Regional good practices and local & traditional knowledge on ecosystem management and ecosystem-based sustainable livelihoods in the Lancang-Mekong Region

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Top left (Photo by Chantal Elkin via Flickr, CC BY-NC-SA 2.0) Tree ordination ceremony performed by Buddhist monks
Top right (© International Union for Conservation of Nature and Suthep Kritsanavarin) Local fishing technique at Siphandone in Lao PDR
Bottom (© Chhin Sophea) Training for local communities on bamboo for ecosystem restoration and livelihood improvement

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ABBREVIATIONS

AFD	Agriculture and Forestry Division (Lao PDR)
AFO	Agriculture and Forestry Office (Lao PDR)
CAS	Chinese Academy of Sciences
CBET	Community-based ecotourism
CBFC	Community-based fisheries co-management
CBNRM	Community-based natural resource management
CDBRP	Conservation and Development of the Kien Giang Biosphere Reserve Project (Vietnam)
CFAs	Community forestry areas
CPAs	Community-protected areas
CSR	Corporate Social Responsibility
DARD	Department of Agriculture & Rural Development of Kien Giang province (Vietnam)
EPCDSWP	Environmental Protection and Community Development in Siphandone Wetland Project (Lao PDR)
FCZs	Fish Conservation Zones
INEB	International Network of Engaged Buddhists
ICMP	Integrated Coastal Management Programme (Vietnam)
Lao PDR	Lao People's Democratic Republic
LCFDPP	Lao Community Fisheries and Dolphin Protection Project (Lao PDR)
LEK	Local ecological knowledge
NNRA	National Nature Reserve Administration (China)
NTFPs	Non-timber forest products
KNP	Kirirom National Park (Cambodia)
REDD	Reducing Emissions from Deforestation and Forest Degradation
XTBG	Xishuangbanna Tropical Botanical Garden (China)

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Chapter1:
Introduction

The Lancang-Mekong region, covering Cambodia, China, Lao PDR, Myanmar, Thailand, and Vietnam, is undergoing unprecedented changes. The region encompasses a vast range of geographic and climatic zones. As a result, it is endowed with diverse and abundant natural resources. Water from the Lancang-Mekong River[1] irrigates large tracts of forest and wetlands that provide building materials, medicines and food and serve as habitat for thousands of species. A large part of the river basin falls in the area identified as the 'Indo-Burma Biodiversity Hotspot', which has been described as one of the most important biological regions on the planet (Tordoff et al., 2012). A broad variety of ecosystems are present in the region, including mixed wet evergreen, dry evergreen, deciduous and montane forests, shrublands and woodlands on karst limestone outcrops, and mangroves. Non-timber forest products provide an important source of income for rural people and supply markets with a vast array of plant and animal products including foods, medicines, and dyes.

Economic growth is threatening natural resources and biodiversity. Conservation in this region is challenging due to conflicts between social and economic factors, and much of the population lives under the poverty line. With the region's natural resources under threat of degradation, traditional knowledge and practices are of great merit in ecosystem management to support local livelihoods disrupted by rapid development. This report presents a collection of good practices and local/traditional knowledge within the Lancang-Mekong countries on ecosystem management and ecosystem-based sustainable livelihoods. It highlights typical and unique cases across a variety of social dimensions including indigenous peoples, gender, youth, traditional knowledge, religion, and private sector engagement. Cases were collected through a comprehensive literature review in English and national languages. In total, this report contains six cases from different ecosystem types, including: sustainable bamboo resource management in China, rubber intercropping system in China, ecotourism development model for nature reserves in Cambodia, small-scale freshwater fisheries management in Lao PDR, forest conservation by Buddhist monks in Thailand, and mangrove protection in Vietnam. These successful cases are highlighted to encourage replication in other developing countries with similar ecological conditions and socioeconomic contexts and other areas within the Lancang-Mekong region. Research gaps, opportunities, and recommendations are also identified.

[1] The river is known as the Lancang in China and the Mekong in the other five countries.

Chapter 2:
Better quality and sustainable bamboo plantation and management in Yunnan Province of China

1 GENERAL INFO

LOCATION: Shuifu City, Yunnan Province, China
KEY INITIATOR AND STAKEHOLDERS: Shuifu government, local farmers, Nanjing Forestry University

2 DESCRIPTION

2.1 Introduction

Southwest China's Yunnan Province, with an area of 383,000 km^2, is bordered by four provinces of China and three countries in Southeast Asia. It is situated at the confluence of East Asia, South Asia, and the Qinghai-Tibet Plateau, three major physical-geographic regions in Asia. It has a large territory, and exceptional natural geographical characteristics and social-ecological diversity. Yunnan is connected to the Qinghai-Tibet Plateau to the northwest and the semi-humid tropical and subtropical regions of the East Asian Monsoon Region to the east. It is also connected to the South Asian subcontinent and the Indochina Peninsula to the west and southwest.

Yunnan is home to one of the most diverse and abundant natural bamboo communities in the world due to the province's mountain ranges and water systems that provide suitable conditions for complex bamboo habitat, growth, and diversity (Hui 2002). In the world there are more than 1,000 species of the bamboo subfamily in 70-80 genera. Among these, over 500 species in 37 genera are found in China, and at least 250 species in 28 genera are found in Yunnan. This means that Yunnan contains 40% of all bamboo in the world and 25% of the world's bamboo species, while China as a whole contains 75% of the world's bamboo and 50% of all bamboo species.

Despite having abundant bamboo resources, Yunnan's bamboo sector is constrained by two significant issues. First, Yunnan has a natural bamboo forest cover of 90%. The productivity and capacity for renewal of natural bamboo forests are much lower than those of managed bamboo forests. Natural bamboo forests contain many more aged individuals and an insufficient quantity of young, newly sprouted bamboo which makes overall productivity and quality of bamboo shoots relatively poor. Second, although the species richness of Yunnan bamboo is high and the proportion of excellent economic bamboo species is similarly high, the output of each species is relatively low and species are widely spread, restricting their industrial use to some extent (Yang and Hui 1999).

Shuifu City is located in the northernmost part of Yunnan Province at the intersection of the Jinsha River and Hengjiang River (Guanhe) triangle. The average annual rainfall is 1,129.6 mm, annual average temperature is 17.8°C, and the frost-free period is 324 days. The main soil types are yellow soil, purple soil, and yellow brown soil. In Shuifu City, *Qiongzhuat tumidinoda* covers an area of 3,800 hectares, accounting for 33.3% of the total bamboo forest area in the city. According to 2018 statistics from Shuifu Forestry and Grassland Bureau, artificial forest only accounts for 1.5% of the total area of *Q. tumidinoda* forest, while the rest is naturally growing bamboo forest. The average ground diameter and height of bamboo were 0.97 cm and 1.94 m, respectively, and the average density was 132,300 plants/ha. The average proportion of dead bamboo was 22% and the maximum was 41%. Therefore the problem of stand renewal was serious (Bai 2021). The income from bamboo shoots has also become one of the primary income sources for the locals

as a result of the high price of bamboo shoots. Degradation of the bamboo forest and aggravation of the unnatural structure of the bamboo forest were caused by excessive shoot harvesting and a lack of efficient management and protection systems. Additionally, the variable quality of bamboo shoots caused by people's lack of knowledge makes it difficult for the sector to develop in a standardised manner.

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

Shuifu city government has promoted the bamboo industry since 2017. Two points should be given attention in reconstructing the Shuifu *Q. tumidinoda* forest. First, considering the age structure of the bamboo forest, we should selectively cut the dead bamboo and a certain proportion of old bamboo before planting and cultivating new bamboo. To address the problem of individuals, collectives, and enterprises over-harvesting bamboo shoots, qualifications of what may be harvested should be defined along with technical standards for harvesting. At present, the length of bamboo shoots collected is 10-40 cm. Among them, shoots with a length of 10-30 cm accounted for 89.3% of the total, and there was a large knowledge gap in the product quality specifications of bamboo shoots (Bai et al. 2021). In addition, to make up for the material loss caused by harvesting bamboo shoots and to enhance the soil and boost income, several communities in Shuifu city should function in mixed forests.

Second, improve local bamboo management practices by standardised services. According to Article 16 of Forest Law of the People's Republic of China, state-owned forest farms are allowed to contract their forest farms to cooperatives (natural bamboo forest is considered forest in China), enterprises, and individuals to operate them. In this way, the conflict between management of the forest and income of local communities can be effectively alleviated (that is, the dislocation of the right of management and the right of earnings). The establishment of bamboo management standards should be carried out through practitioners' training, funding, and technical support.

2.3 INTERVENTIONS

First, classify the bamboo forest. Strengthen the protection of *Q. tumidinoda* in the ecologically vulnerable area following an ecological forests protection scheme. In accordance with relevant laws and regulations, bamboo resources should be utilised rationally. At the same time, try to make use of the multi-functional quality of bamboo and balance its ecological function. The quality of the commercial *Q. tumidinoda* forest with low productivity should be improved. The restoration of naturally growing low-quality bamboo forest and the standard plantation of artificial forest are carried out simultaneously.

Second, villages near the bamboo forest region should establish cooperatives and cooperate with companies with financial support and research sectors. At the same time, the local government should coordinate the cooperation between villagers and enterprises. Bamboo forest plantation, bamboo shoot harvesting systems, and formal benefit sharing mechanisms are necessary for the cooperation between villagers and companies (Bai et al. 2019). The participating individuals will be selected among local cooperative members (villagers), company employees, and contractors. Their plantation behaviour will be standardised including the frequency and permitted period of bamboo shoot picking and the specifications of bamboo shoots products. Additionally, the bamboo forest should be planted and managed with an objective of long-term sustainability.

Third, support scientific development of intercropping management, including planting fungus, grass, medicinal plants, and other suitable crops under bamboo forest.

Fourth, formulate standards and systems for managing *Q. tumidinoda*. These include technical standards for seedling breeding, high-yield

cultivation, modification of low-efficiency natural *Q. tumidinoda*, and shoot selection. The corresponding technical training should be carried out in the distribution area of *Q. tumidinoda* to promote the standardisation of *Q. tumidinoda* management. The study showed that the yield and income of *Q. tumidinoda* bamboo shoots of 30-40 cm length can increase by 58.73% compared with current shoot selection (Bai 2021). Standardising shoot harvesting could improve not only shoot yield and income but also facilitate structural adjustment and rejuvenation of *Q. tumidinoda* forest and promote long-term high and stable yield of *Q. tumidinoda* bamboo.

At the same time, formulate a system to ensure the duration of contract services. Transformation of low-yield bamboo forest should take no less than 3 years, during which time operators must invest significant manpower and financial resources. So, the proposal contract period should not be under 10 years. The contract period of short-term (3 years), medium-term (7 years) and long-term (10 years) cultivation objectives are determined. The contract evaluation indicators should include bamboo shoot yield, bamboo stand structure, average ground diameter and other indicators. Through determining reasonable operating time and strict annual, mid-term, and final assessments, operators are promoted to follow the standard operation.

Fifth is capital investment in technology. The local government raises funds to speed up the cultivation of *Q. tumidinoda* plantation, clarify property and management rights, and usufruct. Financial funds of various afforestation projects and self-raised funds from city budget are expended to solve the problem of artificial afforestation of *Q. tumidinoda*. Some companies also invested in the *Q. tumidinoda* industry. Interested farmers took part in the plantation individually or cooperated with companies. At the same time, the logistic services of bamboo are carried out. Experts from "Ten thousand talents prosper ten thousand villages in Yunnan Province" are dispatched to the key villages where *Q. tumidinoda* is distributed to help train in management of *Q. tumidinoda*. Other scientific research, technology demonstration and technical training were similarly implemented.

2.4 KEY RESULTS AND OUTCOMES

Compared with the *Q. tumidinoda* forest that has not harvested shoots in two years, frequent bamboo shoot harvesting has resulted in a 29.08% decrease in the average height of the sub-generation (Dong et al. 2002). The size of the sub-generation of *Q. tumidinoda* forest showed a trend of decreasing over time. Therefore, it is beneficial to improve the health of bamboo forest by standardising the harvest frequency of bamboo shoots by various methods. The average DBH and height of the new ramet were 1.5 and 1.4 times higher than that of untreated ones. Cutting parent bamboo had a significant effect on the density of progeny ramet, and the number of ramet was 1.92 times as much as that of all preservation treatments (Dong et al. 2002).

In 2019, the annual output of *Q. tumidinoda* bamboo shoots were 81,038 tons (t) using the bamboo shoots picking method. The production of bamboo shoots commodities in Shuifu City increased by 47,593.6 t. Figure 2-1 shows the local workers processing bamboo shoots. According to the current bulk price for commodity bamboo shoots of 9 RMB [2] (around 1.29 USD)/kg, income from picking bamboo shoots increased by 428.34 million RMB (around 61.38 million USD).

Figure 2-1 Local workers are processing bamboo shoots

Source: Yunnan Net 2020

[2] 1 RMB = 0.1433 USD

The development of intercropping of bamboo forest and other crops is beneficial to avoid problems like soil degradation, site productivity decline, regional ecosystem deterioration and others. Due to bamboo logging and bamboo shoot harvesting, nutrients in the bamboo ecosystem continue to be lost, resulting in the deterioration of soil quality before intercropping. After planting edible fungi under bamboo, the nutrients from fungus residue stay in the soil, which can play an important role in improving soil fertility.

The purpose of bamboo-grass intercropping systems is to produce herbage, medicinal materials, or fertiliser for the bamboo forest. Planting nitrogen-fixing plants can improve the self-fertilisation capacity of bamboo forest land, enhance its ecosystem service function, and improve soil condition. Existing studies indicate that higher biodiversity can increase forest productivity. Therefore, mixed bamboo and other suitable crops can effectively improve the productivity of bamboo forest. After 8 years since 2009, it was found that aboveground biomass of a 16-species mixed forest stored about 32 t of carbon per hectare on average, while the carbon storage of the pure forest was only about 12 t per hectare, less than half that of the mixed forest. If forest biodiversity increases, more carbon can be stored, increasing production of wood and bamboo shoots while mitigating the greenhouse effect.

Local resident Wu Pinshu said, "Knowing that the town vigorously developed *Q. tumidinoda* forest management, I gave up my previous work and went home to start a business." He calculated his earning: "I have been planting medicinal materials and edible fungi under bamboo for three years. I planted 10 hectares of medicinal materials last year and made nearly 50,000 RMB (around 7,165 USD). In addition, I planted more than 20 hectares of *Q. tumidinoda,* and the bamboo shoot income was more than 100,000 RMB (around 14,330 USD)."

The annual net income per capita has increased from less than 300 RMB (around 43 USD) in 1996 to 6,217 RMB (around 891 USD) in 2016, and the *Q. tumidinoda* bamboo contributed to over 80% of the income increase. Through 2019, bamboo covers 186 thousand hectares and brings 14.2 million RMB (around 2.03 million USD) per year among 10 thousand jobs.

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

Based on the requirement of bamboo forest function diversification and the principle of species coexistence and material recycling, bamboo forest management can make full use of natural resources and form a virtuous cycle within the system. The purpose of mixed management is to maximise the potential commercial benefits and ecological functions of bamboo forests.

Bamboo forest occupies the upper space of forest with high canopy density, forming a cool, damp, ventilated, and broad understory space. This provides favourable conditions for the growth of shade-loving edible fungi (see Figure 2-2). The intercropping of bamboo and fungus can make full use of natural resources as shade is advantageous for the growth of edible fungi. In addition, it can effectively solve the problem that bamboo litter is difficult to decompose. Residue from edible fungi production can also be used as organic fertiliser for bamboo forest, improving soil quality. This allows a win-win solution in which "bamboo nourishes bacteria, and bacteria promotes bamboo".

Benefiting from the favourable climate in Shuifu City, the local cultivation of edible fungi is not only high in yield, but also good in quality, which is well-received by customers. Edible fungal production is a means of rapid enrichment of under canopy, and the production cycle is generally 1-6 months. This has a relatively low production cost, which makes it easy to apply elsewhere. The input-output ratio is generally in the range of 1:3-1:5. If each household produces 3,000 bags of edible fungi, it can increase its income by 5,000-10,000 RMB (around 716.5-

Figure 2-2 Bamboo fungus growing under bamboo forest

Source: Yunnan Water Technology 2020

Figure 2-3 Local farmers picking edible fungi

Source: Rednet 2021

1,433 USD). Moreover, edible fungi production is a labour-intensive agriculture (Figure 2-3), and the employment rate can be effectively increased by developing edible fungi production.

If managed with low-quality technology, the long-term productivity of bamboo forests is difficult to maintain. The edible fungi intercropped in a bamboo forest can improve physical and chemical properties of soil, which means improving soil structure, combating soil acidification, and increasing soil fertility.

Through intercropping bamboo with grass, legume forages, and herbs in tandem with good soil and water conservation practices, soil improvement effects are promoted. This not only contributes to the improvement of soil structure and soil fertility, but also saves the fertilisers consumed by bamboo breeding and improves economic benefits.

The scientific and rational configuration of species and distribution of nitrogen fixing plants grown under *Q. tumidinoda* forest, in combination with reasonable planting locations and different means of human interference to construct a composite operation model of nitrogen fixing plants under *Q. tumidinoda* forest, can improve woodland use and output and play an important role in the economic and ecological functions of *Q. tumidinoda* forest.

The soil fertility of bambus-broadleaf mixed forest was better than that of pure bamboo forest. In the 0-20 cm soil layer, contents of water, organic matter, total N, total P, and total K of the mixed forest were 125.5%, 131.4%, 110.4%, 112.5%, 124.9% of the pure forest. The hydrolysed N content of the mixed forest was 118.7% of that of the pure forest; available P content was 134.0% of that of the pure forest; and available K content was 108.8% of that of the pure forest (Chen 2022). The mixed ratio of bamboo and broadleaf forest had a certain effect on soil microbial biomass, and the soil microbial biomass and enzyme activities were the best in 20%-30% of the stands (Zhang et al. 2020). Mixed forests with reasonable stand structure and composition have stronger natural reproductive capacity, and the production indices of shoots per hectare, newly grown bamboo, new bamboo quality, and shoots per mother bamboo and adult bamboo are all higher than pure bamboo forests (Lin, Su and Cao, 2018). These indicators explained the high productivity of bambus-broadleaf mixed forest at the soil level.

3.2 Participatory approach

In terms of operation and management, the local government: facilitated the formulation of systems

and operating standards for bamboo forest management; organised retail investors to establish cooperatives; attracted enterprises to invest in, and institutions to support, technology development; and clarified contracts on rights and obligations. These means of joint participation of government and social forces can effectively improve the sustainable development capacity of bamboo forest.

As an example of social forces, Xinda Agriculture and Forestry Technology Co., Ltd. of Shuifu City took the lead in trialing a new development model. In this model, enterprises invested capital and technology, local communities provided land, village collectives participated in management, and income was shared by enterprises, local communities, and village collectives in mutually agreed upon contract terms. In 2019, a bamboo forest demonstration base of 1,500 hectares was established in Sanjiao Village and Shiyan Village of Liangwan Town, which increased the income of 23 households in three villages. In total this benefited 101 people, including 63 people from 15 poor households. The financial benefit attracted three local rich households to develop more than 6,000 hectares of bamboo demonstration base in Liangwan Town, which provided opportunities for 152 peasant families to increase their income.

The government of Zhaotong City (upper administrative region of Shuifu City) supervises and guides the forest and grass departments of all counties in the city to strictly control the quality during the distribution, inspection, and plantation of seedlings in the construction of new planting bases. In other words, the seedlings without certificates are not allowed to enter the bamboo seedling market in order to ensure the high-quality construction of new bases of bamboo plantation in the city (Figure 2-4).

Figure 2-4 Bamboo seedlings to be planted

Source: Yunnan Net 2020

Figure 2-5 Experts explain the development technology of bamboo forest management to villagers

Source: People Information 2021

First, the city government set up several groups to provide guidance to the counties. The municipal government has integrated various types of forestry technicians and experts and established several expert working groups serving to promote and develop bamboo forests. It has also carried out practical technical training in counties in Zhaotong City (Figure 2-5).

Second, the government requires farmers to give intensive and suitable management, and assign responsibilities to individuals. The local management person established 20 hectare units to implement integrated management with a board indicating the location, area, number of plants, person responsible, management time, and management content of each unit.

Thirdly, the local farmers learn from the neighbourhoods to identify issues. The management person adhered to good and efficient management methods by labelling and marking each bamboo seedling and indicating unit and plant number to facilitate the inspection process. The identification of seedling management and the grid management of fertiliser application and pest control are the main reasons for bamboo's success in Shuifu city.

Finally, the municipal government of Shuifu has widely publicised the importance and necessity of developing the bamboo industry. The municipal government has held many publicity meetings and sent representatives to share information with rural households. The favourable policies stating the importance of bamboo forest management have been compiled into booklets and distributed to thousands of households. This way, local residents are encouraged to plant bamboo forest. For example, Tian Shenggao of Sanjiao Village in Liangwan Town invested 20,000 RMB (around 2,866 USD) to plant 50 hectares of bamboo shoots in 2017. The net income from bamboo shoots in 2019 was around 2,000 RMB (around 286 USD).

3.3 Inclusive knowledge base

Promoting the standardisation, normalisation, and large-scale construction of the new bamboo plantation base are the main measures. Superior municipal governments urge all counties to plant bamboo forest demonstration sites one at a time according to annual construction planning as a means to strengthen quality management and ensure the effectiveness of objectives. Make sure seedling quality reaches the construction standard from the beginning. Once the construction guidance reaches the site, responsibility for construction quality is borne by the management person.

Two guidelines—"Zhaotong Jinfoshan bamboo high-efficiency cultivation technology" and "Zhaotong bamboo high-efficiency cultivation technology"—have been formulated by the forest department of Zhaotong City and experts to strengthen scientific and technical services and build a standardised scientific and technical system. The purpose of the system is to: optimise the allocation of natural and human resources according to the local situation, follow the standard bamboo forest base construction guidelines, increase investment in science and technology, and develop talent attraction strategies.

During the bamboo promotion, it is important to establish a bamboo science and technology service support system that fully covers all plantation area. At the same time, forest farms strengthen cooperation with researchers from university and research institutes and begin to build professional technology promotion teams to carry out science and technology training in local areas. There are some officers who oversee the bamboo plantation and management issues, bridging local farmers and government officials or experts. Along with traditional bamboo management techniques, the latest scientific knowledge is integrated in the restoration and transformation process. This allows bamboo farmers to carry out comprehensive management measures such as quality improvement, pest control, and transformation of lower quality bamboo forests to increase production efficiency and ecological performance.

3.4 Replicability and adaptability

As a fast-growing, perennial plant, bamboo provides food, renewable raw material, and regenerative energy. It therefore can potentially provide alternatives to timber products as well as sequester carbon and restore degraded lands in the Lancang-Mekong region. Despite the long history of the bamboo use in China and other places, sustainable management and high-quality use of bamboo resources remain challenging. Research and technology innovation can allow bamboo to become a green alternative through sustainable and high-yielding bamboo plantations adopting technology and management standards.

Here we provided a typical case for establishing a standard, high-quality bamboo plantation and management models. In this case, we established strong technology support systems. Quality control and monitoring are also required throughout the entire chain from seedling to bamboo products. Finally, it is crucial to formulate technical guidelines and train the local farmers. When technology and low-carbon policy create new markets for bamboo, the bamboo industry can support both local job creation and farmer incomes. China is a leader in bamboo plantation and manufacture. The case in Shuifu City showcases its success in transforming unmanaged natural bamboo forests. Since bamboo is abundant in other Lancang-Mekong countries as well as tropical regions, this good practice can be replicated in the development, distribution, and management of artificial and natural growing bamboo forests elsewhere.

4 KEY MESSAGES AND RECOMMENDATIONS

Yunnan is rich in bamboo resources, and bamboo plantation and use have a long history in Lancang-Mekong region. The management of natural bamboo forest often faces the problem of regeneration because of a lack of effective management. The development of bamboo industry is also challenging when the distribution of bamboo is scattered. In general, both planted and natural bamboo forests are managed at a low efficiency level. In order to meet the new market demand under technology innovation and green policy support, the promotion of bamboo and high-quality plantation and management are untaken.

First, the Shuifu municipal government promoted bamboo plantation and restoration as well as intercropping systems with bamboo. In this way, it is important for the government to establish a system of accountability and standards and to attract capital and technology input from enterprises and research institutions. It is also important for the government to facilitate participation of enterprises in bamboo forest management, bamboo shoot processing and sales, and processing and sales of intercropped products in order to form a complete industrial chain and standardise the whole industry. This not only improves the income level and structure of residents, but also improves the risk resistance capacity of local retail investors. At the same time, it raises local government revenue and injects capital and vitality into the operation of the forest management, forming a virtuous cycle.

The second is to enhance technology innovation and science-based management through selective cutting to remove old, weak bamboo and cultivate new bamboo to improve forest health. Old bamboo that does not meet the product standard can be broken and returned to the soil, and litter that is difficult to decompose can be broken and treated to promote nutrient cycling of the bamboo forest.

Chapter 3:
Ecotourism development model of nature reserves in Cambodia

1 GENERAL INFO

LOCATION: Chambok Commune, Kampong Speu Province, Cambodia

KEY INITIATOR AND STAKEHOLDERS: NGO Mlup Baitong (literally "Green Shadow") with financing from the European Union, Bread for the World, Oxfam Novib, and other partners.

2 DESCRIPTION

2.1 Introduction

Cambodia is located in the Indochina Peninsula, bordering Thailand in the West and northwest, Lao PDR in the northeast, Vietnam in the East and Southeast, and the Gulf of Thailand in the South. Cambodia's GDP growth rate in 2019 was 7.1% and is expected to remain at 7% over the next five years. Tourism is the third largest sector for Cambodia's economy after agriculture and the garment industry. According to estimates by the World Travel & Tourism Council, the tourism sector contributed 32.4% of Cambodia's GDP in 2017. This includes indirect contributions such as investment in tourism-related projects from other industries (WTTC 2018). Therefore, tourism in Cambodia plays an important role in strengthening and improving the country's political and economic development. Income generated from the tourism sector helps accelerate economic growth, poverty reduction, cultural identity, and political legitimacy in Cambodia, which was once known for land mines, killing fields and turmoil (Organisation for Economic Cooperation and Development 2018). The Cambodian government has been working with groups from the private sector that are the main drivers promoting tourism in the country.

Ecotourism is the focus of the world's tourism industry. The Lancang-Mekong region is rich in natural ecological resources and tourism resources. In order to ensure the sustainable development of the region, it is necessary to maximise the comprehensive ecological, social and economic benefits under reasonable development. Ecotourism plays an important role here. In the global tourism market, there is growing interest in forms of tourism with an environmental awareness such as ecotourism. Ecotourism is defined as purposeful travel to nature in order to understand the culture and history of the natural environment, without damaging nature, and taking care to ensure interaction between the ecosystem and activities that produce economic benefits to support conservation and protection of natural resources beneficial to the host community (Ross and Wall 1999).

According to the Ministry of Tourism of Cambodia, ecotourism is defined as a type of sustainable tourism in which tourists experience, appreciate and enjoy the nature and culture of their destination. In addition, tourism activities that are commonly seen in Cambodia include birdwatching, hiking, camping, sightseeing, swimming in natural water, biking and other activities. In 2013, there were 56 ecotourism sites in various regions of Cambodia including the northeast, the Tonle Sap area, along the south coast, and in the southwest (Reimer and Walter 2013).

Community-based natural resource management (CBNRM) has increasingly been applied, especially in tropical developing countries, to seek "win-win" outcomes and conserve natural resources while improving the welfare and livelihoods of local populations (Leach, Mearns and Scoones 1999; Berkes 2007). Community-based ecotourism (CBET) is a form of CBNRM. CBET projects have increasingly

been established for natural resource conservation and local community livelihood improvement (Kiss 2004; Khanal and Babar 2007). CBET is defined as responsible travel to natural areas that conserves the environment and improves the well-being of local people (The International Ecotourism Society 1990).

The Chambok is located in Chambok Commune (8,257 ha), part of which is within Kirirom National Park (KNP) (35,000 ha) in the Phnom Sruoch District, Kampong Speu Province, southwest Cambodia. Chambok has many attractions and activities to offer to both local and international tourists who are strongly interested in nature. It is well known for its three streams, waterfalls, and a bat cave with hundreds of inhabitants. Kampong Speu Province, to which Chambok belongs, lies west of the capital of Phnom Penh and is accessed by the national highway. The region originally had a dense forest cover. As the soil is generally unsuitable for agriculture, people traditionally live on using the forests through illegal logging, production of firewood and charcoal as well as hunting of wildlife. In the past, population growth and good market opportunities in the cities led to large-scale deforestation and partial destruction of natural sources for livelihoods, which in turn led to increased impoverishment of the local population.

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

In tropical developing countries, community-based natural resource management has been applied to seek "win–win" outcomes and conserve natural resources while improving the welfare and livelihoods of local populations (Lonn et al. 2018). Almost 15 years ago, the Cambodian NGO Mlup Baitong launched an initiative to lift the community of Chambok out of poverty through ecotourism. To protect and better use the natural resources, Mlup Baitong and Lutheran Worldwide Federation Cambodia have worked with the local community and authorities since 2002 to establish conservation zones, including three community protected areas (CPAs) (in KNP), three community forestry areas (CFAs) (outside KNP), and the Chambok CBET site.

The CPAs are located in KNP under the control of the Ministry of Environment of Cambodia, while the CFAs are located outside the national park under the control of the Forestry Administration. The CBET Chambok has the aims of forest conservation and community livelihood improvement, providing support through funding and capacity building. Moreover, traditions and Buddhist values are alive all over the country. Cambodia now seems to be an attractive tourism destination. More than half of the population has since joined the CBET. Within the implementation of CBET, they are trained in ecotourism skills and receive initial infrastructure improvement support. Chambok has become a model for environmental protection, improved livelihoods, and authentic travel experiences in Cambodia and beyond.

In the field of ecotourism, Mlup Baitong has emerged as a pioneer in Cambodia. Upon request from the tourism ministry, the organisation currently supports CBET in three communities in different parts of the country: Chambok CBET, Preah Rumkel CBET, and Boeung Anlung Pring CBET (Moeurn, Sophana and Morn 2013). Visitors have the opportunity to get to know the Cambodian culture and the unique and near-pristine nature in each place (Figure 3-1). For members of local communities in income-scarce forest areas, this is an important possibility to generate additional income and contribute to community development and forest conservation.

The Chambok CBET site was selected as a case study. There were 761 households comprising 3,670 residents in four villages in Chambok Commune in 2012. Half of the communal area is situated in KNP. Agriculture is a common source of income in rural areas. The people in the area mainly engage in agriculture (rice is planted in May and harvested in December), and supplement their incomes from secondary activities, such as raising animals, hunting, collecting non-timber forest products (NTFPs), wage labour work, working outside the commune, ecotourism-related work, fishing, and

Figure 3-1 Chambok Community-based Ecotourism

Source: Mlup Baitong 2016

operating small grocery stores.

2.3 INTERVENTIONS

The CBET site includes a 40-meter waterfall, the surrounding forest, a trekking trail through the forest, and local streams. The CBET committee facilitates the planning and management of the CBET site. There are no strict rules in relation to becoming a CBET member, which involves registration by the CBET committee, enabling new members to participate in CBET activities. All Cambodian citizens who are living in Chambok Commune can become CBET members and work for tourism-based businesses.

Tourism activities include forest trekking from villages to the waterfall, bird watching, visiting a bat cave, ox-cart riding, biking, homestays, camping, swimming, music and dance, and handicraft production. CBET members can earn wages for providing services such as acting as guides, ox-cart riding, homestays, selling handicrafts, and cooking. The CBET committee members also receive wages. The main sources of income for the CBET committee are entrance and parking fees.

Chambok's location on the fringe of the Kirirom highlands and in relative proximity to the national highway (88 km from Phnom Penh via national highway, plus 20 km of dirt road) and to the attractive waterfalls and other beautiful natural sights made it a potential location for ecotourism. Upon the initiative of the community members themselves and with support from various

training programmes by Mlup Baitong, paths were established, the first tour guides were trained, and more basics for tourism services were developed. Capacity building and training in the fields of general environmental awareness took place with members of the management committee. Traditional and modern tourism services and their management are undertaken. The CBET in Chambok covers measures on environmentally friendly tourism such as waste collection and recycling and setting up forest patrols to contain illegal forms of use. Also, the CBET in Chambok got support for women's groups, and they set up self-help groups and savings groups to establish small businesses, including catering for guests, production of souvenirs, and bicycle rental.

75 percent of the tourism service providers in Chambok are women. There are eight women in the CBET management committee (out of 15 members in total, and thus significantly more than the "at least three women in the committee" stipulated earlier). Apart from providing food for the tourists, the women's organisation contributes intensively to gender equality. Whether from tourism or from the micro-enterprises that the savings group was able to finance, the additional income empowers women in their families (Moeurn, Sophana and Morn 2016).

2.4 KEY RESULTS AND OUTCOMES

Through a CBET approach, ecotourism will also contribute to maintaining the balance of economic development, tourism and cross-sectoral support with the conservation of natural resources and indigenous cultural heritage, ensuring the maximum outputs of socio-economic development based on the principle of shared benefits and equity among stakeholders. Since 2003, on average 1,500 people per year have visited the Chambok CBET site.

In 2009, the CBET programme generated 19,707 USD, of which 25% supported forest conservation, 10% went to community development, 5% to the local Buddhist temple, 5% to local government, 10% to an emergency fund, 5% to a community fund, and the remaining 40% to ecotourism service providers (Reimer and Walter 2013). Through a self-sustaining operation, the CBET generates profits to members and contributes its income to a community development fund supporting women's self-help groups, health projects, micro-enterprise initiatives, and a community water supply system providing water from a connected waterfall.

In 2013 (by early December), 10,000 people had visited Chambok CBET. 75 percent of them were Cambodians, the rest were international tourists from about 30 different countries. During this period, the ecotourism project generated close to 41,000 USD. With a total of 136,050 tourists, the visitor statistics over a period of eleven years included both excursionists as well as guests staying overnight.

As a positive development, a strong increase in revenues can be noted, while the number of tourists remained stable or increased only moderately: from 10,000 tourists in the first year to more than 15,000 tourists in the years 2008 and 2009. Since the beginning of the project, the annual revenues increased tenfold. This may also be due to the significant rise in the number of foreign tourists who pay other entrance fees (3 USD) than Cambodian visitors (0.37 USD) and more often stay overnight, consume more meals in the community (instead of bringing their own picnic) and make use of other tourism services.

In recognition of the success, CBET in cooperation with Mlup Baitong was selected as a finalist for the National Geographic World Legacy Awards 2017 in the category "Engaging Communities". Chambok CBET was one of the three finalists in this category and was selected among over 100 applications from 45 countries across six continents. For Chambok CBET, this was the second nomination for a large international award, after already winning the To Do! Award 2013 together with Mlup Baitong.

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

Based on the plan of the nature reserve, the

local government has carried out a broader tourism development plan. This is an effort at overall comprehensive planning for sustainable development that makes use of the natural advantages of the nature reserve and supports ecotourism of the region in a holistic way by combining infrastructure, transportation, cultural development and other aspects. In this way it is possible to bring more economic benefits to the local tourism sector. Moreover, it has not only increased the income of the community, but also improved the community's attitude towards protecting the local environment and strengthened the protection of, and research on, biodiversity. After all, 70 hectares of the "Community Conservation Area" are located within the national park. Rules and regulations were jointly established to define the work of the committee as well as sustainable uses of natural resources in a binding manner. The entire project area encompasses 161 hectares of forest, 750 hectares of "Forested Community Protected Areas" and 300 hectares of "Community Forest".

The CBET project also benefits all the community members by preventing non-sustainable uses of the forest and the protected areas. The joint patrols have significantly reduced illegal logging and poaching. This has led to the return of animal species like wild peacocks and wild boars which were originally endemic to the area but had been absent for many years. A community-owned tree nursery ensures the successful reforestation of three hectares of forest and a clean environment without garbage that was found scattered around before.

The project thus successfully contributes to poverty alleviation in the community. The tourism revenues of Chambok CBET add up to 216,000 USD over the project duration from 2003 to 2013. Mlup Baitong's total expenditures for the project, with financial support from foreign organisations, amounted to 261,000 USD between 2002 and 2010. All the revenue covered the expenditure at the end of 2014. After twelve years the project achieved a successful financial performance, while other long-term outcomes for the community of Chambok can be noted. First, contrary to many concerns, the ecotourism site has remained clean. Plastic and other waste are being collected and recycled or disposed of in other ways, ensuring garbage is not left in natural spaces. More than 1,100 hectares of forest are managed in a sustainable manner. Forest fires, illegal logging and hunting of wildlife are under control. Before the project started, there were 72 charcoal pits in the area, which have now disappeared. This has stopped the daily logging of hundreds of trees. The forest authorities have been observing a natural reforestation of the area for several years. Even precious wood trees have started to grow in the forest again. The community members and CBET management committee have acquired a lot of new qualifications, with the concerns of the community and its members discussed and decided in the committee.

3.2 Participatory approach

Cambodia adopts the method of community intervention to distribute the operation, protection and management of the reserve to each community. Through the participation of residents, they give full play to the characteristics of local ethnic minorities. The progress of the community and the improvement of residents' living standards play a very important role in realising the sustainable development of ecotourism. Community development is not only one of the goals of sustainable development, but also an important measure to promote the ecotourism industry.

Mlup Baitong began the project with intensive consultations with members of the Chambok community. Many workshops focused on forest resource use and possible advantages and disadvantages of using the area for ecotourism. At the beginning of the project, all nine villages of the Chambok community were part of the decision-making process. Then, the community members clearly decided in favour of controlled ecotourism and elected a management committee of 13 community members to coordinate next steps of the ecotourism project. In the management committee,

Figure 3-2 Chambok Community-based Ecotourism

Source: Mlup Baitong 2016

the forest authorities and the local administration each have one seat. The committee has undertaken the goal of recruiting at least three female members. The Chambok community took the responsibility to organise all ecotourism activities themselves. In the meantime, Mlup Baitong has discontinued its financial and institutional support and transitioned to an advisory role.

Since the project started, people who are illiterate or who had not completed primary school have taken jobs as English-speaking tour guides, chefs and tourism managers which has empowered them to stand up for their rights. All organising activities, billing, and business agreements with tour operators are handled by the management committee. The committee also decides on the distribution of overnight guests among available homestay locations and discusses new tourism services and overall development of the community related to tourism activities. It seems to be important in these decisions and discussions that balance continues to be emphasised between natural resources preservation and tourism activities in a way that benefits the whole community. The management committee is regularly reconfirmed through democratic elections.

The ecotourism programme aims to establish local village-level tourism management committees that increase local ecotourism revenue without threatening the long-term conservation of nature. This assurance is provided by the agreement between the CBET committee, Mlup Baitong and the village. Institutionally, the programme relies on four parties, each of whom plays a key role. First, the elected tourism management committees are responsible for the site management of tourism services, marketing, site promotions, and managing tourism bookings. Local villages should take part

in ecotourism activities and training to adapt to livelihood strategy changes. After it stopped providing financial and institutional support, the Mlup Baitong transitioned to an advisory role. The monitoring, local development plan and nature conservation activities took place between the CBET committee and the village. The CBET aims to integrate local villagers with global tourism through an advanced ecotourism concept. During this process, the local villagers need to learn how to communicate with foreigners in order to book and guide tours, plan accommodations, and other tasks.

3.3 Inclusive knowledge base

Economic efficiency, social equity, and ecological sustainability, which are three elements of sustainable development, are fully considered in the CBET implementation. CBET recognises and emphasises the key role the community plays in ecotourism and fully mobilises the enthusiasm and participation of residents to realise the best community-based resource management. Through the development of ecotourism, it should provide them with more employment opportunities, improve living standards, and promote social and cultural harmony and progress. Additionally, ecotourism development decision-making in which local people can participate will be more conducive to the protection and rational utilisation of resources. In this process, local people should be empowered and their interests reflected from economic, psychological, cultural, and political aspects to ensure the realisation of their power.

Local culture and nature conservation are the most attractive aspects in ecotourism. For generations, residents have relied on local land and natural resources for survival and most of them are engaged in occupations related to agriculture, animal husbandry, wood logging, mineral mining and other livelihood activities. Local people who have lived in destination for a long time have a good understanding of natural resource characteristics in the reserve. Therefore, local communities began to give full play to their regional ethnic and cultural characteristics. By building characteristic ethnic residences into homestays for rent or residential spaces open to tourists, combined with local food and cultural activities, they built an entire ethnic ecotourism route for tourists to experience a series of ecotourism activities (Figure 3-2).

3.4 Replicability and adaptability

Cambodian nature reserves have many advantages for ecotourism development. The country has rich natural resources and is an internationally competitive ecotourism destination. In fact, all the Lancang-Mekong countries have mostly similar ecological bases and so have the same advantages for developing ecotourism as Cambodia.

It should be noted that the Cambodian National Government, local communities, and civil society have played an important role together in policy formulation, financial support, management and implementation of ecotourism in Cambodian nature reserves. Other countries can learn from such government leadership and its driving role to form a diversified ecotourism model through the intervention of local communities and civil society. However, in areas with limited numbers of educated people, the local government and civil society may need to cooperate to provide training in tourism service skills and knowledge about environmental protection. The training methods should be as diverse as possible and could include special lectures, further education, full-time guidance, group discussions, online and offline teaching methods and provide real-time consulting services. Together these will enable local communities to have sufficient awareness on environmental protection before programme implementation.

In Cambodia, ecotourism is an important part of the overall planning and development strategy. It serves as one objective of the development strategy and serves as an effective means to achieve environmental protection and community development. CBET has become a popular tool for biodiversity conservation and livelihood improvement, especially in developing countries (Lonn et al. 2018). Local participation should be promoted in the

ecotourism decision-making process by ensuring multiple stakeholder participation and establishing clear requirements for guidance documents. Because national conditions of every country are different, local participation in ecotourism management not only improves understanding of local tourism, but also improves the quality of planning and decision-making by incorporating the opinions of local people.

The Chambok CBET Project is one of the best examples of a successful community-based ecotourism project in Asia in terms of its performance in economic profitability and cost. In the national context, Chambok CBET has for some time served as a model for many other similar initiatives in the country. With the many lessons learned, a holistic, comprehensive, practical and operational guideline for CBET development and management were designed for Cambodia to ensure projects are developed on the right track and not at the expense of communities, environment, and economic green growth.

4 KEY MESSAGES AND RECOMMENDATIONS

Environmental protection is an important contribution and basic content of the sustainable development of ecotourism. Among typical obstacles for ecotourism development, related environmental education is a key element. For most local residents, the challenge may involve the lack of professional knowledge about environmental protection as well as a lack of training on the environment or culture relevant to their living areas. For tourists, the problem mainly lies in their lack of understanding of local traditional ecological and cultural backgrounds. Therefore, local governments need to prioritise improving the environmental awareness of local people and tourists. New and traditional multimedia including television, newspapers, outdoor advertisements, official government websites, tourism websites, and other channels can be used to promote ecotourism and knowledge about environmental protection in local nature reserves.

The development of ecotourism has had a positive impact on local residents in Cambodia. It provides them with employment opportunities and direct economic benefits which diversifies local economies dependent upon agricultural products. It also improves living standards of local people through infrastructure transformation.

Despite all the success and increases in revenue from the ecotourism project discussed above, some areas remain where improvements can or must be made through, for example, suitable marketing measures to attract more international visitors. Moreover, CBET development requires effective quality management of the tours and activities already offered in addition to a diversification of attractive adventure services in the villages. When it comes to catering to a larger number of international visitors, the management committee must also handle the challenge of training English-speaking guides. The balance of governance between CBET management and leadership from the management committee also requires monitoring. Building leadership among young people in the community remains a further challenge for long-term sustainability of ecotourism in the area. At the same time, the government played a leading role in this process and cooperated with civil society organisations to formulate a series of relevant policies to address this challenge.

Chapter 4:

Local ecological knowledge and rural livelihood enhancement by community-based freshwater fisheries management in Lao PDR

1 GENERAL INFO

LOCATION: The Siphandone Wetland area, Lao PDR

KEY INITIATOR AND STAKEHOLDERS: non-governmental organisation CESVI, Agriculture and Forestry Office (AFO) of Khong District, the Agriculture and Forestry Division (AFD) of Champasak Province, villages in Khong

2 DESCRIPTION

2.1 Introduction

Lao People's Democratic Republic (Lao PDR) is a land-locked country in mainland Southeast Asia, sharing borders with Vietnam to the east, Thailand to the west, China and Myanmar to the north, and Cambodia to the south. With a multi-ethnic population of approximately 5.5 million, most people in Lao PDR are mainly self-sufficient as rural-based farmers and fishermen. The country, which is about the size of Great Britain, is considered one of the poorest in the world with the Mekong River being its hydrological life-blood, flowing for some 1,860 km through the country. Roughly 25% of the Mekong River Basin locates in Lao PDR, which contributes 35% of the Mekong's total flow (FAO 1999).

The Mekong River and its tributaries are the main source of wild fish for local people, and fish constitute the most important source of protein and income for the bulk majority of the Lao PDR population (Baird 1999b; Baird et al. 1998). There is a large variety of fisheries, each dependent on the harvesting methods used, the particular habitats and seasons involved, and the ethnicity and socioeconomic conditions of the fishermen. The fishing methods used are also dependent on the species of fish, or groups of fish, being targeted, and the fishermen' knowledge of the biology and behaviour of the fish (Claridge, Sorangkhoun and Baird 1997; Baird et al. 1998). Certainly, the local ecological knowledge (LEK) of fishermen contributes greatly to their ability to feed themselves and their families, and to generate income. In fact, fish resources and LEK are the basis for livelihoods (Baird 1999a; Baird1999b; Baird and Flaherty 1999). Yet, as human populations have grown, fishing implements have been modernised, markets have become more accessible, and development projects of various types have had a negative impact on fish populations (Baird 1999a; Baird 1999b; IRN 1999; Roberts and Baird 1995). Although there is limited data available on fisheries, there are increasing numbers of reports that individual fishermen are experiencing significant declines in their catches (Martin, Lorenzen and Bunnefeld 2013; Baird et al. 2006; Baird et al. 2001; Baird et al. 2001b; Roberts and Baird 1995).

The Mekong system is characterised by having a large number of fisheries, each operating in

different ways, adding to the complexity of management (Baird et al. 1998). Many of these fisheries are located in relatively remote areas, making the possibility of government regulation extremely difficult, costly, and generally unrealistic (Cunningham 1998). The large number of highly migratory fish species in the Mekong basin that move between two or more countries also makes it difficult to manage many species at the local level (Baird et al. 2001a; Warren, Chapman and Singhanouvong 1998; Roberts and Baird 1995).

In addition, various development projects in the planning or implementation stage can also seriously affect natural aquatic resources. These projects are associated with a number of sectors such as: hydro-electricity production, irrigation development, and industrial expansion (Baird 2001; International Rivers Network 1999). In order to combat ecosystem degradation and improve fish biodiversity, the community-based fisheries co-management (CBFC) was initiated in Siphandone, Lao PDR (Baird 1999a). The Siphandone (meaning 4,000 islands in Lao language) Wetland area, situated in Khong District, Champasak Province, is one of the most complex ecosystems found in the mainstream Mekong River. It is characterised by having high biodiversity and productivity (Baird 2000; Baird 1999a), hence the CBFC system in a wild-capture fisheries of Khong District presents a significant case in Mekong basin.

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

Environmentally friendly freshwater fishery management is an effective means to realise the sustainable development of fishery and obtain long-term benefits. Reports indicate that community-based co-management programmes, as well as the use, dissemination and strengthening of LEK, can improve the management of wild caught freshwater fisheries (Martin, Lorenzen and Bunnefeld 2013; Baird 2007). Therefore, the main objectives of freshwater fisheries management in CBFC are as

Figure 4-1 Khong District, Champasak Province, southern Lao PDR

Source: Baird and Flaherty 2005

follows: (1) Prohibition of overfishing and prevention of population decline, (2) Balance long-term interests and short-term interests, that is, adjust the current interests and long-term interests to a level acceptable to the current society.

With the development of modern fishing technology, overfishing is pushing many species to the brink of extinction. This can result in the collapse of the ecological foodweb and can have serious consequences for other species. On the other hand, the reduction of fish resources, the decline of individual fishing and the low economic benefits will most likely lead to the unemployment of most people and even cause the economic decline of the whole region. In view of these problems, many scientists have put forward suggestions on the joint participation of government, community, and users in fishery management (Cunningham 1998). Based on co-management, some relevant laws and regulations prohibiting overfishing can be enhanced. Secondly, experts recommend promoting the dissemination and exchange of LEK to lay a good foundation for local regulation development and improved management decisions (Roberts and Baird 1995). Finally, local villagers gradually improve and adjust management decisions based on the results of monitoring and analysis (Baird 2000).

Provided that co-management systems remain flexible and can adapt to social and institutional circumstances unique to specific areas, they can represent an important option for improving the management and equitable distribution of natural resources (Baird 2000). A CBFC approach that allows for the full participation of villagers and government should receive increased attention and support in the relevant sector. The implementation of these approaches can result in a significant reduction in overfishing and a significant increase in the exchange of ecological knowledge among villagers (Masae, Nissapa and Boromthanarat 1999). The results suggest that this type of management regime holds considerable promise for furthering local fisheries management in the Mekong Basin.

2.3 INTERVENTIONS

2.3.1 Community-based fisheries co-management

63 villages in Khong District initiate the CBFC process and select the regulations to be adopted according to the local conditions and community consensus (Baird 2007). In addition, communities are empowered to implement and enforce regulations, and they can alter them in response to changing circumstances. Therefore, many communities have adopted similar but slightly different regulations (Baird 1999b), and the most commonly used regulations (Baird 1999b) relate to:

(1) The establishment of Fish Conservation Zones (FCZs) in deep-water (10 to 50 m deep) parts of the Mekong River (see Figure 4-2).

(2) The banning of the blocking of streams with fish traps at the beginning of the rainy season.

(3) The banning of "water banging" fishing (bang the water and riverbed near the nets in order to chase fish into the gillnets).

(4) The banning of spear fishing with lights at night.

(5) The banning of catching juvenile snakeheads (*Channa striata*) (pa kho in Lao), especially when they are less than about two weeks old and still travel in schools.

(6) The banning of frog (*Rana spp.*) catching at the beginning of rainy season, when they spawn, and in some cases, at other times of year.

(7) The banning of tadpole (*Rana spp.*) catching at the beginning of the rainy season after spawning takes place.

(8) The protection of inundated forest habitat by encouraging villagers not to cut down wetland trees and bushes in the mainstream Mekong River (Baird 1999b).

Figure 4-2 Fish Conservation Zones and the regulations in Lao PDR

Source: Fishbio n.d.

2.3.2 Putting LEK to work in fisheries management:

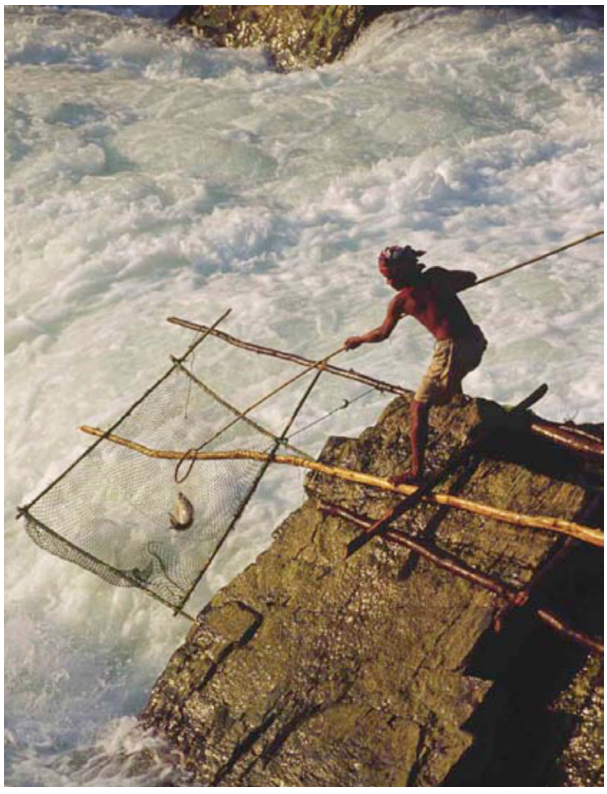
The LEK related to fish and other aquatic resources in Khong is very widespread, and most people in the district have a highly distinct folk taxonomy for fishes, and all medium and large-sized species have specific local names, even when there are only small differences in overall appearances. In addition, local people in Khong District possess a considerable amount of LEK about fish behaviour, including migration and feeding patterns (Baird 1999a; Baird 1999b; Baird and Phylavanh 1999). Fishermen master traditional fishing techniques as part of the local practices (Figure 4-3). However, even local fishermen with vast amounts of LEK are eager to learn more.

Since LEK is often very locally relevant, while lacking a broad and regional perspective, it is often useful for outsiders to provide information of this nature to local fishermen, as a way of helping to improve local fisheries' management decisions. In this way, the Lao Community Fisheries and Dolphin Protection Project (LCFDPP) and the follow-up Environmental Protection and Community Development in Siphandone Wetland Project (EPCDSWP), implemented by Italian non-governmental organisation CESVI, have helped to support the CBFC program in Khong (Baird 2000). Another important way in which the LCFDPP and the EPCDSWP have helped to strengthen LEK and local fisheries management in Khong has been by facilitating the exchange of LEK both within and between communities (Baird 2000).

2.3.3 Adaptive management:

Adaptive management is critical for the successful management of natural resources, especially over the long-term (Walters 1986). When fishermen are involved in making management decisions, as

Figure 4-3 Local fishing techniques at Siphandone



Source: International Union for Conservation of Nature and Suthep Kritsanavarin 2009

they are in Khong, strengthening LEK is a critical component of supporting the adaptive management process. Adaptive management requires making management decisions; implementing them; monitoring and analysing the results of implementation; and then altering management decisions based on those results, gradually improving and adjusting them over time (Walters 1986). This is commonly done by locals involved in the management of all kinds of natural resources, and is common in relation to fisheries management in Khong (Baird 1999b).

Regarding FCZs, it has been observed that fishermen monitor the success of FCZs in various ways, some of which are based on specific observations of natural processes. In Khong, the EPCDSWP has helped develop a more formalised data collection programme to monitor the results of management decisions related to the establishment of FCZs (Baird 1999b). This has been done, not only to help communities improve their management strategies, but also to provide government agencies with quantitative data useful for assessing the value of FCZs (Baird 1999b). The data could also be used to test the knowledge of the fishermen regarding their understanding of the catch structure of fisheries. The process of adaptive management in Khong has also been strengthened through various other activities at the community level, the most important being periodic village meetings (Figure 4-4) to review regulations amongst community members and discuss ways to improve regulations and their implementation (Baird 1999b).

2.4 KEY RESULTS AND OUTCOMES

Most villagers have widely reported increased stocks of certain aquatic species, as well as increases in fish catches, since the adoption of CBFC regulations (Baird et al. 2001b). Some rare and endangered species of fish have also been observed more commonly due to the regulations, thus benefiting biodiversity (Baird and Flaherty 2005). Improved solidarity and coordination within and between rural fishing and farming villages and the government

Figure 4-4 A meeting to announce the rules of the Fish Conservation Zones

Source: Fishbio 2016

has also been observed (Baird 1999b). The initiative can be seen as being relatively successful to date, since both local communities and the environment are benefiting (Baird and Flaherty 1999; Baird et al. 1998).

LEK is not at a standstill but developed through the actual experiences of individual fishermen. Based on the CBFC, LEK was learned by villagers and foreign scholars (Baird 1999b), and exchanged within and between communities, increasing their acquisition of new information, thereby further strengthening local fisheries management. Through adaptive management in combination with LEK, the problems of unreasonable and inappropriate management systems in a certain area are solved in time, which provides a guarantee for the sustainable and high-quality development of fisheries (Baird 1999b).

In general, the adoption of the co-management strategy has achieved quite positive significance: (1) It has improved the relationship between fishermen and the government. By incorporating fishermen (organisations) into the management decision-making system, the contradiction between the managers and the managed in the traditional sense can be alleviated. (2) It has improved fishermen's understanding of the impact of Fishery Ecology and the significance of management. (3) The cooperation between fishermen and scientists has been enhanced, and fishermen have turned their distrust of information provided by outsiders into support. (4) It has promoted the unification among fishermen and the establishment of fishery-related industry associations. In addition, because some management tasks are borne by participants rather than the government, the government's management costs are significantly reduced, and the management rules are easier to implement due to the participation of resource users in decision making process. Reliable data support is also conducive to the steady improvement of management performance.

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

Under the premise of the sustainable utilisation of fishery resources and the feasibility of fishery administration, the co-management model tries to achieve the balance between the maximisation of economic efficiency and the social efficiency of fishery management. In fact, the co-management

of fisheries has been valued by more and more experts, scholars, and people in the field of fisheries management, and has gained a lot of practical experience in Norway, the United States, Canada, the Philippines, Sri Lanka, and many other countries (Cunningham 1998; Baird 1999b). In general, co-management helps to promote the sustainable development of fishery resources and improve the livelihood conditions of residents.

The implementation of the closed season system in participating villages of CBFC has played an important role in reducing fishing intensity, protecting fishery resources and water ecological environment, maintaining aquatic biodiversity, improving the people's awareness of resources and environmental protection, and achieving good ecological, social, and economic benefits (Baird and Flaherty 2005). For example, the fishing moratorium in the summer season has not only enabled the sustainable development of the river ecological environment, but also promoted fishery cooperation among fishing communities (Baird and Flaherty 2005). One of the important reasons why CBFC has been successful in Khong is because the villagers have a strong sense of belonging to their communities, and a strong sense that their children and grandchildren will be living in the same villages in the future (Baird 2007). This has helped to encourage a conservation ethic, and to ensure that many locals manage resources for the long-term objective and not just for the present value. A long-term sense of belonging to their community often leads to successful community-based resource management.

The CBFC in Khong has been successful in improving management strategies and practices related to aquatic animal harvesting, such as increased village solidarity, increased natural resource management capacity at the government and village levels, and observed and/or perceived increases in fish and frog stocks and catches (Baird 2000). Improved village solidarity has all been done at a very low cost to donors and the government, since villagers do most of the work themselves. Moreover, villagers from some communities with CBFC, such as Kokpadek and Chan villages, have reported that increased fish catches have had unexpected benefits in terms of terrestrial wildlife, forest management, and conservation (Baird 2000). In addition, CBFC has helped strengthen LEK and thus local fisheries management in Khong has been facilitating the exchange of LEK both within and between communities (Baird 2007).

3.2 Participatory approach

With the coordination and cooperation between rural fisheries and agricultural villages and the government, most of the work is completed by local people, and the cost of fishery management by the government is very low. Therefore, the local government advocates the CBFC system and hopes to expand the work to other villages in the future.

LEK has been the basis for the establishment of all regulations, and the government and supporting NGO projects have provided additional scientific information to local fishermen to augment their LEK. In this way, the LCFDPP and later the EPCDSWP have helped to support the CBFC programme in Khong. And the data collection plan developed by EPCDSWP not only helps communities improve their management strategies, but also provides quantitative data for government agencies to evaluate the value of FCZs (Baird 1999b). In addition, officials and fishermen have similar backgrounds, hold the same LEK about fisheries, and officials can easily relate to the regulations that communities adopt (Baird 1999b).

Adaptive management decisions are usually made by local communities involved in the management of various natural resources. In addition, allowing fishermen to participate in the fishery management process in a certain form of organisation can not only establish a stable cooperation and dialogue mechanism between the government and fishermen, it can also make fishermen aware of their long-term interests and control the ways to reduce risks, which will help the government and fishermen reach a consensus and finally realise the long-term

sustainable utilisation of fishery resources.

3.3 Inclusive knowledge base

The CBFC system for working with villages to establish co-management plans is based on the principle that villages should not be forced or pressured into establishing aquatic resource co-management regulations. Instead, villages should only be assisted in establishing co-management strategies after they have requested assistance in doing so. The village head should present the draft of the co-management regulations developed by the community, and the group members should consider what regulations to endorse and what level of punishment should be mandated for those who break the regulations (Baird 1999b). The regulations cannot conflict with already established national laws, or result in increased degradation of natural resources, or cause serious conflicts between or within communities (Baird 1999b).

Most villagers in Khong district possess a great deal of LEK regarding aquatic natural resources, which makes it possible for villager discussions to deal with quite detailed and specific aspects of management. And it is difficult for individual villagers to mislead others regarding certain aspects of management because most know enough to easily recognise when somebody is not being truthful. Hence, community members can play an important role in supporting the co-management process due to their LEK of local conditions. During the village discussion, men generally concentrate their regulation-making efforts on large bodies of water and large and valuable fish species, while women tend to focus on issues related to small water bodies and aquatic life in streams, ponds, and rice paddy fields. These gender differences help balance and broaden the final contents of management plans (Baird 2000).

The establishment of FCZs was the most significant co-management initiative for villagers and local government officials in Khong district in parts of the mainstream Mekong River (Baird 2000). Villagers' logic for establishing FCZs is based on LEK, which is accumulated through generations of fishing experience and the personal observations of fishermen. LEK, which is always located in particular contexts, is at least partially dependent on geographical spaces, due to various ecological and social factors, but it also depends on various political and networking factors associated with fishermen involvement in social networks (Baird and Manorom 2019). As a result, in CBFC process, LEK can be revealed during group discussions, and more people will gain access to more knowledge which, in turn, will increase their capacity in CBFC implementation.

The projects also invited two independent monitors to spend two weeks each in Khong to evaluate the aquatic resource co-management programme as a formal way of monitoring and evaluating its success (Baird 1999b). The data collection and monitoring exercise have proven to be very useful in raising awareness amongst villagers regarding the importance of FCZs, and have strengthened the ability of villagers to analyse fisheries management issues, and make appropriate management decisions (Baird 2007). The formal evaluation phase was also successful in strengthening local co-management systems, as it provided the project and local government with valuable information about the status of village co-management systems (Baird 2007). Moreover, NGO, Agriculture and Forestry Office (AFO) of Khong District also attended the workshop to support the CBFC implementation (Baird 1999b).

3.4 Replicability and adaptability

Centrally imposed natural resource management systems typically increase the monitoring and regulatory responsibilities of governments. However, the fisheries departments in non-industrialised nations are typically understaffed and underfunded. Given the pressing need for improved natural resource management, alternative decentralised management models, including "co-management" and "community-based natural

resource management" (CBNRM), are being increasingly proposed in Southeast Asia and other parts of the world (Baird 2007; Baird and Flaherty 2005; Masae, Nissapa and Boromthanarat 1999). In order to highlight the links between government, community, and users, some regions such as the wetland systems in Khong establish CBFC for fishery governance. Between 1993 and 1999, 63 villages in Khong established CBFC regulations to sustainably manage and conserve inland living aquatic resources, including fish, in the Mekong River, streams, backwater wetlands, and rice paddy fields (Baird 1999b). The results show that biodiversity has increased significantly since the adoption of CBFC regulations, and the government also hopes to extend this method to other places. In terms of enhancing the legitimacy and compliance of fishery management, the introduction of a co-management strategy is the best choice.

We can learn from the successful experience of other regions and select regions with relatively mature conditions for a pilot study. The scope of one pilot area would be smaller with fixed fisheries that are easier to manage. The government will gradually transfer some power to fishermen's cooperative organisations, including establishing corresponding legal rights through the promulgation of local regulations or other more formal forms. This may be one of the most difficult tasks to effectively establish co-management, but it is also a key step. After the success of several pilot projects, the number and scope of pilot projects can be gradually expanded until they are popularised throughout the country. Co-management is not a fixed rule system. On the contrary, it needs strong flexibility and adaptability. In other words, not all regions are suitable for this form of management, which requires specific analysis according to local conditions. Therefore, in a new area, every promotion must fully consider the local actual situation.

4 KEY MESSAGES AND RECOMMENDATIONS

4.1 Key messages

Since fish are the most important source of animal protein for villagers living in and around protected areas in central and southern Lao PDR, the sustainability of fisheries is critical to villagers' food security. 63 villages in Khong District established co-management regulations to sustainably manage and conserve inland aquatic resources in the Mekong River. Regulations adopted by villages include establishing FCZs in the mainstream Mekong River, banning certain fishing methods, managing natural ponds and rice field paddy wetland areas, protecting flooded forest habitats, and conserving and sustainably managing frog and juvenile fish populations. It is important to make maximum use of LEK to improve fisheries management, and it is often useful to disseminate and strengthen LEK in various ways. Co-management system achieved success increases in fish stocks and catches were observed, and their management systems were strengthened to ensure that aquatic resources were managed more sustainably. Co-management has been identified as a key factor in reducing conflict and improving management conditions.

The situation may not always be as straightforward as it may appear to be in Khong, especially when one is dealing with less ethnically and socially homogenous communities. But, even when less

homogenous communities are the focus, CBFC may be the most viable option for improving management, especially when one considers small-scale fisheries with few scientific data situated in remote areas. The critical importance of LEK should be recognised, and has considerable potential for strengthening the local management of living aquatic resources.

In general, co-management has considerable potential for improving management decisions regarding particular fish species and habitats, be it in southern Lao PDR, other parts of the Mekong Basin, or elsewhere. LEK can play an important role in the assessment of fish stocks targeted by artisanal fisheries. The use of LEK to assess and monitor fish stocks may be especially important in tropical aquatic ecosystems with high degrees of biodiversity, since human and financial resources required to conduct detailed scientific studies are especially scarce in non-industrialised countries such as Lao PDR. It is likely to be especially important in areas characterised by small artisanal fisheries that are not commercially valuable enough to justify large research budgets for detailed stock assessment activities. The use of LEK provides a cost-effective and pragmatic alternative that has the extremely important added benefit of being participatory and having the ability to draw resource users directly into management decision making processes.

4.2 Key recommendations

Although most areas already have some foundations for the application of common management mechanisms in fisheries, a lot of preparatory work is needed to put it into practice, especially since the government plays a very important role. Recommendations on how to promote the concept of co-management are as follows:

(1) Strengthen the research on the theory and practice of fishery joint management. Although the strategy of fishery co-management has gained rich practical experience in many areas, due to the high flexibility and adaptability required by the joint management itself, the same strategy cannot be directly adopted in other areas. In-depth theoretical research will provide necessary guidance for the establishment of practical fisheries joint management mechanism.

(2) Policy support by the government. Many international experiences show that it is necessary to have in place supporting policy for co-management. The government should encourage more communities and fishermen to participate in fisheries management, support fishermen to hold meetings to discuss problems and solutions and allow them to criticise existing government policies and management measures. In addition, a smooth communication channel between fishermen and the government should be established to ensure not only the "transmission of love from the upper level", but also the "transmission of love from the lower level".

Chapter 5:
Buddhism and sustainable forest conservation in Thailand

1 GENERAL INFO

LOCATION: Many parts of Thailand

KEY INITIATOR AND STAKEHOLDERS: Buddhist monks, Communities

2 DESCRIPTION

2.1 Introduction

Thailand is located in the middle of the Indochina Peninsula, between the Indian Ocean and the Pacific Ocean, with an area of about 514,000 km^2. Thailand is a country of mountains, hills, plains, and a long coastline along the Gulf of Thailand (1,875 km) and the Andaman Sea (740 km), plus about 400 islands, most of which are located in the Andaman Sea. Thailand is very rich in forests, which play an important role in the exports of forest products. This accounts for USD 3.9 billion, or around 1.2% of all exported goods and services (FAOSTAT 2018). In 1961, forests covered 53.33% of the total land area in Thailand. However, due to the logging and harvest of trees, from 1973 to 1998, the forest cover declined from 43.21% to at least 25.28% (APFSOS 2009). There were tragic incidents of floods and mudslides with a sea of logs in the southern region, causing over 700 deaths, which changed the direction of forestry policy in 1989. Later, the government enacted a logging ban that revoked all logging licenses in natural forests, effectively banning commercial logging, especially in the uplands (Lakanavichian 2001).

Thailand has experienced infrastructure development, land conversion for large-scale agriculture, small-scale shifting agriculture, and illegal logging, all of which are major drivers of deforestation in the country (Yasmi et al. 2017). Under strong pressure from various stakeholders to conserve forests, the total amount of forest cover increased and stabilised at 31-33% between 2000-2016 (Trisurat, Shirakawa and Johnston 2019). According to the 12th National Economic and Social Development Plan (2017–2021), Thailand has set a target of having at least 40% of the country's total area forested (NESDB 2017). In addition, the National Forest Policy Committee was established in 2017 to supervise and guide the forest policy at national level.

In terms of social aspects, the vast majority of the Thai population (92.6%) identify themselves as Buddhist (Global Religions Futures 2020). Buddhism has been institutionalised through law. For many Thai people, Buddhism is considered a philosophy and a way of life. Its values are found throughout Thai culture and provide a sense of stability by offering a structure for people to base their everyday routines. Due to most Thai people practicing Buddhism, monks hold an influential role as leaders to whom people look for guidance in all aspects of life including topics related to the environment and its conservation. Through public outcry, Thai citizens have found leadership, principle, and voice in a small number of Buddhist monks engaging in ecological conservation projects. They are known as the self-proclaimed 'Ecology Monks' or Phra Nak Anuraksa in Thai language (Rick 2018). Some of the ecology monks have influenced the monastic movement by practicing the ordination of trees in order to reverse the unsustainable economic development caused by environmental degradation and excessive human consumption (Darlington 2019). Buddhism encourages all people to live in a balance way

Figure 5-1. Monks and Buddhists take the forest as a place to practice Buddhism

Source: Teenee 2017

Source: Masii 2019

and consume the natural resources sustainably (Phrakhruphiphitcharutham 2014).

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

Buddhism is a traditional religion inherited from generation to generation in Thailand, and it is also the centre of Thai life. There are more than 30,000 temples in the country and Bangkok, the capital of Thailand, is known as the capital of Buddhist temples. As the kings of Thailand believe in Buddhism, Buddhism also naturally becomes the Thai religion. Monks are respected and are allowed to speak in all sectors of society. Royal ceremonies, national education and life are also regulated by Buddhism.

Thai people respect religion, maybe even more than laws, and most people follow it by heart. The unique practices of Buddhism focus on conserving forests spiritually with respect and kindness just as if it was another human being. The ecological theory of Thai Buddhism regards human beings as appendages of nature under the premise of ecology as its centre. It also takes the forest as a place to obtain peace and joy of mind and finally reaching the highest spiritual consciousness (see Figure 5-1). Therefore, it is feasible for Buddhist monks to participate in strengthening forest sustainable conservation (Sponsel et al 1997).

The Self-proclaimed Ecology Monks (Phra Nak Anuraksa) are the essence of the Buddhist ecology movement. The monks witness the environmental destruction of the forests and other environmental problems caused by human activities which is a crucial factor leading to human suffering. Improving awareness of people towards things related to the environment, the sustainable use of its resources, as well showing people ways to soothe their suffering are just some of the responsibilities of the monks (Darlington 1998).

2.3 INTERVENTIONS

Buddhism is simply a religion that expresses the natural processes. Studies have found that the concept and role of monks in forest protection can be summarised in the following: 1) teach people to care and understand the value of the environment, 2) become leaders in forest protection, and 3) support communities in protecting forests (Pattawee 2018). Below are two concrete examples of how the Buddhist monks play a leading role in forest conservation and sustainable livelihoods.

(1) *Ordination of trees*: The sustainable development of Buddhist ecology emphasised that humans have wisdom, right view, right thought, and right action,

originating from the Noble Eightfold Path, which could be used for developing a more environmentally conscious community and society. In relation to this spiritual concept, there is a ceremony called the 'ordination of trees' in which the Buddhist monks tie saffron robes around the trees (Figure 5-2), symbolically making the trees as monks to remind people that nature should be treated as an equal to humans, deserving the same respect that all humans receive just as all living beings should. Buddhist monks in Northern Thailand have been ordaining trees since 1988, with the help of Thai villagers and by combining Buddhist ceremonial tradition with local spiritualism. There are two main causes of suffering, first is negative desire ("tanha", in Pali language) and second, is greed. The tree

Figure 5-2. Buddhist monks tie saffron robes around the trees, a ceremony called the 'ordination of trees' (Photo by Chantal Elkin via Flickr, CC BY-NC-SA 2.0)

Source: Barua 2021

ordination and other rituals related to religions and belief aim to teach villagers to avert desire and temptation brought upon by consumerism and commercial agriculture, by promoting sustainable agriculture and self-sufficiency instead (Darlington 1998).This is a clever scheme to prohibit cutting down trees and take care of forests. The rituals can be powerful tools for social change to challenge state-led capitalist development and to encourage a lifestyle that promotes environmental conservation, in keeping with their interpretation of Buddhist teaching (Darlington 2007).

2) *Conservation and self-sufficiency farming learning centre*: For monks, education is of the utmost importance. Many temples throughout Thailand offer courses combining conservation and the noble truths. For example, prominent eco-monk Phrakhu

Figure 5-3. Phrakhru Pariyat Viriyaporn explaining concept of the 'Sufficiency Pit' (left) and receiving a national award presented by the Thai Prime Minister in 2015 (right)

Source: Kasetsanjorn 2020

Source: Chum Chang Subdistrict Municipality 2015

Sangkom Thanapanyo Khunsuri has established a traditional farming school at his temple in the Maab-Euang Meditation Centre of the eastern Thai province of Chonburi, with the objective of Sufficiency Economy. The Sufficiency Economy theory was developed by the late Thai King Bhumibol Adulyadej to promote subsistence farming, self-sufficiency, and detachment from materialism and consumerism. In Bangkok, another eco-monk, Phrakhu Win Mektripop introduced the interrelationship between Buddhism and environmentalism to the students who are NGOs, and farmers (Mongabay 2018). In the northeastern province of Kalasin, Phrakhru Pariyat Viriyaporn has turned his Nakham Forest Temple into a learning centre on conservation and an integrated farming system (Figure 5-3). His temple has attracted national and international visitors to learn about, among others, the 'Living Weir' for community water resources conservation and 'Sufficiency Pit' that grows different plants for household consumption.

2.4 KEY RESULTS AND OUTCOMES

Over the past three decades, these 'Ecology Monks' have promoted a small but influential movement that protects forests from degradation. Forest and nature conservation are developed to create prosperity in the use of resources sustainably. Employing the Buddhist doctrines as a tool to understand and sympathise the nature around us can effectively realise human care and attention to all living and non-living things. Using Buddhism to protect forests is beneficial to the sustainable development and integrity of society (Phrakhruphiphitcharutham 2014).

Monks are highly respected and revered members of the Thai society and have a considerable impact on local agricultural communities (Sponsel et al. 1997). They have close contact with farmers and can better understand their needs and obligations that affect rural life, so as to formulate a forest protection plan consistent with local context. For example, the 'Tod Pa Bah', Buddhist robe-offering ceremony, provides an opportunity for the community people to make merits and donate funds for the conservation efforts (Tiyavanich 1997).

One specific example can be given from northern region of Thailand where deforestation rate was high, especially in Nan Province. Between 2000 and 2012, Nan's forests declined 33%. The farmers in Nan were facing the challenge of lacking land title. Around 80% of the province was protected land, including national parks and national preservation

forests. Only about 14% of the province's population had rights on their land. Without a land title or land deeds, farmers in Nan chose to cultivate cash crops, such as maize, because they offer the short-term investment and return. Importantly, without a land title, farmers felt no responsibility and converted the forest land into agricultural fields (Baicha 2016). After the distinguished monk Phrakhru Somkit Jaranathammo realised these issues, an innovative approach was developed to solve the problem of deforestation by the implementation of Buddhism practices so that people can live in harmony with nature while taking care of their communities and themselves altogether. Through diversified cultivation of crops and animals in a way that mimics nature, an integrated agriculture system (kaseet phasom phasaam in Thai) helped farmers move towards greater self-reliance. The monk not only gives recommendations but also establishes a learning site of environmentally friendly and sustainable livelihoods at his temple.

It is also found that the Buddhist doctrine has solved the problems of deforestation. The Buddhist ethic coincides with conservation goals of biodiversity protection, which could influence and restrain people spiritually. Although in many cases it may not be powerful enough to prevent the destruction of forests in the first place, monks have gained greatest successes in community cooperation in forest protection and restoration. Almost all temples in Thailand engage in tree planting, and 75% temples indicated a policy to protect the forest in their domain (Wester and Yongvanit 2005).

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

The relationship between monks and communities are inseparable. In addition to teaching people and becoming spiritual leaders, the main responsibilities of monks are to support communities in protecting and utilising forests for their livelihoods. The concept of the holistic world of Buddha that all livings are interrelated has become a religious doctrine that emphasises animals and wildlife. At Khao Ang Rue Nai Wildlife Sanctuary, it is found that after applying the Buddhism's approach, the forest area and quantity of wild animals increased (Pattawee 2018). Some 'Ecology Monks' have witnessed deforestation from agricultural encroachment. Therefore, they have led the pilot to undertake the farming activities that balance economic and environmental conservation, as well as to encourage farmers to adopt integrated agriculture which imitates ecological relations. These measures improved the ecological condition and the livelihoods of communities relying on natural resources (Darlington 2019).

3.2 Participatory approach

In Thailand, Buddhism is part of Thai people's lives from the moment they are born until they die. In this regard, Buddhist monks are seen as spiritual leaders and temples are the gathering places for local community's unity. Many schools, even in Bangkok, are also hosted by temples and the students are engaged in Buddhism in certain ways. With this background, activities led by the monks are always participatory - engaging local communities living near the temple or far, government officials, celebrities, and the youth. In many cases, the private sector also provides financial support for those activities as part of their Corporate Social Responsibility (CSR) scheme.

In the case of forest conservation, those activities, including the two examples provided under the intervention section, are often highly participatory. Figure 5-4 below shows different ceremonies for the *ordination of trees* that involve various groups of stakeholders with the aim of conserving the forest.

Moreover, the Buddhist community forest management in northeastern region of Thailand has developed a guideline for working between people and relevant government agencies in that area. It creates the participation process with people and community in the area to cooperate. Participation of ecology monks enabled the community forests to be restored and helped create a stable community forest management process and a clear system

Figure 5-4. Ordination of trees, participated by park rangers (upper left), indigenous peoples (upper right), students (lower left), movie stars (lower right)

Source: Forest Office 10 n.d.

Source: Transbordernews 2014

Source: Gotoknow n.d.

Source: Thai Rath Edition 2020

so that people can manage natural resources in a sustainable and holistic way (Phra Saengjun and Thitapanyo 2019). In addition, community forest management has been integrated so that all stakeholders including monks and local communities can become a committee. In this way, they could manage their forests fairly and strengthen governance, including from youth groups (Pattawee 2018).

3.3 Inclusive knowledge base

The knowledge related to ecology principles and guidelines in Buddhism doctrine are divided into 2 parts, which are Dharma and Discipline. This is an important message of nature, which helps people be free from suffering. As natural forests are the sources of livelihood, monks act as a spiritual community leader that use social doctrines and practices to protect the nature and good morality of society. To integrate the concept of community forest conservation model, the leader of the community must be selfless and knowledgeable, and be responsible for determining policies or management guidelines for the benefit of society. Besides, there is a deep spiritual connection between all living creatures and we must respect others. The best practice of the concepts is the ceremony, such as a tree ordination. As a means of protecting community forests, it usually combines local spiritualism along with Buddhist rituals, as well as the recognition of Buddhism and Thai values of right behaviour toward the environment. Sometimes, if a community is not Buddhist, a ceremony might be conducted to dedicate a forest to the Lord of the Land Spirit, or to God as defined by Christians (Tannenbaum 2000).

The knowledge and wisdom of a community are different based on the geography and personalities

of people in each region. The practices to conserve forests are also different. For instance, the central region follows the five precepts and the threefold way teaching, which is different from the northern region which is more attached to the forests. The local wisdom and knowledge that they practice is a tree ordination or establishing a Buddha statue in forest (Punyawuttipredda 2019).

3.4 Replicability and adaptability

As society leaders, ecology monks are influencers who spread throughout Thailand. Their work is diverse but basically involves in the development of livelihood, community forest rights for indigenous peoples and farmers, and forest and environmental conservation. Phrakhu Supoj Suvacano is an ecology monk that stands out due to his involvement in trying to prevent the land around a meditation centre in Chiang Mai from being converted into a tangerine farm.

There are monks around Thailand who have been working without being highlighted on the media. As the Buddhist environmental movement in Thailand was going on, there was one Cambodian who was inspired by this movement when he was studying in Thailand. Then he founded the Monks Community Forest in Oddar Meanchhay Province, which was once the final stronghold of the Khmer Rouge. Cleared of much of the physical remnants of war, the province is now home to 13 community forest groups that comprise the nation's first Reducing Emissions from Deforestation and Forest Degradation (REDD) pilot project (Adams 2014). This shows that a movement with the same spirit and taught by the same doctrine would move the sense of spirituality in the heart of people who respect the same. There is also an international network, the Bangkok-based International Network of Engaged Buddhists (INEB), which aims to connect Buddhist and non-Buddhist social and environmental activists across Asia and around the world. The Thai and Cambodian monks also practice and share their experiences through this organisation (Dipen 2020). Therefore, this practice can be replicated in other Buddhist countries in the region, for example, Lao PDR and Myanmar, as well as others with strong religious beliefs like Nepal and Sri Lanka. Moreover, this concept can also be applied to other faith-based groups, not just Buddhist nations.

4 KEY MESSAGES AND RECOMMENDATIONS

Forests have an ultimate ally with Buddhism and it started since the Siddhartha Gautama (i.e. the Buddha, founder of Buddhism) was born, achieved enlightenment and physically departed. The Bodhi trees have become Buddhist pilgrimage sites and the forest remains an important retreat for meditation. Forest conservation is developed to create prosperity in the use of forest resources and wildlife wisely, by using the least to the greatest advantage. The Buddhist Doctrines can serve as a training tool to practices to understand and sympathy with the nature including the living and non-living (Phrakhruphiphitcharutham 2014). In the world of capitalism, people consume excessively and encroach forest areas, especially for illegal logging and agriculture expansion and lost the way of Buddha's tenet (Tannenbaum 2000).

In the Lancang-Mekong region, deforestation and illegal logging are a major threat to people. These have affected the local economy, food security, biodiversity, and livelihoods of people, especially vulnerable group. The ecology monks began their work simply to promote the Buddha's teaching of the awareness that everything exists through complex interactions and conditions, which in turn become the interactions and conditions of other phenomena. From this perspective, the world is a huge interdependent network, in which human and environmental wellbeing are inseparable. Therefore, individuals, communities, enterprises, and governments must integrate mindfulness of this reality into their daily work to avoid destructive behaviour against nature. The ultimate goal of their work is to protect forests and trees for the wellbeing of the environment while also eliminating mental defilements and relieve human suffering. The work of the prominent ecology monks can be found not only in Thailand, but also in other countries where Buddhism is practice by the majority of their population. There are collaborations between Buddhist monks and activists in Thailand and Cambodia to protect threatened forests, to integrate Buddhist principles with environmental awareness, to provide consultation to government officials about environmental issues, and to implement sustainability projects. They are also involved in tree ordination. They highlight how the selfish and short-sighted desire for economic gain and accelerated development led to the exploitation of resources. They regard it as their responsibility to integrate traditional religious concepts and rituals into contemporary ecological needs (Mongabay 2018).

The cooperation and collaboration of the ecology monks among regions could be an example that shows unity and follows the Buddha's spirit to seek an intermediate path of development, one that recognises both the instrumental and the intrinsic value of nature and balances economic growth with the rights of local communities (Adams 2014).

Another aspect that should not be ignored is the challenges that ecology monks have faced since the beginning of the movement. They might be discredited, bribed and even assassinated. Therefore, further measures must include cooperation between monks, NGOs, and the public. In this way, it would be engaging more power for the forest conservation movement (Darlington 2007; Mongabay 2018).

Chapter 6:
Coastal protection from climate change in the Vietnamese Mekong Delta

1 GENERAL INFO

LOCATION: Vam Ray, Hon Dat, Kien Giang Province of Vietnam

KEY INITIATOR AND STAKEHOLDERS: The Department of Agriculture & Rural Development of Kien Giang province (DARD), the Conservation and Development of the Kien Giang Biosphere Reserve Project (CDBRP, a project funded by the Australian Aid Programme (AusAID) and implemented by the German Agency for Technical Cooperation) , and the Vam Ray community

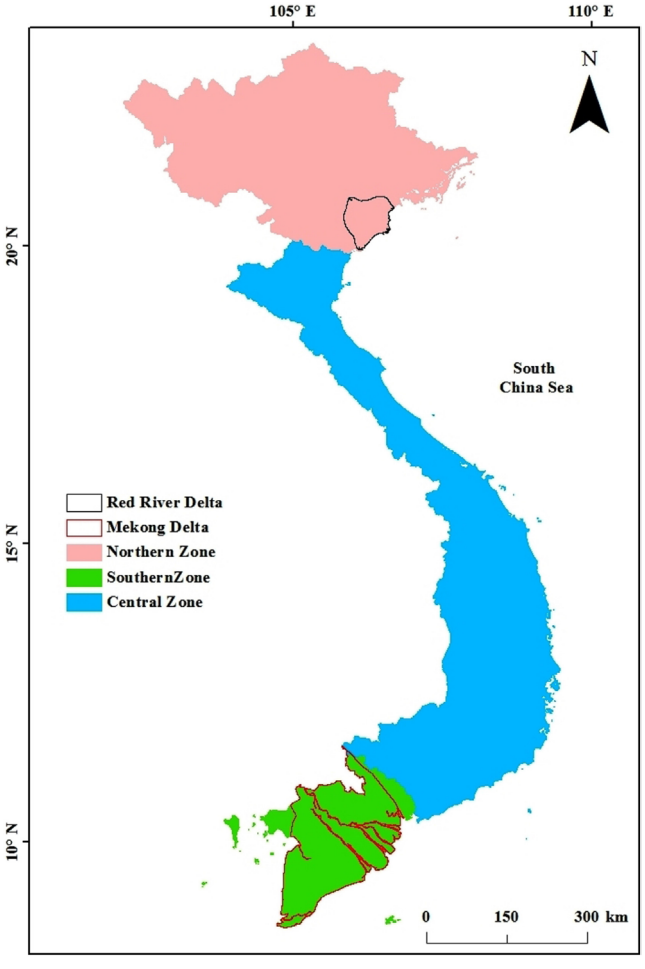
2 DESCRIPTION

2.1 Introduction

Due to their reliance on coastal natural resources for economic growth, coastal communities are particularly susceptible to direct anthropogenic degradation, such as that caused by aquaculture, deforestation, and urbanisation (Friess et al. 2016; Veettil et al. 2020). In addition, phenomena, such as sea level rise, shoreline erosion, floods, storms and typhoons exacerbate the impacts of these negative anthropogenic stressors (Veettil et al. 2020).

The coast of Vietnam can be broadly divided into northern (from Ngoc Cape to Lach River Mouth), central (from Lach River Mouth to Vung Tau Cape) and southern (coast of Southern Vietnam) zones (Figure 6-1). The Red River Delta belongs to the northern zone and the Mekong Delta belongs to the southern zone. The Vietnamese coastline is one of the most populated regions in Southeast Asia and a large proportion of the gross national income originates from coastal economic activities, such as fisheries, aquaculture, tourism and marine transport. Unfortunately, low-lying

Figure 6-1 Different zones in Vietnam based on geographical features



Source: Veettil et al. 2021

Figure 6-2 Mangroves (Ben Tre Province) and Casuarina (Ba Ria-Vung Tau) as bioshield for coastal hazard reduction in southern Vietnam

Source: Veettil et al. 2021

areas (such as the Red River and Mekong Deltas) are the most vulnerable areas in the country due to the combined effects of coastal disasters and climate change. Even though Vietnam has implemented a variety of steps to protect its coastlines, such as building sea dykes, enhancing river channels, and putting in place flood early warning and forecasting systems, the country still suffers considerable flooding damage (Veettil et al. 2021).

Agriculture is the integral part of Vietnam. However, disturbances, such as diseases, long periods of cold weather, and extreme weather events, especially major storm floods and droughts, have seriously hindered production over recent years. In the event of storm flooding, a significant volume of water might cross the dykes and create a sizable water body that extends 20 to 30 km inland. Such an occurrence would result in the salinization of the soil, putting the livelihoods of tens of thousands of farmers at risk and turning major portions of the coastal delta into a brackish environment. River floods and peak flows are expected to worsen throughout the wet season. According to the Integrated Coastal Management Programme (ICMP) led by Ministry of Agriculture and Rural Development of Vietnam, declines in dry season flow cause severe freshwater shortages.

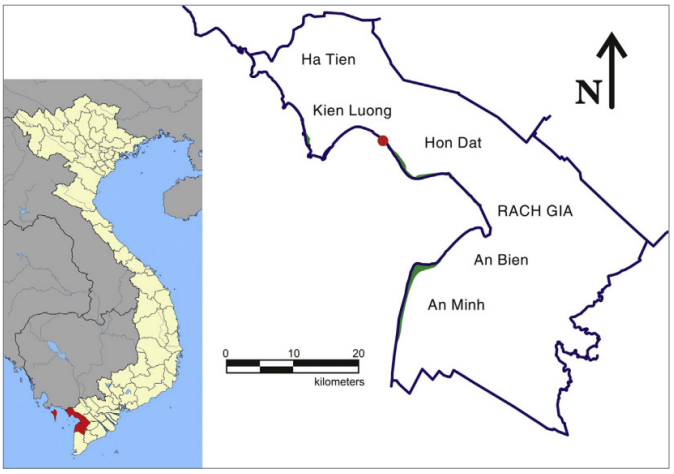
The current and future challenges described above highlight the fact that the entire Mekong Delta is under threat, and its protection is critical, and in many ways, existential. It is now crucial to develop appropriate mitigation and adaptation strategies, such as the use of coastal bioshields.

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

Coastal bioshields or green structures for long-term coastal protection are widely used in many places in the world (Feagin et al. 2015). Ecosystem-based strategies for reducing the risk of coastal hazards have caught the interest of research, policy, and planning organisations in Vietnam (Nehren et al. 2016). After the 2004 Indian Ocean Tsunami, Hurricane Katrina and Cyclone Nargis, coastal vegetation has been widely promoted as a bioshield against extreme events (Feagin et al. 2010).

In Vietnam, non-woody coastal vegetation (e.g., seagrasses and salt marshes) in general and mangrove forests (Figure 6-2) play key roles in protecting coastlines from the dual impacts of storms and an increase in sea level (Veettil et al. 2019). Nature-based solutions, including mangroves, have been recognised as a potential agent in tackling climate change impacts in Vietnam since the 1990s (e.g., Tri, Adger and Kelly 1998). They act as a natural shield protecting vulnerable coastal areas and communities, critical infrastructure and commercial zones from extreme weather events, rising sea levels, and the risks of flooding and erosion. The most common species used for this purpose are red mangrove (*Rhizophora stylosa*), Pisang pisang (*Kandelia candel*), and Crabapple Mangrove (*Sonneratia caseolaris*) as natural defences against landslides, coastal erosion and sea level rise (McElwee et al. 2017). The Vam Ray restoration project was undertaken between 2009 and 2011

Figure 6-3 Vam Ray, the study site (red dot), Hon Dat, Kien Giang Province of Vietnam



Source: Nguyen et al. 2016

with the aim of ensuring a high survival rate of planted mangroves and stabilising the eroding area that provided favourable conditions for natural regeneration.

2.3 INTERVENTIONS

Vam Ray is located in Hon Dat District; one of the four coastal districts of Kien Giang Province (Figure 6-3). It is in the tropical monsoon region and has two distinct seasons: wet and dry seasons. The wet season stretches from May to November with the highest rainfall months, being July, August, and September, with north-east winds. The dry season ranges between the months of November and April

Figure 6-4 Wave break fence for stabilising heavily eroded coastlines and sediment trap fences for areas of low erosion and for natural regeneration used in Vam Ray restoration project

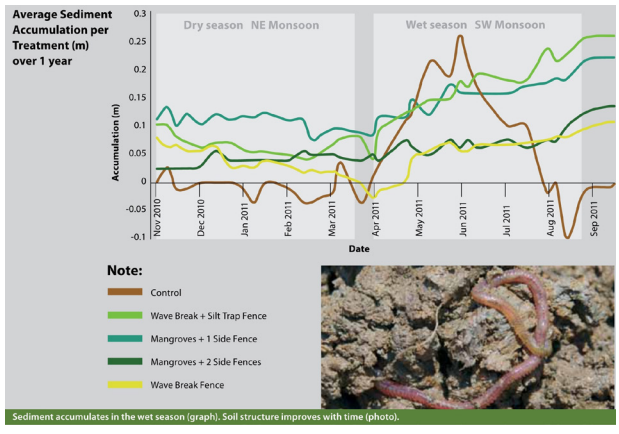
Source: Brown, Russell and Cuong 2012

Figure 6-5 Treatments for monitoring the effectiveness of coastal management by four different combinations of fences and existing mangroves, compared to the old fence built by DARD with no planted seedlings

Treatment 1	**Single Fence**	Wave break fence with planted seedlings of *Avicennia spp* and *Rhizophora apiculata*.
Treatment 2	**Double Fence**	Combination of wave break fence and sediment trap fence with planted seedlings of *Avicennia spp*, *R. apiculata*, *Bruguiera spp*, and *Nypa fruticans*.
Treatment 3	**Mangrove + 1 silt trap fence**	Plantings behind existing mangrove belt and one side fence. Planted seedlings of *R. apiculata* and *Nypa fruticans*.
Treatment 4	**Mangrove + 2 fence**	Behind existing mangrove belt and two side fences with planted seedlings of *R. apiculata* and *Nypa fruticans*.
Treatment 5	**Control**	Old fence built by DARD with no planted seedlings.

Source: Brown, Russell and Cuong 2012

Figure 6-6 The total sediment accumulated in each treatment over one year (2010-2011)



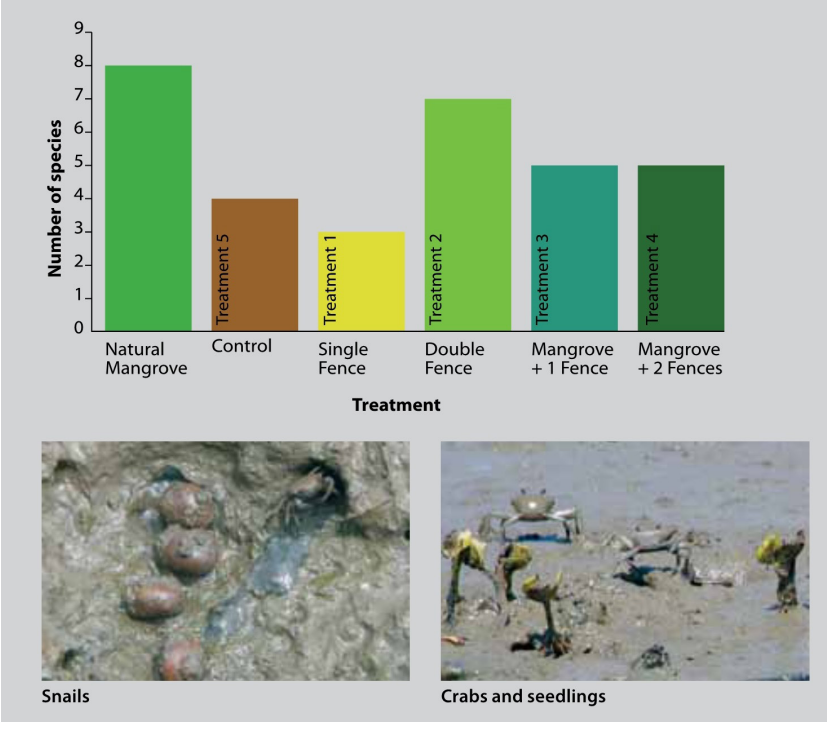
Source: Brown, Russell and Cuong et al. 2012

with the southwest winds (DARD 2007).

The Vam Ray area is mostly influenced by the tidal regime of the Gulf of Thailand. Tides are diurnal, however these shift periodically. The tidal range in nearby Rach Gia city varies from 1.0 m to 1.6 m, with an average of approximately 1.3 m. The highest tidal range occurs in October, while May and June having the lowest tidal ranges during the year (DARD 2007). The Conservation and Development of the Kien Giang Biosphere Reserve Project, a project under the joint Australia-German Agreement of Cooperation, has developed an innovative approach to coastal rehabilitation using melaleuca pole fences with bamboo matting and fish netting to reduce erosion and protect young mangrove seedlings (Figure 6-4).

The coastal management model for the project

Figure 6-7 Benthos diversity and density in treatments and natural mangrove forest



Source: Brown, Russell and Cuong et al. 2012

was established in 2009 over a 4-hectare area. Four distinct fence-and-mangrove stand combinations were established (Figure 6-5). The effectiveness of these treatments in preventing erosion and allowing mangrove restoration has been monitored from 2010-2011.

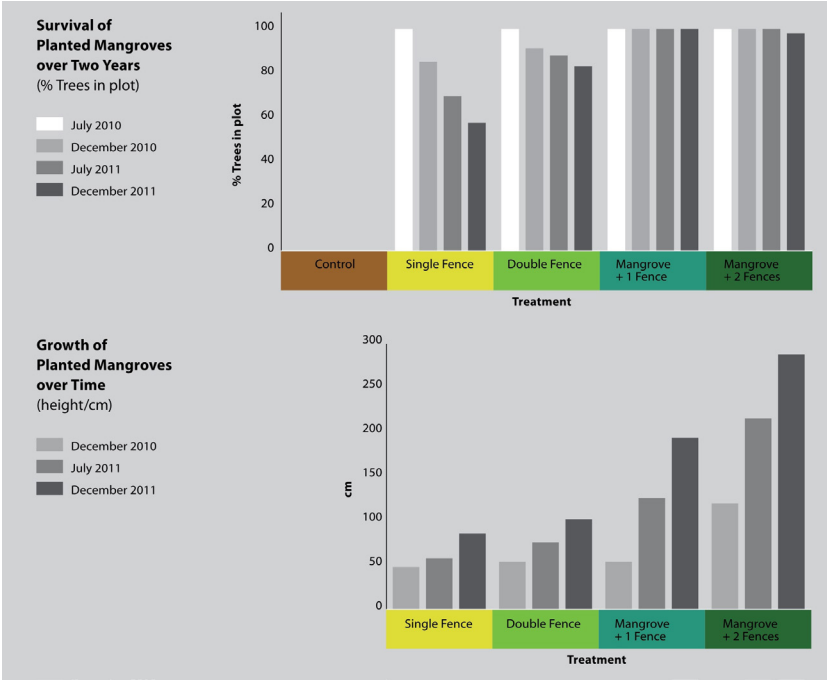
2.4 KEY RESULTS AND OUTCOMES

Figure 6-6 depicts the total sediment accumulated in each treatment over a year (2010-2011). As a result, despite large changes in sedimentation throughout the year, there were no changes in the net balance of sediments between November 2010 and November 2011. Except for the control, all four treatments increased sediment accumulation during the wet season, and soil texture improved over time.

Two years after the enclosure was built, a study by the Institute of Climate Change at Can Tho University revealed that the benthic biodiversity (i.e., number of different species) and density (i.e., number of individuals/m^2) in the enclosure dramatically increased when compared to the control region (Figure 6-7) (Can Tho University Dragon Institute 2011).

The places with the highest defence against wave action and sediment disturbance was observed to be where planted seedlings thrived and survived (Figure

Figure 6-8 Survival of planted mangroves over two years and growth of planted mangroves over time



Source: Brown, Russell and Cuong et al. 2012

6-8). In treatments with a mangrove belt in front and a sediment trap fence to the side, around 95% of the seedlings that were planted survived (Treatments 3 and 4). Around 82% of the seedlings in the double-fenced regions (Treatment 2, wave break plus sediment trap fence) survived. The survival rate was lower but still considerable at 57% in the strong wave area with the single wave break fence (Treatment 1).

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

In Vam Ray Village, Binh Son Commune, Hon Dat District, Kien Giang Province, the project established a coastal rehabilitation and mangrove restoration model. The novel approach used a series of melaleuca fences to reduce wave action and current forces of sea water while protecting mangrove seedlings until they could grow. Fences aid in sediment deposition, which supports mangrove growth. The fence design significantly reduced the effect of waves while allowing free movement of water and animals into and out of the protected area. The fences allowed coastal mangroves to recover, and after two years, no negative effects or changes in natural soil deposition along the fence's length were detected, whereas sediment deposition behind the fence increased significantly. Wave break fences, as another example, are intended to reduce wave energy in areas of high turbulence and thereby aid in the stabilisation of eroding shorelines. Fencing in many forms prevents coastal mangrove erosion and supports mangrove restoration through natural regeneration and planting. Fences also keep planting areas free of marine debris that can suffocate newly planted seedlings. Sediment trap fences are intended to reduce wave energy in moderately turbulent areas to detain sediment deposited during the rainy season and to provide an anchoring substrate where seeds and seedling roots

can grow. Mangrove seeds can also be captured by fences for natural regeneration. This fencing concept can be erected inside breakwaters in high-erosion locations or in sedimentary or lightly eroded areas as a cost-effective means of assisting recovery through natural replenishment. Sediment trap fences also prevent trash from flowing into planting areas and strangling seedlings, much like breakwaters do (Brown, Russell and Cuong 2012). Within three years (2009–2011), almost three hectares of mangrove forest were restored. Today, this mangrove forest covers 1 km of coastline and even extends further out to sea.

Melaleuca, a wood that is easily accessible in the Mekong, is used to build the barriers. The wood was chosen due to the extensive range of environmental benefits offered by melaleuca forests and for the wood's durability in the muddy and damp conditions of mangrove environments. The wood appears to last for at least 10 to 15 years, remaining sturdy and splinter-free as it also resists rot and insect assault. *Melaleuca cajaputi* is a tree native to the Mekong Delta that grows well in submerged acid sulfate soils. By using Melaleuca in coastal fencing construction, and by demonstrating natural stand thinning methods that increase melaleuca growth rates, this project shows how to add value to a melaleuca forest (DARD 2007). Melaleuca use in fencing should increase demand and drive up the timber price, encouraging farmers to protect their forested areas and to enhance the management of acid sulfate soils. This will guarantee the protection of coastal areas. Remaining trees that are not initially harvested will grow more quickly and yield more valuable lumber as a result of the thinning, but the first cut should also provide usable fencing material. In this way greenhouse gas emissions will be reduced and the farmers' income will increase because the common practice of burning tree leftovers from trimmed trees will not be necessary due to the timber sales (Brown, Russell and Cuong 2012).

When the coast was properly protected, locals and officials could concentrate on enhancing livelihoods. By giving production inputs (fish fingerlings, plant seedlings and conducting several training sessions on the best farming and growing techniques) to the locals, the project assisted in raising their incomes. At the same time, the desolate, degraded terrain has been replaced by vibrant orchards, shrimp ponds, and deep blue fish ponds. Mr. Nguyen Văn Kich and his family are now able to earn an extra 3,000 USD per year growing pineapple-coconuts, and Ms. Lam Thi Nga and her family have increased their income by 450 USD per year by cultivating seabass. Now that the mangrove forest is productive, many more homes in the area can support themselves by collecting fish, snails, and crabs. Ms Lam Thi Nga, vice head of Vam Ray Village, is delighted about what has been achieved: "Not only are we now protected from the strong winds and rising sea levels, but the number of fish and crabs in the mangrove forest is clearly increasing. We therefore take great care to protect the mangroves by preventing illegal deforestation." (ICMP 2021a).

3.2 Participatory approach

Several parties were involved in the project, including the Integrated Coastal Management Programme (ICMP), led by the Department of Agriculture & Rural Development of Kien Giang province (DARD), the Conservation and Development of the Kien Giang Biosphere Reserve Project, the Australian Aid Programme (AusAID), the German Technical Cooperation Agency, and the Vam Ray community (Nguyen et al. 2016).

Under this project, the issue of unsustainable resource use and the destruction of mangrove forests was addressed by co-management. This consisted of a partnership agreement in which the local population received the right to sustainably use natural resources like forests, fish, and shellfish and was also assigned the responsibility to sustainably manage and protect these resources.

Co-management, in which local populations can access state-owned mangrove forests for their economic needs, was introduced in the project.

Under this system, local communities use mangrove forests to obtain timber, to fish and to collect clams and other seafood, snakes, rodents, birds and honey. Co-management also creates a framework for shared decision-making between communities and the government. The fact that local residents directly benefit from safeguarding the forest, such as through increased income, means that they more readily accept the restrictions against accessing particular protection zones at specific times.

3.3 Inclusive knowledge base

Between May 2009 and May 2011, DARD and the Vam Ray community were engaged in participatory processes to learn from past successes and failures associated with mangrove transplanting and fence construction, and to implement the new fencing project. Previous failures were attributed to incorrect planting time, poor seedling quality, and inadequate Eucalyptus fences (not protective enough). As part of a new project, integrating local knowledge and scientific understanding was critical for developing strategic, marketable, and innovative solutions (Nguyen et al. 2016).

The project has increased the environmental awareness of local residents. They now have a better understanding of the value of nature and how to adapt to changing environmental conditions. A great deal of effort has gone into this, including mangrove planting events, workshops and training sessions to promote biodiversity, environmental education for schoolteachers and children, and the establishment of a mangrove garden at nearly every school in the area. As a result of these efforts, community awareness has grown, mangrove forests are better protected and are even expanding. Community benefits are continually increasing (ICMP 2021a).

Local knowledge was an important contributor to the Vam Ray project's fence designs and treatment regime. Accumulated over generations by those living near the site, local knowledge is invaluable. The local knowledge in this study was systematically collected to inform the fence design and to assist the locals in solving their specific obstacles to mangrove restoration. The use of local knowledge has not only significantly reduced the costs of fence construction and mangrove restoration, but it has also encouraged replication elsewhere in Kien Giang Province (Nguyen et al. 2016).

3.4 Replicability and adaptability

The Vam Ray project documented many lessons learned in terms of fence construction and transplantation, and an international conference was organised in order to facilitate upscaling and replicating the project elsewhere. One major takeaway was that fences should be built at the start of the rainy season to ensure high rates of sea mud accumulation because rapid sea mud accumulation (which is greatest during the rainy season) is critical to the survival rate of planted mangroves and promotes the natural regeneration process. Sea mud accumulation can be aided by erecting additional fence lines on the landward side. Latitudinal single line silt trap fences can also be used effectively in abandoned shrimp and fish ponds, semi-enclosed water areas with scattered mangroves, and higher elevation areas facing the sea (Nguyen et al. 2016).

The melaleuca fence, made of melaleuca wood native to the Mekong River, provides a variety of environmental services and is resistant to wet and muddy conditions in mangrove habitats. Melaleuca grows well in submerged acidic sulfate soils and offers robust protection. In addition, it has high preservation quality and is resistant to pests and decay (Brown, Russell and Cuong 2012).

A shared decision-making model of this type has been tested in three district sites in Soc Trang Province (Tran De, Vinh Chau, and Cu Lao Dung) and the Ngoc Hien District in Ca Mau Province. Local communities directly benefit from forest protection, so they gradually develop a strong sense of ownership. In this partnership arrangement, resource users and local governments negotiated the co-management agreement for state-owned land together.

4 KEY MESSAGES AND RECOMMENDATIONS

The Vam Ray mangrove restoration project resulted in significant sea mud accumulation, a high survival rate of planted mangroves, and strong biodiversity returns. The design, construction, and deployment of melaleuca fences, as well as the gradual expansion of mangrove areas, were successful project strategies and interventions.

To meet urgent demands for more feasible action plans and strategies that help address coastal erosion in Kien Giang Province and in the Mekong Delta, the project made the following key recommendations in relation to coastal erosion control:

a) Such demonstrated practices can be better implemented in coastal management;

b) To achieve feasible and marketable solutions that can be replicated in the future, local communities should participate in co-management to protect the coasts.

Although the effectiveness of the fences in accumulating sediment and in providing for mangrove regeneration has been demonstrated, mud deposition processes have not been measured. This necessary investigation will involve detailed measurements of hydrodynamic parameters such as waves and water movements. If additional opportunities arise, measurements of hydrodynamic parameters should begin during fence construction to determine the underlying processes that cause the changes reported here.

Monitoring and proper record keeping are extremely important. The study's limitations included a lack of data and an unsystematic recording of mud sedimentation, survival rates of planted mangroves, and natural regeneration at the start of the implementation process. Photographs taken previously in the area were used in some cases during meetings, discussions, and site visits to help people visualise the extent of sea mud accumulation, mangrove survival rates, and natural regeneration that had occurred. These recollections supplemented the erratic recordings and observations of the technical advisor, project volunteers, and project workers (Nguyen et al. 2016).

Sustainable resources benefit both the local community and the environment. Only when people see that it is in their best interests to protect forests will they refrain from engaging in harmful practices. This is why education and training are so important in spreading awareness of the larger environmental processes, and why sustainable development is in everyone's best interests.

One threat to the Mekong Delta ecosystem is climate change, but there are many other human-created issues as well, such as detrimental farming practices, the clearing of mangroves for development, etc. Frequently, a lack of ecological knowledge allows these actions to take place. Environmental topics, particularly those relating to human influences on the environment, are rarely covered in schools. Few locals are aware of the intricate relationships between environmental interactions and human well-being. Therefore, it is particularly crucial to promote and enhance environmental consciousness. For instance, incorporating environmental themes into the curricula for various Mekong Delta coastal provinces' schools can help. Efforts to increase environmental awareness among the local populace and government workers should go beyond educating people (ICMP 2021b).

Chapter 7:

Integrated farming system (IFS) for sustainable smallholders in Yunnan, China – the case of Rubber-based Agroforestry

1 GENERAL INFO

LOCATION: Yunnan, China

KEY INITIATOR AND STAKEHOLDERS: Yunnan Institute of Tropical Crops, Xishuangbanna Forestry and Grassland Bureau, Community, Yunnan natural rubber industry group, Xishuangbanna Hukun biotechnology and Menghai Longjiao Biotechnology Company etc.

2 DESCRIPTION

2.1 Introduction

Yunnan, located in Southwest China, is an inland province at a low latitude and a high elevation. It is characterised by rich biological and cultural diversity and connects two global biodiversity hotspots, the Mountains of Southwest China and Indo-Burma. It is also the source of the headwaters and major tributaries of the Yangtze, Salween, Irrawaddy, Mekong, Red, and Pearl Rivers. Combined, these rivers directly or indirectly influence the lives of more than 600 million people. Substantial private investment in land development, especially for rubber plantations, coincides with centrally planned increases in the economic development of the region, and the ecological health of the "roof" of Southwest China and Southeast Asia is rapidly deteriorating.

Rubber (*H. brasiliensis*) has emerged as a key cash crop replacing traditional agriculture and secondary forests in the Mekong region (Ziegler et al. 2009) due to high demand in China, the world's largest rubber consumer, for foreign rubber. Situated in the upper Mekong, the Xishuangbanna Dai Autonomous Prefecture is a biologically diverse region in the tropical zone of southwest China. The Prefecture covers only 0.2% of the land area of China, but it harbours some 16% of the vascular flora, 21.7% of mammals, and 36.2% of birds found in the country (Zhang and Cao 1995). Three fragmented rain forests and one primary forest in southern Yunnan were studied, two of which were surrounded by rubber plantation (Zhu et al. 2004).

In Yunnan Province, the annual income per capita was 23,295 RMB (3,338 USD) in 2020 (ranked 28). In rural areas of Yunnan, the annual income per capita was 12,842 RMB (1,840 USD) in 2020 (ranked 28), which was quite lower than the 17,131 RMB (2,455 USD) average in China overall. Xishuangbanna is also a less developed area, with an annual income per capita in rural areas as low as 15,452 RMB (2,214 USD). Xishuangbanna is culturally diverse. More than two-thirds of the population belong to one of 12 ethnic minorities, including the valley-dwelling Dai, who practice rice-paddy and home garden intensive agriculture, and upland peoples, such as Hani (or Akha), Jinuo, Yao, Lahu and Bulang, who are largely engaged in swidden agriculture with a forest mosaic landscape. It is one of the most famous tourism destinations regionally. Xishuangbanna initiated forestry property right reform in 2007, when state forest tenure was reassigned to collectives and smallholders with a 70 year old certificate, though management rights can also be transferred to others

by contract.

Due to the rubber price boom that lasted until 2007, the rapid expansion of smallholder rubber farming, most of which is grown in monoculture, has triggered the loss of virgin forest and has caused ecological degradation (Xu 2006; Zhang et al. 2007). At present, the negative effects of rubber farming on local ecosystems, including decreased biodiversity and increased soil erosion, are widely recognised by scholars and policymakers. The degradation of ecosystem services reduces the environment's capacity to support a diversity of livelihoods. Moreover, due to the drop in rubber price, rubber farms are receiving a reduced income from the rubber harvest, which largely threatens their overall cash income and livelihood. To transform the industry so that rubber is environmentally-friendly and technically and economically sustainable, rubber-based agroforestry is being experimented and promoted across Xishuangbanna.

The Mekong region is one the global biodiversity hotspots, but its diversity has been seriously threatened due to environmental degradation and deforestation, especially due to the expansion of rubber plantations (Lan et al. 2022). Greater efforts should be made to balance agricultural production with nature conservation in this region.

2.2 OBJECTIVES, UNIQUENESS, DRIVING FORCES

Recent reports indicate that agroforestry systems offer multiple benefits over monoculture systems. That is, rubber-based agroforestry systems are considered a preferable approach to monoculture for enhancing ecosystem services because agroforestry systems can maintain soil microbial diversity and community composition (Jiang et al. 2017; Chen et al. 2019; Rao et al. 2021). The local government is promoting the establishment of rubber-based agroforestry systems to mitigate the negative effects of rubber plantation expansion on the ecological environment, which means that making ecosystem services sustainable is also an important goal. Ecosystem recovery may also attract tourism, which is quickly becoming more prominent in Xishuangbanna. Lastly, increasing smallholder livelihood strategy diversification in terms of their cash income is also an important objective.

The Xishuangbanna region is a typical rubber plantation zone and has experienced great loss in natural forest resources. In 2010, rubber plantations occupied approximately 22% of the regional landscape. The sustainable use of rubber plantations requires the development of suitable planting configurations as alternatives to monoculture. Secondly, Xishuangbanna is a resource-rich but less developed area with a lot of ethnic minorities. The ethnic minorities have a lot of smallholders who depend on natural resources for their livelihood and have a much lower annual income than the average. Meeting the goals of increasing smallholder cash income and improving ecosystem services is quite challenging in the rubber plantation region.

Monoculture rubber plantations have spurred several environmental and ecological issues. To respond to these problems, rubber-based agroforestry systems were proposed by the Chinese government and scientists to replace the monocultures. Scientists have suggested that rubber forests should make use of gaps and the underground area to introduce intercropping modes and to build a compound agricultural structure relying on the original rubber plantation. Governments have also published plans to explore and promote demonstration projects on rubber-based agroforestry in Xishuangbanna.

During the expansion of rubber production, smallholders achieved unprecedented wealth and a significant reduction in poverty. By 2011, rubber prices had peaked and subsequently, they began to steadily decline. The price shock threatened the well-being of smallholder farmers while also influencing their decision-making in their choice of livelihood strategies. As a result, some farmers have started to plant other crops in their rubber fields under the guidance of experts. The results indicate that the monoculture plantation is more vulnerable than the agroforestry system, which increases diversity

Figure 7-1 Rubber–Konjac plantation in Xishuangbanna

Source: Chen 2019

and also enhances the resilience of smallholder livelihoods.

2.3 INTERVENTIONS

The local government is promoting the establishment of rubber-based agroforestry systems to mitigate the negative effects of rubber plantation expansion on the ecological environment. Rubber plantations are commonly intercropped with beverage crops, fruits, and Chinese medicinal plants for further economic benefit. These intercropped cash crops generally exhibit dense growth, which inhibits other plant growth under the rubber trees. *F. macrophylla* is a perennial multipurpose shrub legume, known for its high N-fixing capacity and its therapeutic uses (Wang 2015). Rubber–*F. macrophylla* systems have been widely popularised in Xishuangbanna.

As part of the promotion of rubber-based agroforestry, some local governments have also considered the local conditions of each county and city in their purview to design a development plan well-suited to allocating production factors reasonably. "Green" rubber forest products and their processing was promoted, and some local governments even started promoting rubber farm tourism. Forestry departments of local governments then use the selected strategy to build a distinctive pilot base, employing the model of "leading enterprises + professional cooperatives + family farms (bases) + smallholders" to promote and drive the development of the rubber-based agroforestry.

2.4 KEY RESULTS AND OUTCOMES

Rubber-based agroforestry systems are considered a desirable approach for enhancing ecosystem services (Jiang et al. 2017; Rao et al. 2021). Rubber-based agroforestry continues to be a promising land-use practice in Xishuangbanna. Local improvement of soil infiltrability and preferential flow in the rubber-tea agroforestry system could attenuate runoff generation and soil erosion, redistribute soil moisture, and facilitate deeper water recharge, contributing to the management of water resources on the watershed scale (Zhu et al. 2019). Rubber–*Theobroma cacao* and rubber-*Flemingia macrophylla* plantations increase soil carbon, nitrogen, and phosphorus contents, relative to same-aged monoculture rubber plantations (Chen et al. 2019). The conversion of rubber plantations into rubber–*F. macrophylla* plantations alters soil carbon and nitrogen fractions and improves soil dissolved

Figure 7-2 Rubber-*Flemingia macrophylla* plantations

Source: Hainan Daily 2016

organic carbon, nitrate nitrogen, and microbial activity (Liu et al. 2018). Rubber–*Clerodendranthus spicatus* and rubber–*Amomum villosum* systems are useful for maximising the utilisation of water resources by promoting soil physical conditions (Jiang et al. 2017). Splash erosion can reach 50 t/ha within rubber plantations, while splash erosion is significantly less in rubber agroforestry systems (Liu et al. 2016). For example, compared to the rubber monoculture system, rubber–tea intercropping systems increase soil fertility and reduce pest outbreaks. Wu, Liu, and Chen (2016) also found that rubber–tea intercropping systems improve water-use efficiency due to complementarity between the species.

Rubber–based agroforestry systems bring substantial income to farmers at different levels (Tang 2016). In terms of economic benefits, rubber-*Flemingia macrophylla* > rubber-tea > rubber medical > rubber-cocoa > monoculture rubber forest. According to financial production estimation, people can increase their income by 142,350 RMB (20,399 USD) per hectare, and the village can obtain a collective economic income of more than 20,000 RMB (2,866 USD) per hectare from the rubber-based agroforestry harvest and process (Tang 2016). In 2018, the total market value of output from konjac reached more than 20 million RMB (2.87 million USD) in a pilot in Jinghong, Xishuangbanna (Yunnan Media 2020).

3 ANALYSIS

3.1 Enhancing ecosystem health and human livelihoods

Favourable soil properties, multiple-layered canopies and ground cover in agroforestry systems all promote three-dimensional hydraulic redistribution in the soil profile. The infiltration of rainfall into the soil is enhanced and surface runoff and soil erosion are mitigated, which allows a greater volume of water to be transported, redistributed, and stored in the different soil layers by the most dominant preferential flow, water exchange and lateral flow in soil profiles. These water supply mechanisms enable intercrops to uptake water from different water sources than the surrounding rubber trees. Hence the results highlighted that rubber-based agroforestry systems are a useful management practice to maximise the utilisation of land and water resources (Jiang

Figure 7-3 Rubber–tea intercropping systems

Source: Xu 2021

et al. 2017). Rubber-based nitrogen-fixing systems reduce the release of soil exchangeable Ca and Mg by mitigating soil acidification processes compared to rubber plantations (Liu et al. 2019). The rubber-leguminous shrub systems significantly improved the soil organic carbon sequestration rate and reduced greenhouse gas emissions compared to the same-aged rubber plantations. At their advanced age, mature rubber plantations could be improved by implementing practices that could decrease annual CO_2 flux by 64,000 kg/ha (Rao 2021). Capillary porosity can retain water in the dry season, which can partly explain why soil moisture was significantly higher in rubber-based agroforestry systems than in the rubber monocultures (Chen et al. 2019). Tea was the most suitable intercrop in terms of water use because interspecific competition for water was moderate and this agroforestry system retained much more soil water and improved the water use efficiency of the rubber tree (Wu et al. 2016). The study also demonstrates that intercropping tea trees with rubber trees positively impacts soil hydraulic properties, with higher infiltrability and preferential flow measured in soils underneath tea trees. Long-term tea growth (22 years) significantly improved soil physico-chemical properties, with a lower bulk density, higher porosity, higher field water capacity, higher TPSI, and higher organic matter content observed. The emissions of CO_2, N_2O and CH_4 decreased as the trees aged in the rubber plantations (Zhu et al. 2019).

Utilising the huge amount of land space under the rubber forest canopy, especially the space between the rubber rows, reduces the amount of land input, improves the land output rate, and saves money in the cost of renting land. In other words, intercropping in rubber fields greatly reduces production cost by reducing water and fertiliser use. Intercropping other crops in rubber farms may increase economic income, but farmers also recognise that intercropping inhibits the growth of weeds, all in the same amount of space. According to He and Mo (2017), 31 household (11.88%) respondents reported

that their families were or had been planting other crops in their open cutting rubber plantations. They mainly planted medicinal herbs to improve space efficiency (output per unit area), with more than half of respondents planting *Alpinia oxyphylla* or other medicinal materials for their economic benefit. Some responding families who adopted rubber-based agroforestry expressed their expectation to get financial support and technical guidance during the implementation process.

Rubber-*Flemingia macrophylla* agroforestry brings the highest economic benefit, mainly because *Flemingia macrophylla* has significant medicinal value, and it does not need pesticide or chemical fertiliser. Thus, it can benefit rubber farmers financially. In addition to its high medicinal value, leaves and twigs of *Flemingia macrophylla* can be used as high-quality husbandry feeding, and stems and branches can be used for fuel. These additional uses can also directly or indirectly benefit farmers financially. In conclusion, local practices indicate that intercropping, when using crops with high economic value and market demand, under rubber trees could enhance local livelihoods.

3.2 Participatory approach

The director of the department of environmental protection of Yunnan Province went to the rubber forest fields and encouraged the experts of the National Nature Reserve Administration (NNRA) in the Yunnan Naban River Basin to explore new ways to restore the ecological environment of the rubber forest. Yunnan Province has since made a great effort to solve the ecological and environmental problems caused by large-scale monoculture rubber planting. In September 2012, the environmental protection department of Yunnan Province arranged a provincial special fund of 400,000 RMB (59,000 USD) to support a joint effort by NNRA in Yunnan Naban River Basin and XTBG to carry out experimental research concerning the rubber-based agroforestry ecosystem. This project has achieved remarkable results, creating three demonstrative agroforestry models that have led to strong economic and ecological returns. Following this initial effort, in 2013 the department of environmental protection of Yunnan Province arranged for 2 million RMB (295,000 USD) to support the NNRA in Yunnan Naban River Basin in implementing a green rubber restoration pilot project in the Naban River Basin of Xishuangbanna.

The local forestry government employed the model of "pilot base + leading enterprises + professional cooperatives + family farms + smallholders" to promote and drive rubber-based agroforestry adoption. Leading enterprises selected and dispatched village-based teams with practical experience, strong communication ability and great physical fitness to carry out the implementation within each targeted local village. Poverty alleviation was a vital objective during this process, and it is also a core goal in rural China. Hani village joined the pilot project in 2013. In the beginning, few villagers took part in the project because they were worried the *Flemingia* crop would usurp the nutrients from the manure used to fertilise rubber trees, thus resulting in lower productivity. Under the promotion by NNRA in Yunnan Naban River Basin and the on-site guidance by experts from XTBG, the villagers gradually came to recognise the benefits of the Rubber-*Flemingia* plantations, and they opted to increase the restoration area to 256 ha in 2014, which was more than double the size of the originally planned area.

Taking Rubber-Konjac intercropping as an example, Xishuangbanna has developed 1,000 ha of agroforestry plantations and 140 ha of improved seed breeding beds with steel frame shade network facilities. Fifteen enterprises and cooperatives are now registered and participate in investing in these projects, and a processing plant that can process 20 t of fresh konjac powder per day has been built in Menglong Town. This enterprise involves 2,000 farmers from over 700 poor households, who now are incentivised to adopt rubber-konjac agroforestry. According to one estimation of production, their income will increase 75,000 RMB (10,748 USD) per hectare in 2021.

3.3 Inclusive knowledge base

Rubber-based agroforestry is initiated or driven by the department of environmental protection of provincial governments with scientific knowledge support provided by research institutes for ecological conservation. In the beginning of a project, the department of environmental protection of the provincial government arranges a special fund to support a rubber-based agroforestry experiment. A research institute then cooperates with the NNRA to implement the experiment in the pilot fields, and to document the experience and lessons learned. The head of the NNRA aims to collect and report on the ecological characteristics of rubber forests at different ages to inform estimates of the economic, ecological, and social benefits at each stage. Moreover, provincial departments also support the NNRA by implementing a green rubber restoration pilot project to promote rubber-based agroforestry.

Tea and konjac are crops that have a long history of being planted here, whereas *Flemingia macrophylla* and cacao were recently introduced from abroad and have a shorter plantation history. The incorporation of all these crops into rubber fields was part of the initial research experiment. The local farmers did not have practical knowledge when the project was new, so some of them were reluctant to adopt these new plantation models. Through the pilot projects and the technology provision, leading enterprises and family farms were tempted to trial these new crops, first intercropping under rubber trees. In some areas, professional cooperatives played an important role by trailblasing the implementation and encouraging local smallholders to do the same. After gaining multiple benefits and accumulating experience from the trial periods, the smallholders grew in confidence and tried to increase the area of intercropping.

3.4 Replicability and adaptability

One similarity between Xishuangbanna and other Mekong areas is that several ethnic minorities rely on natural resources in a rich biodiversity hotspot under economic constraints. Other large-scale rubber monoculture plantations in the Mekong region are encountering price drops for the rubber crop and are urgently searching for means of alternative income. Thus, the rubber-based trials in Xishuangbanna, Yunnan, may offer some valuable insights for them as they consider establishing an intercropping system under rubber trees to create an alternative source of cash income while also restoring the fragile ecological system.

Tea, konjac, *Flemingia macrophylla* and cacao are all well-suited to growing in the Mekong region, climate-wise. However, tea and cacao cultivation require intensive care and specific skills. As a result, crop selection for rubber-based agroforestry should consider whether local villagers have any prior knowledge of these potential crops. Moreover, before agroforestry can be promoted on a large scale, experiments and pilot demonstrations must be established to build trust. Researchers and the government alike must play active roles in the initial stages.

The model including "pilot base + leading enterprises + professional cooperatives + family farms + smallholders" is creative and useful in China. It is essential to start a pilot base together with leading enterprises because they are more willing to try new crops than smallholders. Rubber-based agroforestry is considered a solution to local poverty alleviation. To ensure the sustainable development of the industry, poverty alleviation teams have established a professional Farmers' Cooperative, which drives the smallholders to actively take part in rubber-based agroforestry plantations. Professional cooperatives are collective organisations to coordinate agriculture activities, particularly specialised technology training and adoption, in China. Moreover, due to the context of cooperating with ethnic minorities, local elites (including leaders, the educated, and other influential people) and organisations play significant roles in this process of establishment.

4 KEY MESSAGES AND RECOMMENDATIONS

The rapid expansion of smallholder rubber farming, most of which is done in monoculture plantations, has caused ecological degradation. After 2011 rubber prices began to steadily decline, and many smallholder farmers continue to be threatened by this price shock under the rubber monoculture plantation model. Hence, rubber-based agroforestry systems are considered a preferable approach for enhancing ecosystem services while increasing smallholders' income. This new rubber intercropping systems seems quite promising as an upgrade to the standard smallholder rubber monoculture plantation in the Mekong region.

Rubber-based agroforestry continues to be a promising land-use practice in Xishuangbanna. For example, leguminous species have nitrogen-fixing rhizobia that increase the soil nutrient availability. At the same time, green manure can also improve soil organic matter and maintain soil fertility. In contrast, total revenue from the agroforestry system is more diversified and resilient than that of the vulnerable monoculture rubber forest. The local minority ethnic groups rely on the cash income from the agriculture systems, so selecting the right model is of the utmost importance for their wellbeing.

Local governments, together with other stakeholders, have jointly promoted the development of rubber-based agroforestry by building pilot bases and employing the model of "pilot base + leading enterprises + professional cooperatives + family farms + smallholders". For the agricultural sector, this model is especially helpful for promoting the technology involved. However, because Xishuangbanna is a multi-ethnic minority area with rich natural resources, the local conditions vary greatly among lower-income smallholders. There were several conflicts involving rubber plantations during the rubber boom. As a result, it was challenging to engage the participation of smallholders, even though the changes aimed for the improved the farmers' livelihood and the protection of the local ecosystem. During the pilot phase, the pilot base functions as a demonstration space, and leading enterprises are the ones bearing the risks as this new approach is first tested. In addition, researchers and new technologies are very helpful by offering support during the process.

Moreover, during the rubber-based agroforestry promotion stage, some farmers have reported that financial support and technical guidance are both needed. How to increase a poor smallholder's credit access and financial capita is an especially important issue. Moreover, providing technological guidance, technical training and supervision is also required. Hence, fostering a partnership between smallholders and research institutes is urgently needed at the onset of this transformative effort.

To combat the adverse ecological and economic impacts of rubber-monoculture plantation fields, transforming the existing rubber monoculture fields into rubber-based agroforestry systems offers an appealing and feasible solution. With multiple cultures and minority ethnic groups in the Mekong region, the adoption of the new rubber-based agroforestry system will be a challenging task. Local government should play an active role in this process, while research institutes can test the local feasibility of the various intercropping models. Moreover, a new method of promoting intercropping technology during the pilot base with the coordination of local elites is recommended.

Chapter 8:
Conclusion

After analysing these six cases, some key findings were drawn. Under the complex context of multiple cultures and minority ethnic groups in the Lancang-Mekong region, traditional knowledge should be integrated into modern natural resource management. Governments could play an important role in this process, and they should work with research institutes that will examine the local feasibility of the resource management mechanism. Moreover, establishing pilot sites should help to determine good practices given the local context. Providing local farmers with sufficient technology extension services is recommended, as well as getting support from local elites, such as village leaders, educated persons and other persons of influence, to coordinate the promotion of agroforestry.

Promoting the standardisation, normalisation and large-scale construction of new bamboo plantation bases are the main efforts in Shuifu City, Yunnan Province of China. To strengthen quality management and to achieve a good outcome, Shuifu and neighbouring counties planting bamboo are required to plant plots following the guides in annual construction operation design. In the construction of a major new bamboo plantation, it is recommended scientific research institutes establish professional and technical teams to assist in technical training. Moreover, the bamboo industry's science and technology service support have led bamboo farmers to carry out comprehensive management measures such as quality improvement and transformation of inefficient bamboo forests and pest control.

Environmental protection is an important and basic element in the sustainable development of ecotourism. In Cambodia, environmental education of ecotourism is a key element as well. For most local residents, the root of the problem may be that they lack professional knowledge of environmental education and have rarely received training in ecological knowledge or natural culture of Cambodia. For tourists to Cambodia, the problem mainly lies in their lack of understanding of the local traditional, ecological and cultural background. Therefore, the local government needs to attach great importance to improving the environmental awareness of local people and of tourists. New and old multimedia, including television, newspapers, outdoor advertising, government official website, tourism website, etc., can be used to publicise and promote ecotourism in local nature reserves and to popularise environmental protection knowledge.

The CBFC system has considerable potential for improving management decisions regarding particular fish species and habitats, be it in southern Lao PDR, other parts of the Lancang-Mekong Basin, or elsewhere. The LEK can play an important role in the assessment of fish stocks targeted by artisanal fisheries. The use of LEK to assess and monitor fish stocks may be especially important in tropical aquatic ecosystems with high degrees of biodiversity because the human and financial resources required to conduct detailed scientific studies are especially scarce in non-industrialised countries such as Lao PDR. It is likely that LEK will be especially important in areas characterised by small artisanal fisheries that are not commercially valuable enough to justify large research budgets for detailed stock assessment activities. The use of LEK provides a cost-effective and pragmatic alternative that has the extremely important added benefit of being participatory and having the ability to draw resource users directly into management decision-making processes.

The Buddhist Doctrines in Thailand serve as a training tool to enhance understanding and sympathy for the social environment among the living and non-living. With capitalism, people consume to excess and encroach on the forest area through activities involving illegal logging and agricultural plantations. The people have lost the way of Buddha's teaching. In the region of Southeast Asia, deforestation and illegal logging are major threats to the people. Therefore, this is a major challenge for the region's forest. These practices affect local economies, food security, biodiversity and livelihoods of people, especially the most vulnerable. The ecology monks have started their work simply to promote awareness of dependent origination, as taught by the Buddha.

The Vam Ray mangrove restoration project in Vietnam achieved a high survival rate of planted mangroves, a significant level of sea mud accumulation, and strong biodiversity returns. The design, construction and deployment of seven types of melaleuca fences and the gradual expansion of mangrove areas were successful strategies and interventions in this project. The project involved significant international funding, and the community was actively involved in the project planning and implementation. However, the community was not sufficiently involved at the reporting stage. Insufficient local involvement resulted in lessons not being learned. Inadequate documentation almost certainly contributed to problems when there was an attempt to replicate the project elsewhere.

Rubber-based agroforestry systems in Xishuangbanna, China, are expected to enhance ecosystem services while increasing smallholders' cash income, in contrast to a monoculture plantation. Local forestry governments promote rubber-based agroforestry by building a pilot base and employing the model of "pilot base + leading enterprises + professional cooperatives + family farms + smallholders" to promote and drive the adoption of rubber-based agroforestry. Researchers and technology extension services are very helpful to the smallholders during this process. To combat the adverse ecological and economic impacts resulting from rubber-monoculture plantation fields, the transformation of existing rubber monoculture fields into rubber-based agroforestry may be a useful and feasible approach.

In all these cases, it is clear that strengthening the foundational research on the theory and practice of sustainable management can contribute to their continued success. However, although the best practices have been determined in some areas of this region, the same model cannot be directly adopted in all areas due to the great variation in conditions. In-depth theoretical research will provide necessary guidance for the establishment of practical management practices.

Moreover, most of the cases require the government to provide policy support. Many international examples show that co-management is the preferred means of governance in policy. The government should encourage and support more farmers, fishermen and local communities to participate in good management as well as offer more incentives to local participants. In addition to the top-down policy, bottom up–feedback is crucial in any project implementation. Hence, establishing an effective communication mechanism among various stakeholders can safeguard the success of project implementation.

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