and its partners on the predator Nile perch that threatens other fish species and habitats in Lake Victoria, with a view towards eradicating the alien species in accordance with Article 8(h) of the Convention on Biological Diversity (CBD).

- **Creation of mechanism for information sharing**

A website for the project will be setup to enable information dissemination and sharing.

## 5. Conclusion

Although much research work has been devoted to the fisheries of Lake Victoria in general, and more recently to the Nile perch question in particular, emphasis has largely been on biological, ecological and technical aspects. Socioeconomic perspectives have been deliberately and greatly neglected, even though they are essential to sound planning and effective management of the fisheries and the SEPLS as a whole. Hardly any of the above highlighted interventions, with the exception of EPIC, recognized the negative impact of Nile perch on loss of biological diversity and livelihoods. Instead, their activities were designed to support the development of the Nile perch industry. This implies that existing interventions are part of the problem in lieu of being part of the solution.

The Nile perch fishery tragedy on Lake Victoria represents a gross crime against humanity and a contemporary environmental problem in an international context that has failed to be elevated to the global agenda, due to corporate-financed, misleading, biased research work and conflicts of interests among major stakeholders. Moreover Nile perch exports account for less than three percent of the GDP in each of the riparian states (World Bank 2009, cited in Turyaheebwa 2014). The short term economic gains accruing to riparian states do in no manner justify the environmental costs involved. The deliberate alteration of Lake Victoria fishery by colonialists that has caused misery for 40 million inhabitants is socially unacceptable and unlawful, as viewed from the standpoint of the Convention on Biological Diversity. Article 8(h) of the Convention on Biological Diversity requires parties to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or

species. In addition, the Lake Victoria Fisheries Act of 1950, which restricted the introduction of exotic fish species in the Lake, was in force prior to the transplant of Nile perch in Lake Victoria. Hence, there is great need, basis and opportunity for pursuing legal action to implement Article 8(h) of the CBD and to secure damages for the lakeside communities that lost their livelihoods as a result of the unlawful introduction of Nile perch in Lake Victoria.

The study found that economic benefits flow almost exclusively to foreign companies that reap profits from Nile perch exports, while riparian communities face the brunt of environmental degradation and the resulting loss of livelihoods. Whereas foreign companies have the flexibility to switch to other ventures, the riparian communities depend heavily on ecosystem goods and services derived from Lake Victoria for their food and livelihoods. It can be inferred therefore that restoration of fish species diversity in Lake Victoria, as opposed to expansion of the Nile perch fishery, is key to solving the current social and economic dilemma in this SEPLS.

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Chapter 12

# From payment to co-investment for ecosystem services: Stewardship and livelihood improvement in the Lake Naivasha agro-production landscape, Kenya

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## Abstract

Ecosystem degradation in upper catchment of Lake Naivasha in Kenya poses major threats to the overall watershed and people living in the Lake Naivasha agro-production landscape. In upstream areas, where mostly poor smallholder farmers practice traditional farming methods, people suffer from low agriculture productivity caused by unsustainable farming practices. While in downstream areas, urban dwellers and highly commercial industries, which are key to national income, endure costly living standards and inefficient production processes caused by decreasing ecosystem services (ES). The payment for ecosystem services (PES) scheme in the Naivasha basin provides lessons on how joint investment in social and financial capital enhancement among upper and downstream communities ensures better livelihoods and a healthier socio-ecological production landscape (SEPL). Lake Naivasha, located downstream of Naivasha basin, is a designated Ramsar Site with rich biodiversity and an important global floriculture centre accounting for 35 percent of all flower sales in the European Union. Other industries include ranching, tourism, pastoralism and geothermal power generation. The upstream areas, consisting of a national park, forest reserves and smallholder farming lands, are important water towers for Lake Naivasha and its surroundings communities. Landscape degradation in the upstream catchment due to unsustainable agricultural farming practices, such as cultivating on high gradient land across contours and slash and burn of vegetation, has led to low farm productivity. The situation has significantly diminished the livelihoods and food security of upstream indigenous people and accelerated siltation and pollution of water bodies, thereby reducing water quantity and quality flowing downstream, and increasing the threat to the lake's ecological potential to support socioeconomic and cultural activities. The PES scheme was initiated by NGOs in collaboration with government agencies, communities and the private sector to reverse the degradation trend. The scheme links upstream smallholder farmers and downstream commercial private investors as providers and beneficiaries of ES respectively. This study analysed the influence of PES practices on livelihoods and environmental conservation in this Kenyan SEPL. The PES contractual agreement covers rehabilitation and

maintenance of riparian zones through tree planting, grass strips, terracing along steep slopes, contour cropping, agro-forestry, improved seed varieties, crop rotation, fallowing and reduction in agrochemical use. The types of PES interventions were selected based on level of farm degradation, implementation cost, expected benefits, indigenous knowledge and gender. The main challenges to the PES scheme included involving more voluntary co-investors, incentive distribution and institutionalizing PES. Lessons learned revealed that feasibility studies, benefits of increased farm productivity over and above actual payments, and stakeholder willingness to participate in PES are all vital attributes to PES design as an incentive-based intervention tool to sustain ES provision in the SEPL and enhanced local livelihoods.

**Keywords:** Upland smallholders; Payment for ecosystem services; Agrobiodiversity; Watershed services; Lake Naivasha

## 1. Introduction

Watersheds in developing countries reflect terrestrial socio-ecological production landscapes with human and nature linkages. Upstream areas are typically characterized by agricultural landscapes supporting indigenous smallholders who mostly live in remote villages and depend on natural resources (NR) including land for their livelihoods. Downstream areas are dominated by lucrative commercial agribusiness and highly populated industrial cities that demand a huge amount of ecosystem goods and services mainly sourced from upstream areas. The interlinkage between upper and downstream areas becomes a vital relationship to ensure sustainable flows of ecosystem goods and services that support the livelihoods of people living in the watershed.

The Lake Naivasha watershed is an important socio-ecological landscape in Kenya (GoK 2013a), where 46.3% of people in the watershed is below the poverty line (GoK 2013, p. 43) and depend on healthy ecosystems. The upstream area of the Lake Naivasha watershed hosts national conservation areas including the Aberdare National Park and Aberdare Forest Reserve, surrounded by agricultural lands that support local farming communities' livelihoods and habitats for biodiversity. The downstream watershed has similarly rich biodiversity, ranging from Lake Naivasha as a designated Ramsar Site, the Oserian Wildlife Sanctuary and the Hell's Gate National Park (Figure 1). The downstream areas are commercially important for Kenya's GDP. Commercial global floriculture investment contributes to over 35% of all flower sales in the European Union (EAC-EU 2015, p. 12), and 280MW of geothermal power generation is connected to the national grid (KENGEN 2017). Other industries include tourism, as well as various local livelihoods such as ranching, fishing, pastoral livestock and farming.

Despite the area's enormous economic potential, unsustainable land use practices mainly in the upper catchment have been a major source of ecosystem degradation (Figure 2). Unsustainable farming practices, such as farming on high gradient and riparian areas, overuse of agrochemicals, slash and burn of vegetation, and cultivation across contours, have led to low farm productivity, diminishing the livelihoods and food security of almost 600,000 upstream inhabitants dominated by the indigenous Bantu people. Historically, however, the indigenous people in this watershed, with beliefs that flora and fauna are sacred, applied indigenous knowledge to conserve nature and cultivate their lands. These people protected forested areas as shrines for communal worship, practiced a system of fallowing and rotational cropping to allow the natural regeneration of soil fertility, maintained agricultural diversity through mixed cropping and agroforestry practices using indigenous species including medicinal plants and herbs, and applied organic manure rather than inorganic fertilizer. Related government agencies, including the Kenya Forest Services (KFS), Kenya Wildlife Services (KWS), Ministry of Agriculture (MoA) and Water Resource Management Authority (WRMA), have supported initiatives to preserve local wisdom through joint collaboration in formally publishing a forest conservation gazette, rehabilitating degraded lands using indigenous trees, and organizing collection of non-forest timber products to ensure sustainable harvesting. Apparently, these efforts have not been sufficient. Poor farming practices, due to population increase, economic pressures and other human-induced factors, have continued to accelerate siltation and pollution of water bodies, and reduce the water quantity and quality of the rivers flowing downstream (Figure 2), thus threatening the lake's ecological potential to support socioeconomic, cultural and business activities downstream (Nyongesa et al. 2016, p.2).

Payment for ecosystem services (PES) as a voluntary and performance-based policy instrument can influence people's values and behaviours concerning ecosystem services (ES) and change their modes of livelihood towards more sustainable agricultural practices (Namirembe et al. 2014). PES involves smallholder farmers as land managers who provide ES to beneficiaries of ES through mutual voluntary contractual agreements. PES[i] schemes have gained global popularity as alternative livelihood conservation mechanisms to restore and maintain ES, and the PES concept has evolved beyond market-based policy instruments (Van Noordwijk & Leimona 2010, p. 1). PES has the potential to conserve biodiversity and enhance sociocultural and economic well-being and is therefore

used as a tool for natural resource management (NRM) in socio-ecological production landscapes (SEPLs) in Africa (Nantongo 2016, p. 120; ADB 2015, p. 9; Kisaka & Obi 2015, p. 175). For Lake Naivasha, the PES scheme particularly targets the restoration of the watershed, biodiversity conservation and improvement of local livelihoods. The PES incentive principally motivates subsistence farmers to adopt practices that sustain provision of ES (Bymolt & Delnoye 2012, p. 33). Disregarding the livelihoods of local communities under a PES scheme can undermine the role of PES in providing the ES benefits humans derive from natural ecosystems. Thus, in developing countries, where poor rural communities are integral parts of agro-conservation practices linked to their own livelihoods, PES becomes a sustainable co-investment scheme. The ES providers and beneficiaries jointly invest their livelihood capital in the provision of ES and put economic benefits back into the ecosystems as landscape stewardships (Leimona et al. 2015).

This chapter presents how the payment and co-investment for ES scheme in the Lake Naivasha landscape serves as a major policy driver for local smallholder farmers to revive their socioeconomic and cultural wisdom in providing ES through watershed, riparian and conservation farming, and to simultaneously enhancing their livelihoods over the long term. Downstream ES beneficiaries jointly invest in a healthy watershed. Supported by intermediary NGOs (World Wide Fund for Nature and CARE Kenya) and in collaboration with government agencies, the PES scheme connects upstream smallholder farmers and downstream commercial private investors as ES providers and beneficiaries (Figure 3).

Figure 1. Above: Biodiversity around Lake Naivasha (Photos: WWF 2012); Bottom-left: Horticulture greenhouses around Lake Naivasha; Bottom-right: Inside a greenhouse (Photos: Nyongesa JM 2013)

Figure 2. Left: Farming on high gradient in the upper catchment before PES scheme; Right: siltation around Lake Naivasha riparian land (Photos: WWF 2008)

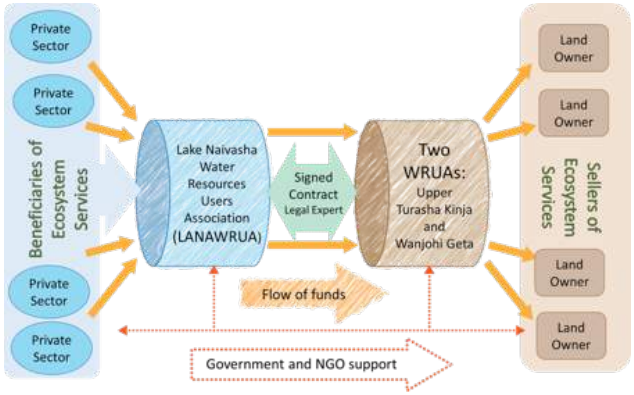


Figure 3. The conceptual framework of PES business design and flow of funds

## 2. Lake Naivasha as a socio-ecological terrestrial landscape

The Lake Naivasha basin (upper and lower catchments) covers an area of 3,400 km2 (WGC 2013, p. 5) in Nyandarua County (upper catchment) and Naivasha district (lower catchment). Nyandarua is divided into five administrative sub-counties: Kinangop, Kipipiri, Ol'kalou, Ol'jorok and Ndaragwa (ASDSP 2011). The upper and lower catchment (Naivasha district) populations are over 596,268 and 376,243 people respectively (GoK 2013; GoK 2013a). The catchment provides habitats for diverse biological resources that support socioeconomic development and contribute to the resilience of indigenous people. The interdependence and interaction between diverse human socio-cultural and economic activities and natural resources in a highly heterogeneous landscape such as the Lake Naivasha watershed, are illustrative of the area's importance as a key SEPL in Kenya. The two sub-basins of Tulaga and

Geta, covering areas 1, 2, and 5 in Kinangop and Kipipiri sub-counties (Figure 4 and Table 1), were identified for PES interventions based on following criteria: (1) main water recharge areas, both surface and groundwater; (2) existence of high sediment yield and significant pollutants points; (3) significant socioeconomic demographics, high population density and poverty levels and (4) dynamic land cover changes with expansive land degradation.

Table 1. Information on the watershed and PES sites (Source: Gathenya 2007; GoK 2013; WGC 2013)

| Description | Area (hectares) |
|---|---|
| Total upstream and downstream areas | 340,000 |
| Total watershed recharge area (upper catchment, Nyandarua County) | 324,500 |
| **Sub-watershed areas with prioritized interventions** | **Area (hectares)** |
| Tulaga area (Turasha and Kinja River) | 639 |
| Geta (River Wanjohi) | 4,680 |

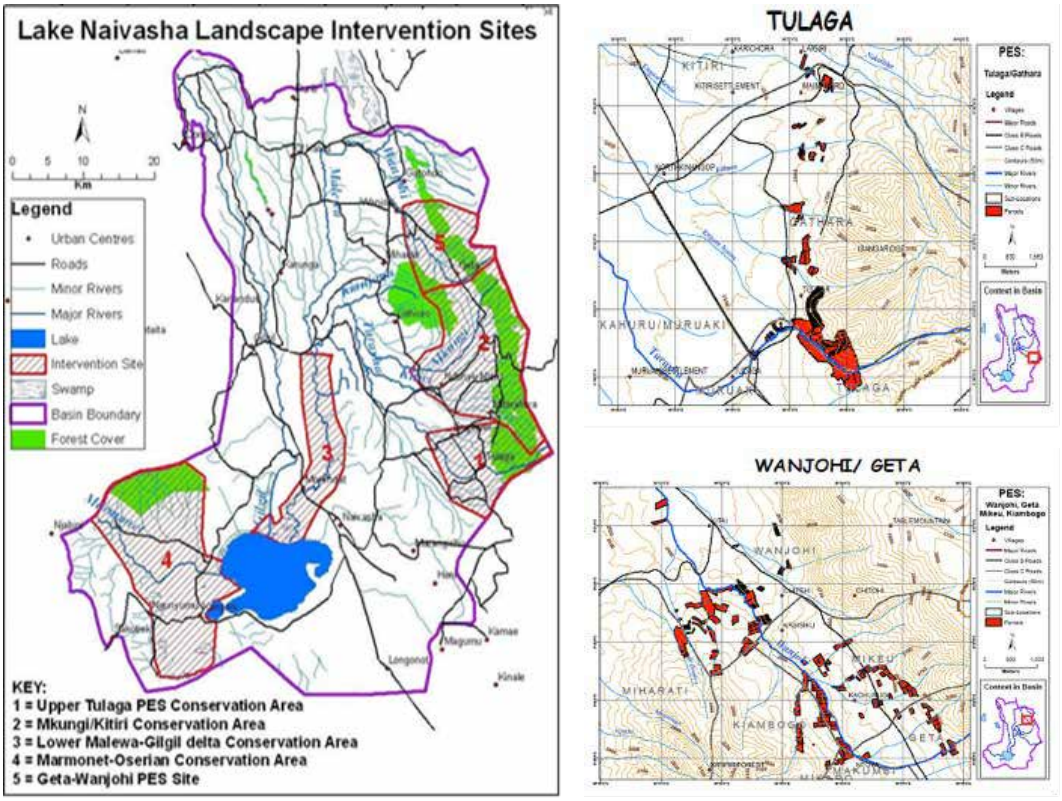


Figure 4. Left: Prioritized PES sub-basin sites (Source: Gathenya (2007, p. 5), modified by authors); Right: Position of the selected degraded farms (red) in the Upper Turasha and Wanjohi Water Resource Users Associations (WRUAs) (Source: WWF 2007)

## 2.1. Payment for ecosystem services in Lake Naivasha

The Lake Naivasha PES scheme had two implementation stages (2008-2011 and 2011-2017) involving the Upper Turasha and Wanjohi upstream WRUAs and one downstream Lake Naivasha Water Resource Users Association (LANAWRUA) as legal entities. The upstream WRUAs were composed of the farmers that provide watershed services, and the LANAWRUA was composed of commercial horticulture investors, the buyers of ES (Table 2).

Table 2. Number of upstream farmers registered as WRUA members under PES scheme between 2008 and 2017 (Source: LANAWRUA compiled by authors)

| No. | WRUA | Number of farmers (2008-2011) | Number of farmers (2011-2017) | Total |
|---|---|---|---|---|
| 1 | Upper Turasha | 385 | 1,025 | 1,410 |
| 2 | Wanjohi | 615 | 1,255 | 1,870 |
| 3 | Kianjogu [ii] | - | 455 | 455 |
| Total | | 1,000 | 2,735 | 3,735 |

This study focused on the Upper Turasha and Wanjohi WRUAs, specifically famers involved in PES interventions between the years 2008 and 2011. Selection criteria for joining PES included: (1) private farm land owners; (2) land located on steep slope and along rivers with unprotected river banks; (3) degraded farm lands that were highly eroded, infertile, bare, with little or no vegetation cover, or with low productivity; and (4) farm lands dominated by high water consuming tree species *(Eucalyptus grandis and Eucalyptus camaldulensis)* close to rivers.

Table 3. Characteristics of the PES scheme in Naivasha

| | |
|---|---|
| Conservation agricultural activities under PES contractual agreement | • Enriching farms using indigenous trees and agroforestry practices by planting fruits and timber trees (Table 4);<br>• Practicing conservation agriculture, including: grass strips, terracing along steep slopes, contour cropping, crop rotation, fallowing and reduction in agrochemical use (Figure 5);<br>• Enhancing productivity by cultivating improved certified crop seed varieties and applying drip irrigation technology for water use efficiency (Figure 6);<br>• Rehabilitating and maintaining riparian areas (Figure 7). |
| Targeted ecosystem services | • Improved water quality<br>• Reduced agrochemical pollution;<br>• Reduced sedimentation/siltation from agriculture lands and riverbank erosion; Enhanced agro-biodiversity<br>• Improved soil nutrient cycling, productivity, habitat, soil retention and food. |
| Performance-based payment | Annual average[iii] USD 17-30 per farmer through voucher system redeemable in the form of agricultural inputs from selected agro-input supplier shops (Figure 8), mainly improved certified crop seed |
| Monitoring and evaluation | • 3 times a year by multi-stakeholder representatives before annual payment;<br>• Verification of general performance of agreed activities;<br>• Water quality and quantity monitoring. |
| Main actors | 2 upstream (ES sellers) and 1 downstream (horticulture commercial companies as ES beneficiaries) WRUAs; WWF and CARE Kenya (PES initiators/intermediary NGOs); Government agencies (MoA, KFS, WRMA) as technical facilitators; local administration. |

Table 4. Selected PES planting materials (Source: Authors)

| Type | Description |
|---|---|
| Description | Napier grass—Kakamega 1 variety (*Pennisetum purpureum*), Elmba Rhodes (*Chloris gayana*) and cock's foot* (*Dactylis glomerata*) |
| Tree* seedlings | Cedar (*Juniperus procera*), rosewood (*Dalbergia spp.*), *Prunas africana Dombeya torrid, Grevellia spp.* |
| Fruit tree seedlings | Olives (*Olea europaea*), tamarillo (*tree tomato*) (*Cyphomandra betacea*) and apples (*Malus pumila*) |
| Other important improved crops/ fodder | Potatoes (*Solanum tuberosum*)—*Kenya Karibu and Kenya Sifa* varieties, Livestock fodder: Lucerne (*Medicago sativa*), Desmodium (*Desmodium intortum*) |

*indigenous species

Figure 5. Left and centre: Joseph Mang'ara Njuguna on his PES conservation farm; Right: PES conservation farm adjacent to Aberdare forest (Photos: Nyongesa 2012)

Figure 6. Left: Joseph Thairu (next to camera, Wanjohi WRUA) shows transplanted vegetable seedlings under drip irrigation on his plot under the grass strip; Right: Joseph on his second plot planted with vegetables along contours (Photos: Nyongesa 2012)

Figure 7. Riparian land under vegetation cover along River Malewa tributaries (Left photo: Peter Muigai and right photo: Nyongesa 2011)

## 2.2. Establishing the PES scheme

The PES scheme was initiated through a stakeholder engagement process in a three-phased approach:

### 1) Feasibility assessments

Feasibility assessments consisted a series of studies. First, hydrological analysis was carried out to assess how land management practices influence water quality, sedimentation levels and agricultural chemical yields, and to identify prioritized sub-basins for interventions (Gathenya 2007, p. 24). Likewise, a socioeconomic baseline study was conducted to assess the legal status of land tenure and local livelihoods, to identify alternative land use practices able to promote agricultural conservation, and to establish a PES business opportunity for buyers and sellers (Makenzi, Omollo & Mutinda 2007, p. 19). Cost-benefit analyses were also performed to assess opportunity cost[iv], estimate the expected loss and gains of PES interventions, and to establish willingness to accept payment and to make payment on the part of sellers and buyers of ES respectively (Gamba, Owuor & Onyuma 2007, p. 24).

### 2a) Contract negotiation, signing and implementation

This process was initiated and supported by WWF and CARE Kenya and involved potential ES providers and beneficiaries in a series of mobilization and sensitization activities on the PES concept. Target hotspot parcels (degraded farms) were selected and mapped, and identified participating farmers were empowered through various trainings involving technical and managerial aspects (on soil and water conservation, livestock management and water quality monitoring). The culmination of this process was contract negotiation and signing between ES providers and beneficiaries facilitated by legal experts with payment organized annually as a public event (Figure 8).


Figure 8. Wanjohi WRUA (left) and Upper Turasha Kinja WRUA (centre and right) officials display their dummy cheques received from ES buyers during two annual events, 2010 and 2012 respectively (Photos: Nyongesa)

### 2b) Monitoring and evaluation

Ongoing monitoring and evaluation is organized by the verification team (Figure 9) composed of the management committees of three WRUAs, supporting NGO representatives, and government agencies (WRMA, KFS, MoA and local administration[v]). Water quality and quantity flowing downstream into Lake Naivasha is monitored by trained upstream WRUA management personnel using turbidity meters and river gauges installed at specific points along rivers. Water samples are taken twice weekly and data is send to WRMA for compilation. Soil retention on farms is monitored by trained land owners using calibrated pegs (Figure 10).

Figure 9. Left: Margaret Mundia Wanjiru cutting conservation grass for livestock feed (Upper Turasha WRUA); Right: Section of verification team on Joseph Njuguna's (wearing cap-Wanjohi WRUA) farm before payment (Photos: Boniface Thiga 2012)

Figure 10. Left and centre: David Mbugua, Secretary (Upper Turasha WRUA) taking water sample for quality assessment; Right: Mr. Thuo on his potato farm (Wanjohi WRUA) with installed calibrated staff to monitor soil retention by grass strips on contours (Photos: WWF 2012); Inset: high yield potato harvest ready for market (Photo: Nyongesa 2012)

**3) Scale-up and exit strategy**

The PES scheme initially started with 565 farmers in 2008 and ended up with 1,000 farmers in two upstream WRUAs in 2011 (Table 2). These farmers continue their conservation agricultural practices although the contract has ended. In 2011, NGO intermediaries began the second phase of interventions involving new farmers in both existing and new WRUAs with similar selection criteria. The NGOs handed over the PES project to the key stakeholders, the ES buyers and sellers, to be organized under the full management and control of the WRUAs. Government agencies continue with technical backstopping.

## 3. Methodology

This chapter is based on the results of a socioeconomic survey conducted at study sites between 2012 and 2013, covering the Upper Turasha and Wanjohi WRUAs. Existing literature was reviewed to collect secondary data. Primary data was collected from 200 sampled respondents from source lists of PES participating farmers. A team of research assistants administered semi-structured questionnaires through face to face interviews with respondents and key informants. A transect walk across PES farms and focus group discussions complemented primary data collection. Temporal series data was collected to assess whether or not there were any changes in farm productivity and income. Likewise, farmers' perceptions on PES benefits for livelihoods and the environment, as well as their willingness to continue participating in the PES scheme, were evaluated. Farmers were asked to provide time series productivity changes for both crops and livestock enterprises on same land parcels before and after PES interventions. Productivity was computed in terms of changes in the marginal income of farmers before and after PES initiation, with 2008 and 2013 as base and current years respectively. Both qualitative and quantitative methodologies were applied to analyze data. Stata, a statistical software, and the Statistical Package for the Social Sciences (SPSS) software were utilized to manage and analyze data.

## 4. Results

### 4.1. Perceived PES benefits to local socio-ecological conditions

Conservation agriculture and farming diversification efforts under the PES scheme have positively influenced socio-ecological conditions. Directly, over 90% of farmers perceived that soil fertility was improved through soil and water conservation interventions on their farms. This perception is related to revenue increment from crop and livestock enterprises under the PES scheme. Application of conservation agricultural technologies was perceived to increase crop productivity (Table 6). Most farmers (84%) qualitatively noted water quality improvement. Indirectly, a significant 54% of farmers perceived higher agricultural crop prices due to the improved quality of their produce under the sustainable conservation agriculture practices, while 57% perceived that the PES scheme influenced distribution of local human labour on agricultural farms.

Practicing conservation in the watershed increases the capacity of the landscape to buffer shocks. For example, rehabilitating the riparian areas reduces riverbank collapse, flooding to farming lands and landslides. Farmers perceived that their efforts through the PES scheme contributed to such buffering effects (70%). Perception on PES contribution to improved livelihoods was also highly significant (99%). Farmers enjoyed increased skills and knowledge gained from a series of trainings designed to improve their execution of the PES contract, in addition to other direct benefits (i.e. enhanced crop productivity, improved nutrition, increased farm commodity prices and payment from ES buyers). Further, on general livelihood enhancement, focus group discussions and key respondent interviews revealed that additional income supported families to cover household expenditures such as children's school fees, medication and improved family leave conditions. The involvement of women in PES farming activities (Figures 9 and 11, left) improved gender parity and ensured efficient and effective equitable distribution of PES benefits.

Table 5. Farmers' perception of benefits in joining PES scheme

| Variable description (0=No; 1=Yes; 2=Don't know) | Statistic | | | |
|---|---|---|---|---|
| | NO | YES | Don't know | Mean |
| ***Direct benefits*** | | | | |
| Improved soil fertility | 2 | 198 | | 0.99 |
| Increased crop productivity | 4 | 196 | | 0.98 |
| Better water quality | 32 | 168 | | 0.84 |
| ***Indirect benefits*** | | | | |
| Better agricultural crop prices | 93 | 107 | | 0.54 |
| Local labour distribution | 53 | 114 | 33 | 0.57 |
| Buffering capacity of watershed | 60 | 140 | | 0.70 |
| Quality of livelihood | 2 | 198 | | 0.99 |
| Valid N (Listwise)=200 | | | | |

Figure 11. Left: PES farmer nurtures her indigenous tree seedlings; Right: Farmer admires his Tamarillo crop ready for harvesting (Photo: WWF 2012).

### 4.2. Increases in estimated crop and livestock revenue

The estimated mean gross monthly revenue from farm and off-farm activities and revenues from the crops and livestock of PES participating farmers were compared for the years 2008 and 2013 (Table 7). The mean gross monthly income was increased by 60%. Meanwhile, the national average household income in Kenya at 3,440 KES (Kenya Shilling) equivalent per adult per month, a figure from data on household expenditure as a proxy for estimating income (Government of Kenya Central Bureau of Statistics 2009; Government of Kenya Central Bureau of Statistics 2013, p. 16), increased by 20% over a similar time period. A marginal increase in revenue was associated with an increase in productivity following improved soil fertility under the PES conservation interventions. Conservation farming practices enhance productivity and farmers' income, contributing to improved well-being (Aerni & Neves 2013, p. 7).

Table 6. Household monthly revenue profile of farmers participating in PES schemes in 2008 and 2013

| Statistic | Gross monthly revenue (KES) | | Monthly crop revenue (KES) | | Monthly livestock revenue (KES) | |
|---|---|---|---|---|---|---|
| | 2008 | 2013 | 2008 | 2013 | 2008 | 2013 |
| Mean | 6,891.96 | 11,011.48 | 5,046.54 | 8,379.98 | 3,532.43 | 6,618.03 |
| Std. Dev | 5,101.12 | 14,719.42 | 7,790.85 | 14,568.32 | 3,597.74 | 5,147.55 |
| Range | 500-42,167 | 1,000-194,000 | 0-100,000 | 0-180,000 | 0-31,000 | 0-35,000 |

1USD=100 KES (Kenya Shillings) at the time of survey; Average of 2 acres land size

Monthly crop revenue increased by 66% over the five-year period, while the mean income from livestock enterprises increased by 53% over the same period, from 2008 before PES to 2013 after PES was implemented. Revenue increase from crop and livestock is attributed to increased farm productivity and availability of fodder for livestock, which increased milk yields. Improved livestock, soil and water management skills acquired during PES trainings equally influenced the productivity increase (Figure 12).

Figure 12. Left: Famers display hay they prepared after training; Right: Farmer feeds his dairy cattle (Photo: Nyongesa 2012)

### 4.3. Willingness to continue implementing PES practices

Overall, 97% of farmers were willing to continue implementing PES practices irrespective of the type of PES practice (Table 8). Riparian land is important due to its proximity to water sources. It provides ES, especially food, during the dry season and buffers water sources from siltation during the rainy season. This study confirmed a 39% farmer willingness to rehabilitate degraded riparian land to provide ES for livelihood sustenance. Related studies (Rafuse 2013, p. 5) have shown riparian land to be vital for provision of ES and significant in maintaining water quality. Agroforestry and grass strips were highly favoured by participating farmers (above 90%). Agroforestry trees and grass ensure food security, and sources of fodder and firewood for households. Moreover, grass strips have an important role in soil and water conservation. Adopting this practice directly contributes to supporting services such as nutrient cycling and soil formation, while tree-based farming systems support the buffering functions of the watershed as regulating services.

The lower number (15%) of farmers willing to implement terracing is attributed to different reasons. For instance, the

Table 7. Willingness to continue implementing PES practices

| Variable description | Statistic | |
|---|---|---|
| (0=No; 1=Yes) | Mean | Std. Error |
| Willingness to continue implementing all PES practices | 0.970 | .013 |
| **Specific PES interventions** | | |
| Rehabilitation and maintenance of riparian zones | 0.390 | .035 |
| Grass strips | 0.950 | .015 |
| Terracing | 0.150 | .025 |
| Contour cropping | 0.320 | .033 |
| Agroforestry | 0.960 | .014 |
| Improved certified seed varieties | 0.620 | .034 |
| Fallowing | 0.370 | .034 |
| Crop rotation | 0.530 | .035 |
| Reduction in agrochemical use | 0.700 | .032 |
| Valid N =200 | | |

high physical labour demanded for mapping and digging terraces discourages the female gender and elderly farmers due to the drudgery. Contour cropping was favoured by 32%. Though it requires high skill and is preceded by marking out contours on the farm, the technology retains soil on farms and controls soil erosion.

Certified seed for crop varieties increases resistance to pests and disease and yields higher for improved food security. This explains the high number of farmers (62%) willing to continue planting improved seeds. Willingness for fallowing correlates with small land parcels (average of 2 acres) per household. Concern that fallowing on small land parcels would reduce farm produce and significantly affect food security influenced the low willingness (37%) for fallowing. Crop rotation was preferred to reduce pest and disease prevalence associated with climatic changes. Crop rotation improves soil structure and soil fertility, which attracted a 53% willingness to implement. Willingness to reduce agrochemicals (70%) implies the need to avoid cost for inorganic agrochemicals and the significance of this approach in the reduction of environmental pollution in ecosystems.

The farmers' willingness to continue implementing PES practices signifies the acceptance of the PES scheme and its positive influence on the environment and household livelihoods. High willingness to restore ecological functions is an indicator that PES can work in the agriculture sector where ES are under threat and the opportunity costs for alternatives practices are not very high (FAO 2011, p. 26).

## 5. Discussion and lessons learned

Socio-ecological production landscapes provide abundant ES that support human socioeconomic and cultural development and are habitats for biodiversity conservation. Despite the significant potential of SEPLs to improve social well-being, human development needs and economic pressures threaten ecosystems and biodiversity sustainability. Payment and co-investment for ES have been recognized as an incentive-based intervention that can serve as an alternative policy to sustain socio-ecological production landscapes for ES provision and enhanced local livelihoods. The Naivasha PES is a hybridized approach, combining compensation to the upstream ES managers for the opportunities foregone and a collaborative co-investment PES model with private sector beneficiaries of ES in the landscape.

In this chapter, we characterize the perceived and actual livelihood benefits for smallholder farmers that are implementing PES conservation agriculture on their lands, and carrying out conservation activities collaboratively on public lands (such as riparian and surrounding natural forests), with incentives under the payment and co-investment for ES programme in Lake Naivasha. We found that if similar programmes were to be replicated, most farmers would be willing to join in while maintaining their practices voluntarily.

Our lessons from the PES design in Naivasha show that feasibility studies are an important preliminary stage in

PES design. These studies provide baseline information, including information on ecological problems in the watershed that affect the socioeconomic and cultural benefits of the programme. Designing PES is a challenge during the initiation stage. Mobilization and sensitization of identified stakeholders on the PES concept and early engagement of key actors through voluntary participation ensure the sustainability of the PES scheme. Knowledge on ecosystem linkages to sustainable livelihoods, such as restoration of degraded landscapes, builds the capacity of local communities to embrace PES farm practices.

Willingness to participate in PES is a key attribute in PES design. This study has shown a high willingness of farmers to implement PES practices as an indicator for adoption and sustainability of the conservation practices. An increase in productivity as an in-situ benefit was a significant factor influencing the adoption of PES practices, more so than the actual PES payment. Increased productivity enhances additional income and technical farm skills and knowledge, and is more rewarding in the long-run. These in-situ incentives have a direct impact on a rural community's well-being, and thus farmers are motivated to adopt practices that will conserve ecosystems to sustain their livelihoods.

Non-PES farmers can implement conservation activities without enrolling in the PES scheme. Though this contributes to conservation and livelihoods on scale, it is a challenge as the PES concept is lost in the long run. Involving more stakeholder "buyers" or co-investors of ES would sustain PES over time, but remains a challenge. Moreover, institutionalizing PES as a legal policy tool would strengthen its recognition as an instrument to enhance socioeconomic and cultural development and create markets for ecosystem based value chains at the local community and national levels.

Payment or incentive modalities for sellers of ecosystem services need to be efficient, fair and equitable. The PES Naivasha scheme adopted a first-year flat rate payment of USD 17 to USD 30 (as of reporting time in 2017) annually for all PES farmers through a voucher system negotiated between ES buyers and sellers and depending on the available buyers' contributions. However, distribution of benefits that satisfies the expectations of farmers remains a challenge. The incentive modality needs to involve reinvestment back into livelihood capital for sustainability, and thus we extended our concept beyond payment to integrate a co-investment policy for ES stewardship. When emphasizing the aim to enhance the livelihoods of local communities and support marginalized people, PES can be envisioned as "a joint and voluntary investment between smallholder ES providers and commercial investors as beneficiaries in co-investment and binding agreement under different degrees of conditionality for the provision of ES" (Leimona et al. 2015, p. 16-28). Consistently, these findings corroborate with other studies in Africa (Namirembe et al. 2014, p. 89-97).

## 6. Conclusion

As a SEPL, the Lake Naivasha watershed in Kenya provides an immense amount of services. It is a source of provisions, and provides regulating, cultural and supporting services. Upstream and downstream communities in the watershed depend on the landscape for their socio-economic and cultural well-being. Managing the production landscape sustains the provision of ES and thus creates the mutual interaction between people's livelihoods and biodiversity conservation. However, increasing demand for ES has raised concerns of ecosystem degradation in the landscape, necessitating the need to promote mitigation mechanisms that restore and conserve degraded ecosystems to sustain local community livelihoods.

This chapter indicates that PES is a major natural resources-related policy driver for local smallholders to restore their farming landscape and cultural wisdom in providing ecosystem services. The payment and co-investment for ES scheme provides perceived and actual benefits for the smallholders by engaging diverse stakeholders including the most important ones—the downstream ES beneficiaries—in joint investment towards a healthy watershed. Upstream benefits include improved livelihoods from increased farm productivity, increased income (in-situ from PES interventions and ex-situ from downstream incentives), enhanced skills and knowledge and improved social welfare. Downstream communities benefit from increased water quality and quantity flow which sustains their commercial horticulture investments and biodiversity. Findings show that farmers have endorsed the PES scheme and adopted conservation agricultural technologies to improve farm productivity, soil fertility, livelihoods, water quality and quantity and to support mitigation of climate change. Results further reveal the farmers' willingness to continue participating in the PES scheme. This willingness confirms the benefits farmers are getting compared to the foregone farm activities practiced before PES was introduced. In summary, the mutual upstream-downstream co-investment in watershed conservation contributes to ecosystem service provisions and agro-biodiversity conservation, and more importantly, the livelihoods of the people including their income, food, skills and knowledge.

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i The PES concept is based on the proposition that those who provide ecosystem services by conserving natural ecosystems are paid by those who benefit from the ecosystem services.

ii Kianjogu WRUA joined the PES scheme in the year 2015.

iii Payment rate negotiated between buyers and sellers of ES. Price/rate varied increasingly over years depending on the number of buyers joining the scheme and the amount they jointly contribute. The annual contribution is divided and paid equitably as a flat rate to all PES implementing famers after verification of agreed PES interventions on farms. Mode of payment is negotiated and agreed between buyers and sellers of ES.

iv The cost benefit analysis conducted during the feasibility study indicated $200 as opportunity cost/acre/farmer/year. As a voluntary PES scheme, the current payment is negotiated depending on available cash contributed annually by buyers of ES as incentive to sellers. Sellers are motivated as well by additional higher in-situ benefits.

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