APFNet

APFNet Supporting Sustainable Forest Management and Forest Rehabilitation

in Cambodia

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APFNet Projects

F orests have long been a prominent part of people's daily lives, particularly for people who live inside or near forests. Besides contributing as a source of livelihood to millions of people, forests have important ecological functions including carbon storage, nutrient cycling, water and air purification, and maintenance of wildlife habitat. However, year by year forest cover around the world keeps declining, resulting in the loss of local livelihoods and becoming a source of many environmental problems, climate change in particular. With this alarming loss, forest rehabilitation is now a global goal. The **Sydney Declaration on Climate Change, Energy Security and Clean Development** in 2007 set an aspirational goal to increase forest cover in the Asia–Pacific Economic Cooperation (APEC) region by at least **20 million ha by 2020**. In alignment with this, APFNet's mission is to help promote and improve sustainable forest management and rehabilitation, to increase forest cover, enhance carbon stocks, reduce forest loss and enhance forest–related benefits to people in the Asia–Pacific region.

In Cambodia, nearly 4 million people — more than 30 percent of the population — live within 5 km of forests, and an average of 10 to 20 percent of their livelihood is directly or indirectly dependent on forests, thus making intact forests crucial for local people. However, natural forest cover in Cambodia has decreased from 73% in the 1960s to 49.48% (that is to 8,985,164 ha)[1] of the economy's total land area in 2014.

[1] Forestry Administration. 2016. Cambodia forest cover 2014. Forestry Administration, Phnom Penh.

The National Forest Programme

Seeing the trend in forest cover loss, the Royal Government of Cambodia (RGC) set a target to reach 60% forest cover in the economy by 2029. The **National Forest Programme (NFP) 2010–2029** set out six programs that aim to improve sustainable forest management in Cambodia. Among those programs, the decentralization of forest rehabilitation from national to sub–national and local communities is one of the key activities. It aims to increase forest cover and to ensure that forests will contribute to the livelihoods of local people. Prior to 2005, the annual reforestation rate remained relatively low, but it grew in subsequent years.

Since 1988, almost 475,000 ha[2] of land have been reforested, mainly thanks to the efforts of three different sectors:

Public sector: responsible government agency, the Ministry of Agriculture, Forestry, and Fisheries (MAFF), in particular the Forestry Administration (FA) is tasked by the Forestry Law to conduct forest rehabilitation and mobilize resources to encourage the planting of trees by establishing 149 nursery stations in the economy to supply seedlings to stakeholders and hold Arbor Day annually.

Private sector: the plan for reforestation was initiated in the mid–2000s with the approval of the government through Economic Land Concessions (ELCs). ELCs refer to a mechanism in which private land is granted to a concessionaire to use for agriculture and industrial–agricultural exploitation. There are currently about 200 ELCs, the majority of which were established to invest in agribusiness enterprises, and 8 ELCs have invested in plantation forestry. The government also encourages local farmers and private partners to plant trees on their private land and state degraded area for economic and environmental purposes.

Community forestry (CF): A substantial number of community forests in Cambodia have been degraded and require rehabilitation to make them more productive. Local communities have sought outside assistance for such rehabilitation efforts with both financial and technical support needs. Most community forestry has been initiated and established by local and international NGOs, international donors, local authorities and government agencies.

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[2] Forestry Administration, Department of Forest Plantation and Private Forest Development, 2017

Community Forestry and Forest Rehabilitation

Community forestry is a decentralized form of forest management in which **the local community becomes involved with forest management under a contractual agreement with the government**. A certain number of forest management practices must be established in order to qualify for community forest status. Local people directly elect the members of the community forest management committee, and contribute to the design, approval and amendments of community forest regulation and management plans, including the forest benefit sharing mechanisms between the members of the community and the CF group as a whole.

By its nature, CF is multi–purpose as it balances multiple benefits. Productive benefits such as timber and non–timber forest products are the most direct and obvious. Besides that, CF also contributes to local cultural development and generally improves environmental conditions. While local people have the right to use forest resources in a customary way, in the 15 years of the agreement established with the Forestry Administration, communities also bear the responsibility to protect and use community forests in a sustainable way. Through strong efforts of the government and other stakeholders, 610 CFs were established across the economy, which resulted in over 506,000 ha[3] of forest land falling under the management of local people. However, challenges are still arising due to financing issues and a lack of capacity in forest restoration in particular. This is because some of the land under the management of local people is degraded and needs proper restoration in order to enhance ecosystem service provision and contribution to local livelihoods.

Forest areas covered under CF management plans are divided into different types, namely areas that are degraded and areas that are not degraded but need to be put under sustainable forest management. For areas classified as degraded, CF management plans always consider restoration by tree planting. The planting activity can be done more or less frequently depending on the availability of financial resources and seedlings, so most of the time community forest users seek external assistance. Unfortunately, traditional planting is done mainly by planting existing and fast–growing tree species without a clear methodology, only having the main objective of increasing forest cover in the community forest as quickly as possible. External support is needed, particularly financial and technical support on forest rehabilitation.

[3] Forestry Administration. 2017. Community Forestry Statistics in Cambodia. Forestry Administration, Phnom Penh.
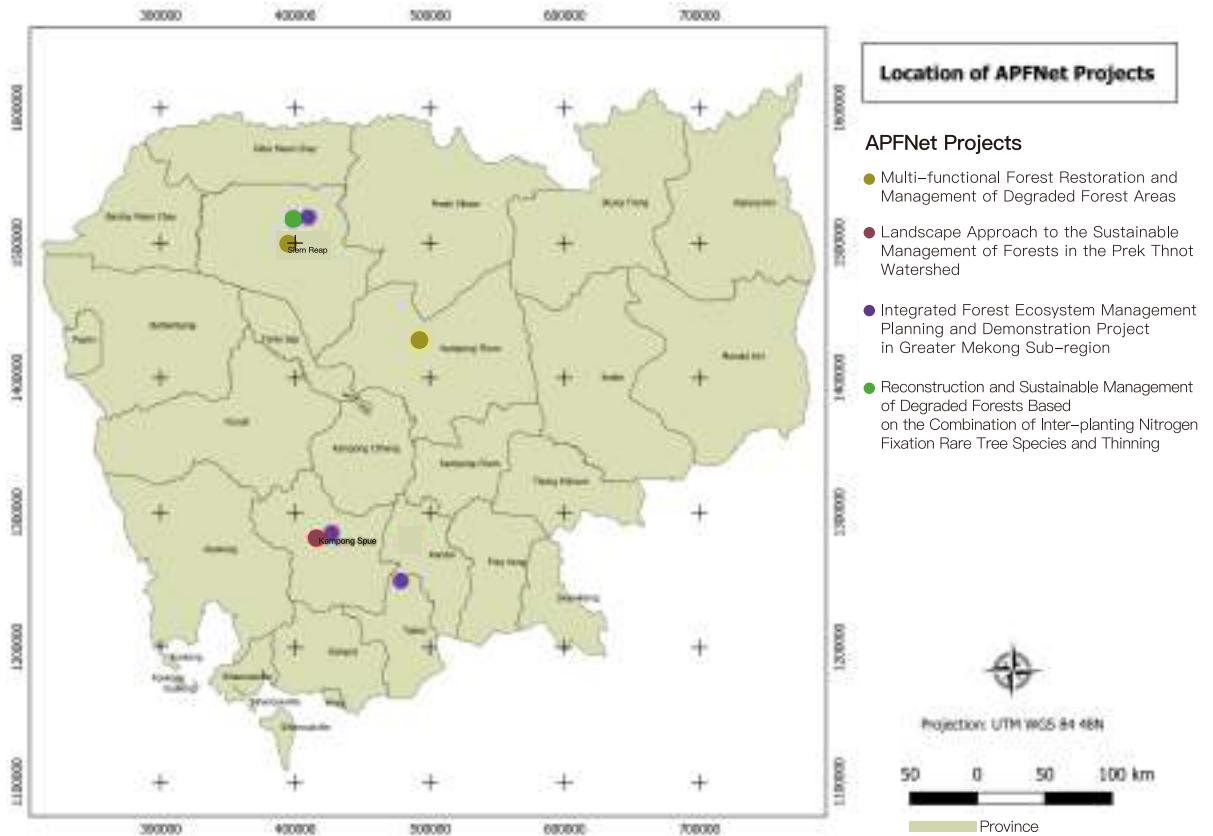
The forest landscape approach was identified by the Royal Government of Cambodia and determined in the National Forest Programme as a holistic and cross–sectorial approach to enhance the sustainable management of forests in Cambodia. Under this approach, it is expected that socio–economic and environmental considerations in one landscape are balanced, and that benefits from the landscape to stakeholders are maximized. To fulfill this goal, there is a need for a legal and spatial planning framework for allocating forest resources and other land use purposes in the landscape, while the concerns and interests of different sectors have to be addressed through consultations and taking into account various land use options.

RGC has conducted **Participatory Land Use Planning (PLUP)** on the commune level throughout Cambodia. Based on this, more support has been provided to enhance **Commune Land Use Planning (CLUP)**, which is a program under the Ministry of the Interior, including the sustainable forest management project under UNDP, which supported implementation in the area around Cardamom Mountain. Still, there is a crucial need to conduct integraded forest management using landscape approach in Cambodia, in particular in watershed areas where the loss of forests will have a greater negative impact than other areas.

Support from APFNet

Location of APFNet Projects

APFNet Projects

- Multi-functional Forest Restoration and Management of Degraded Forest Areas
- Landscape Approach to the Sustainable Management of Forests in the Prek Thnot Watershed
- Integrated Forest Ecosystem Management Planning and Demonstration Project in Greater Mekong Sub-region
- Reconstruction and Sustainable Management of Degraded Forests Based on the Combination of Inter-planting Nitrogen Fixation Rare Tree Species and Thinning

Projection: UTM WGS 84 48N

50   0   50   100 km

Province

To meet the urgent need for support in forest rehabilitation in Cambodia, APFNet has been providing support to the forest sector through collaboration with the Institute of Forest and Wildlife Research and Development of the Forestry Administration since 2011. **Four projects** on promoting sustainable forest management and forest rehabilitation have been initiated. The first project focused on community forestry in Siem Reap and Kampong Thom and subsequent projects have been implemented in Siem Reap, Kampong Speu and Takeo province.

Area Restored and under Sustainable Forest Management (Ha)

SFM 21

Forest Rehabilitation 116
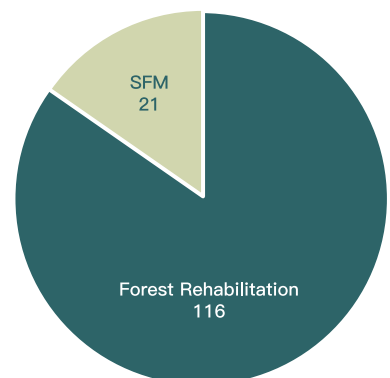
Multi-functional Forest Restoration and Management of Degraded Forest Areas

Supervisory agency: Forestry Administration

Executing agency: The Institute of Forest and Wildlife Research and Development, Cambodia

Budget in USD (total/APFNet grant): 441,830/386,570

Project duration: 12/2011–12/2014 (extended to 03/2015)

Site Location: Siem Reap and Kampong Thom province

Objective: To train local communities on seedling production and forest restoration, establish community nurseries and forest restoration models, and restore two community forests, one each in Siem Reap and Kampong Thom provinces.

Project outputs:
- Two community nurseries established, one in each pilot site;
- Local communities trained on seedling production and forest restoration models of forest restoration plots established on each pilot site;
- Knowledge and experience on multi-functional forest restoration published and disseminated to relevant stakeholders and general public.

CF goals aligned well with the goals of APFNet to rehabilitate forests in the Asia–Pacific region. Therefore, APFNet funded this project in collaboration with the Forestry Administration (FA) of Cambodia. The overarching aim was to rehabilitate the degraded forests on the project sites and transform them into multi–functional healthy forests that are well stocked with high–value timber species (HVT) and non–timber forest products (NTFPs). Furthermore, the project sites are intended to become a recognized model on forest rehabilitation and rural livelihood improvement. The project was conducted in two community forests, Prey Kbal Toeuk CF located in Tbeng Lech village, Siem Reap province and O Soam CF located in Kampong Thom province. The two communities had different visions that APFNet and FA strived to support:

O Soam CF: A forest that is comprised of large diameter high–value timber species which can support construction needs, with abundant NTFPs and well–stocked creeks with fish that can support the livelihoods of the community.

Tbeng Lech CF: The forest is recovered and biodiversity is restored so that forest products can be provided for household use, and income is generated from ecotourism.

Restoration for Multi–Functional Forests Tailored for each Community

Before the project, the Community Forest Management Committee (CFMC) members and some villagers involved in tree planting applied traditional techniques to improve forest health and forest cover in the area. However, their methods were not able compensate for the high rates of forest degradation. As a result, there was a need for new techniques. From 2011–2014 with the support of the project, a **forest restoration plan** was produced to guide local communities on where and how to restore the forests. Some parts of the community forests did not actually require planting and natural regeneration was sufficient. New techniques such as silviculture, enrichment planting, assisted natural regeneration and agroforestry were also applied in the two CFs of the project.

The major restoration activity covered a total area of **50 ha** (30 ha in O Soam and 20 ha in Tbeng Lech) through the enrichment planting of 15,718 and 6,879 seedlings of priority species, respectively, which were identified by the communities. This includes thousands of species, some of the most important being rattan, bamboo, fruit trees, and particularly high–value timber species such as Siamese rosewood (*Dalbergia cochinchinensis*), the Apitong (*Dipterocarpus alatus*), Ta–Khian (*Hopea odorata*), and the Burma padauk (*Pterocarpus macrocarpus*).

Enrichment planting was identified as an appropriate restoration tool in the two CFs because not only does it increase forest cover, but it also provides socio–economic support to the CF. In the future these species will provide construction material, food and more. These NTFPs come in all shapes and sizes. For example, Mr. Chhin Sath, a CF member in O Soam, collects mushrooms, wild fruits, fuel woods and spiders to sell to a local dealer from which he can earn about USD 75 per season compared to USD 1,041/year of income from overall forest products per household. This has shared a big proportion of their main income from agriculture activities and other jobs in the community.

Community members plant rattan in the restoration plot (top). Edible spiders are collected by the local community (Bottom).

Additionally, four one–hectare areas of degraded forests in each CF (a total of eight plots) were set aside for the testing of new forest restoration models, two in thinned areas and two in unthinned areas. Twenty seedlings were tagged for collecting data on height, diameter at breast–height (DBH), and other data four times in total, attempting to compare the results from treated and non–treated plots. This will help CFs to keep only the significant and most successful trees and later on focus on planting only the desired tree species.

Seedling Propagation

Preparation and production
of seedlings
in the nursery

Community nurseries and affiliated facilities were established at each CF, which did not exist at the two CFs before the project. With the nurseries in place, the two communities did not only grow seedlings for their own needs, but also supplied seedlings to the region. For instance, the O Soam nursery was contracted to supply 3,600 seedlings of six species, namely Custard apple (*Annona reticulate*), Papaya (*Carica papaya*), Mango (*Mangifera indica*), Moringa (*Moringa olifera*), Jackgruit (*Atrocarpus sp.*) and Rosewood (*Dalbergia cochinchinensis*) (five of them are fruit trees) for a local forestry administration in 2015. It was anticipated that such a contract will be made every year considering the increasing need for tree planting by the local administrations and NGOs. Additionally, representatives of the communities and the local administrations increased their capacity through learning about seedling production and forest rehabilitation techniques, namely seed collection, seed pre–treatment and the preparation of potting mixes.

It can be proudly said that the two CFs have become a hub for different visitors (members of other CFs, university students, local and international foresters) to visit and learn about their restoration models, including techniques for the restoration of community forests. In the future the local communities at the two CFs will be key players in spreading knowledge about forest restoration, as during the project community members were already invited to share their experience at various events throughout Cambodia.

Landscape Approach to the Sustainable Management of Forests in the Prek Thnot Watershed

Supervisory agency: Ministry of Agriculture, Forestry and Fisheries

Executing agency: The Institute of Forest and Wildlife Research and Development

Budget in USD (total / APFNet grant): 573,015/499,215

Project duration: 01/2015–12/2017, extended to 06/2019

Site Location: Prek Thnot Watershed, Kampong Speu province
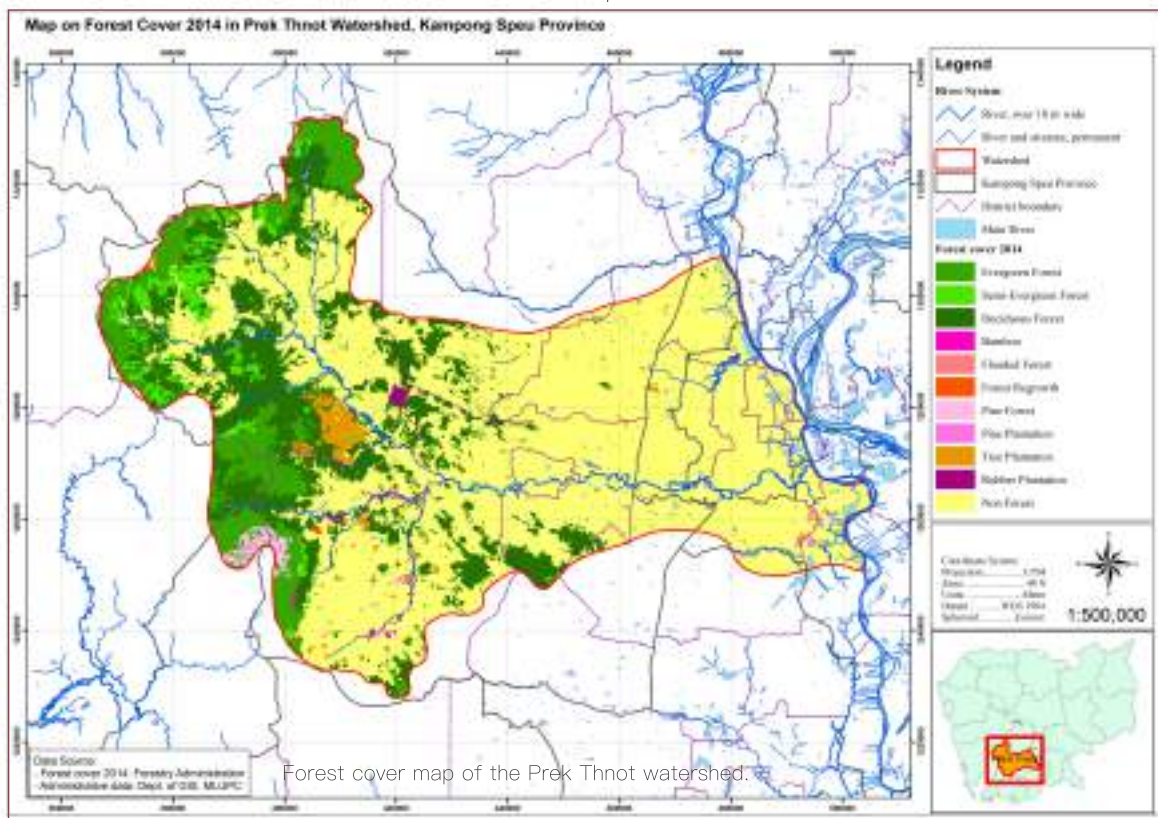
Objectives:

- To build capacity and raise awareness on the concept of integrated watershed/landscape planning for central and local stakeholders through scientific assessments, analysis and participatory watershed/landscape planning processes;

- To develop a watershed management plan for the Prek Thnot watershed with the participation of stakeholders;

- To share the experiences and lessons learned from the project to stakeholders.

Expected outputs:

- Improved knowledge and awareness of target stakeholders on the concept of integrated Watershed planning and development issues faced in the Prek Thnot Watershed that affect forest–dependent communities;

- Watershed characterization report of Prek Thnot Watershed;

- Development of an integrated watershed landscape development plan for the Prek Thnot Watershed;

- Two demonstration sites established on agroforestry systems that contribute to soil and water conservation and livelihoods;

- Forest–based community enterprises are supported;

- Project success and experiences disseminated and policy briefs for the sustainable development of the Prek Thnot Watershed submitted to relevant authorities.

Maintaining good forest cover is crucial for the effective functioning of a watershed. The Prek Thnot watershed covers a total land area of **666,764 ha**, of which 77.8% are in Kampong Speu Province that partly or entirely encompasses 65 communes and 6 districts. Most of the forest cover in the watershed is found in the northwestern part, although a few patches of forests can still be found downstream in the southeastern part, which consists of highly urbanized residential areas. Rice producing areas that depend on the water from the tributaries of Prek Thnot are also located at the southeastern part of the watershed.

Forest cover map of the Prek Thnot watershed.

However, this area is facing the threat of ongoing deforestation in the uplands which increasingly puts the watershed function of the Prek Thnot area under a high risk of impairment. The loss of its watershed function can lead to many negative environmental consequences including soil erosion, depletion of soil nutrients, sedimentation of reservoirs, decrease of water quality and flooding of low–lying downstream areas, ultimately impacting a large number of people. Thus immediate and proper action is needed.

Started in July 2015, this APFNet project was designed and developed to build capacity and raise awareness on the concept of integrated watershed planning for central and local stakeholders through scientific assessments, analysis and participatory land use planning at the landscape level, and promoting agroforestry for soil erosion control and livelihood improvement.

Integrated Watershed Management Planning

After two years of implementation, the project achieved a great deal of results, especially in the **development of a watershed management plan**. This plan provides a new approach to manage the watershed to maximize the benefits for each stakeholder, while at the same time protecting the ecological functioning of the watershed.

The watershed management plan was developed through a participatory approach by collecting the views of different stakeholders including: community management committees, CF members, the local FA and other local authorities. They were tasked with sharing their perceptions on what they considered to be important aspects of the management plan, criteria for land use in the watershed and negative impacts of unsuitable land use during a consultation workshop conducted in 2016. The outcomes of the workshop, combined with the GIS data collected by an expert, an assessment of the socio–economic conditions of the community and land use and farming practices of the area were analyzed to produce the land allocation map and watershed characterization.

The watershed characterization focuses on biophysical and socio–economic conditions of the Prek Thnot watershed. In particular, this includes the documentation of existing land use practices and the creation of an environmental risk reduction plan within the watershed area. This characterization then provides the information basis on which the land allocation map was built. The land allocation map optimizes various land use model options in the watershed by, for example, assessing whether a given plot of land should be used for agriculture or harbor forests. It does this with the consideration of societal goals on food security and poverty alleviation that are in alignment with key governmental goals. Overall, the map provides options for sustainable land use in the watershed that were integrated to develop a watershed management plan. This draft was then put forward during a stakeholder consultation in the four districts.
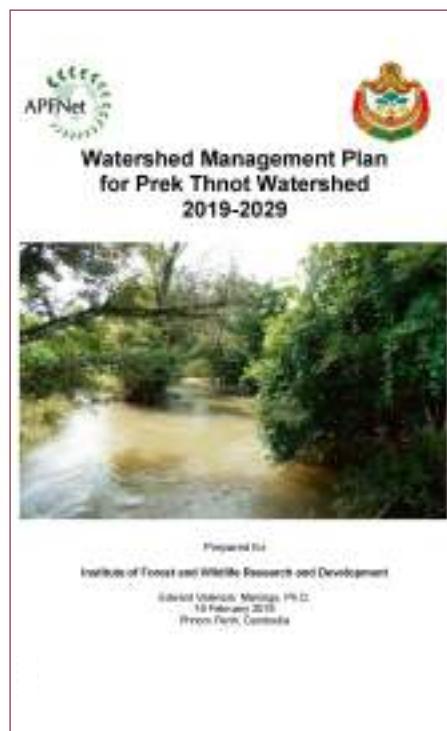
The watershed management plan is expected to be adopted by stake–holders, especially by relevant provincial departments and to be a new showcase in Cambodia in terms of landscape land use planning. Moreover, it can be used to streamline the formation of the Commune Land Use Planning and provide a guide for the prioritization of future development programs of NGOs and development partners in the Prek Thnot watershed.

Agroforestry as a Tool for Soil and Water Conservation

Increasing the income of CF members is among the main objectives of the project. As such, the project engaged CF members to implement agroforestry to increase their income, improve land conditions and also collect data for the future analysis of soil erosion in agricultural land. The project started with a capacity building training for ten farmers on agroforestry and hydrology monitoring, in particular soil and water conservation on agricultural land.

Then, together with the project team, the local FA identified farmers who were interested in piloting agroforestry trials on their private farmlands. As a result, four plots were established using high value timber species such as Siam Rosewood (*Dalbergia cochinchinensis*), Apitong (*Diterocarpus alatus*) and Ta-khian (*Hopea ordorata*) and inter-planted with annual agriculture crops and perennial fruit tree species such as sour-sop, jack fruit, mango and moringa. All four sites had installed rain collectors and soil collecting troughs to collect rainfall and soil erosion data for further analysis. After the trials had been initiated, the farmers stated that their practice has gradually changed.

> ❝*The crops that we have planted on the agroforestry plots including pineapple, corn, lemon grass, jack fruit, mango, sour soap, etc. have grown well and we can see that soil has gradually changed from white (sandy) to black.*❞

said Mr. Soung Van from the Domrey Chakthlork Community Forest and a model agroforestry farmer of the project.

Agroforestry site for soil erosion and hydrology monitoring

Integrated Forest Ecosystem Management Planning and Demonstration Project in the Greater Mekong Sub-region

Supervisory agency: Forestry Administration

Executing agency: The Institute of Forest and Wildlife Research and Development, Cambodia

Budget in USD (total / APFNet grant): 1,792,663.60 /1,515,465.60

Project duration: 06/2017–06/2021

Site Location: Siem Reap and Takeo province, and Damrey Chak Thlork Community Forestry in Kampong Speu province

Project Objectives:

- To develop a model for community forest management by strengthening CF management and testing appropriate restoration and silviculture technology;
- To mitigate the dependence of community on forests by improving household farming systems;
- To enhance forest protection by adopting advanced forest monitoring systems (Forest Watcher);
- To extend achievements and related techniques in Cambodia and GMS by demonstration and experience sharing.

Expected outputs:

- Community Forestry Management Plan formulated;
- Community Forestry boundary demarcated and patrolled;
- A FA Triage nursery improved;
- Restoration and silviculture models established;
- Village water supply system established;
- Agroforestry and homegarden farming systems established;
- Forest watcher system and auxiliary facilities installed and maintained;
- An integrated forest management technology assembled and a technical handbook formulated;
- Experience and technology demonstrated and disseminated.

To fully manage their forest in a sustainable way, secure land tenure and improve livelihoods, each CF needs to produce their own community forest management plan. These plans can be used to guide to forest management in the area. But, with traditional techniques in tree planting, many forest stands failed to improve. As a result, in 2017 APFNet and the Cambodian FA implemented a new project called "Integrated Forest Ecosystem Management Planning and Demonstration Project in Greater Mekong Sub–region", which aims to establish a demonstration site for the rehabilitation and restoration of ecological services and improve forest product provision through the improvement of community forest management. Through this community–based restoration, the conservation of the remaining forest will be enhanced and contribute to the sustainable forest management in the Greater Mekong Subregion. The project helps the Damrey Chakthlork Community Forest in Dokpor village, located in the Krangdeivay Commune of Phnum Srouch District in the Kampong Speu province to demonstrate the improvement of CF management through the development of restoration techniques and demonstration, assistance in patrolling of integrated management models.

Forest Restoration Models in Community Forestry

To improve sustainable forest management for the CF, a comprehensive management plan is developed and implemented in all forest areas (1,452 ha). This plan combines modern techniques and traditional practices, provides an analysis of forest conditions and recommends specific actions to be taken to further improve management in the future. Moreover, it will be a showcase for the restoration of different types of degraded forests that serve different purposes. This differs from the previous APFNet project **"Multi-function forest restoration and management of degraded forest areas"** as it does not focus on achieving a multi-functional forest in general but conducts restoration according to specific needs based on different degrees of degradation. In this project, a trial of 16 hectares for 3 restoration models and one silvicultural treatment will be developed as follows:

Restoration activities and thinning practice in degraded community forests

(1) Restoration of a deforested (open) area: this area is divided into four blocks (one hectare each) and is intended to grow into a high value timber plantation using tree species of *Pterocarpus macrocarpus*, *Dalbergia cochinchinensis*, *Dalbergia oliveri*, and *Tectona grandis* using a total of 6,000 seedlings.

(2) Restoration of a severely degraded forest: this area is intended for firewood collection using a single species, *Cassia siamea*. Dominant trees with straight trunks in the top forest layer will remain, while small trees, shrubs and weeds under remnant trees are cleared out.

(3) Restoration of a moderately degraded forest: precious trees with straight trunks will be maintained while non-valuable trees will be cleared out. This model incorporates multistory management using pepper and other rosewood tree species such as *Pterocarpus macrocarpus* and *Dalbergia cochinchinensis*.

(4) Silvicultural treatment of dense forests: this model is applied through tending, thinning and enrichment planting using timber species such as *Pterocarpus macrocarpus*, *Dalbergia cochinchinensis* and *Diptercarpus* species to speed up forest succession.

Value-added Traditional Practices for Local Livelihood

In addition to a forest management plan and restoration models to improve forest ecosystems, providing more livelihood options to local communities is a great way to mitigate their dependence on the forest. Agroforestry farming systems and home gardens are selected as suitable ways to improve local livelihoods since farmers already practice farming and home gardening, but the key challenge is finding the right techniques. Current techniques prevent farmers from using the land to its full potential as on any given piece of land, farmers only plant one type of crop or one tree species. As a result, the project will involve farmers who are interested and have land available, to adopt sustainable agriculture and agroforestry according to international best management practices. A portion of the farms will be used for multistory cropping using vegetables and other cash crops; and the home garden will be set up in open areas and degraded secondary forests within the areas of farmers' households. These practices will provide immediate income for the farmer in the short term as well as in the long term.

Farmer growing jackfruit in agroforestry system

Strengthening State-owned Forest Conservation

State-owned forests account for a large share of forests in Cambodia. These forests, however, are facing many problems including forest fires, illegal logging and hunting, land encroachment, grazing, and pests and diseases. Since state forests usually cover large areas, many people are needed to effectively monitor it. This is not possible due to a lack of funds and human resources. These constraints can be overcome by using cutting edge technologies. While state of the art technologies are available to conduct real time forest monitoring for better forest management, their large-scale introduction is currently not feasible, either, as Cambodia lacks the financial capacity to acquire these.

The Khun Ream Forest Research Station in Siem Reap province and Tamao Zoo Forest in Takeo province, covering a total area of 4,368 ha of forests, are a typical example of state-owned forests that are constantly under the threat of encroachment. Thus, they have been chosen as demonstration sites for new and modern technologies. Through this APFNet project, two sets of the **forest watcher system** were installed in these areas. The system itself is a reliable high-tech platform that uses cameras and infrared technology to monitor and detect forest fires. It can be left unattended to continuously monitor the surroundings in real-time throughout the day. It is mounted on a tower that autonomously captures real-time images of its surroundings. It can cover a radius of 15 km every 30 minutes and has a target positioning accuracy of 100 meters. It has the ability to "patrol" forests faster than man-based patrol, in addition to fast image recognition, positioning accuracy, all-weather monitoring and real-time data transmission. Thus, the protection of these two state-owned forests are expected to be increased in the foreseeable future.

Barely four months after the installation of the forest watcher system in Tamao Zoo, one case of forest fire was reported to have been successfully detected and extinguished, preventing its spread to a wider area. It thus prevented larger damages since the forest watcher system detected the smoke soon after fire ignited and provided clear and accurate information regarding the location of the fire, so that the firefighting crew in the area was able to take action much earlier than before.

Inaguration ceremony of the forest watcher system in Tamao Zoo

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Reconstruction and Sustainable Management of Degraded Forests Based on the Combination of Inter-planting Nitrogen Fixation Rare Tree Species and Thinning

Executing agency: Experimental Center of Tropical Forestry, Chinese Academy of Forestry

Implementing agency: Institute of Forest and Wildlife Research and Development, Cambodia

Budget in USD (total / APFNet grant): 503, 000/378, 000

Project duration: 01/2019-12/2021

Site Location: Bos Thom village, Khna Por commune, Soth Nikum, Siem Reap province, Cambodia.

Objectives:
- To demonstrate effective approaches on degraded forest transformation to improve the growth and quality of the forest stand and enhance ecological services by promoting forest restoration and sustainable forest management;
- To improve the livelihood of the local forest dependent people and those living in poverty;
- To share information and knowledge of best practices on forest restoration and rehabilitation.

Expected outputs:
- Explore and demonstrate effective approaches on degraded community forests, optimize the forest structure, and improve forest ecosystem services;
- Livelihood building activities beyond forestry-based activities are developed;
- Information and knowledge of best practices on degraded forest restoration and rehabilitation in Cambodia are shared.

Restoring Forests by Restoring their Soil

APFNet has tested several different restoration models across Cambodia, especially enrichment planting, agroforestry, assisted natural regeneration, and general silviculture techniques in Siem Reap, Kampong Thom, and Kampong Speu province.

In contrast, the degraded forests of Bos Thom CF in Siem Reap province will adopt a new method with technical support and experiences from the Experimental Center of Tropical Forestry of the Chinese Academy of Forestry. The method will focus on close–to–nature forest management through **group inter–planting** in forest gaps with rare tree species that have a nitrogen fixation ability such as rose wood species *Dalbergia cochinchinensis*, and *Senna siamea*. This approach of using nitrogen fixing trees is one of the most promising low–cost measures for restoring degraded forests both above and below ground. This method involves removing poorly growing or damaged trees to make space, and inter–planting the stand with nitrogen fixing species.

Gradually in the community forests, the approach will promote a resilient uneven–aged mixed forest and enhance productivity, stand quality, stand stability and ecological function of the forests, as well as accelerate forest succession and provide timber resources through the thinning of non–target tree species.

What are nitrogen–fixing tree species?

Nitrogen is one of the key nutrients in soil and is essential for plant growth. Generally, the way soil obtains nitrogen is through the decomposition of plants and organisms on the forest floor (that is, falling leaves or other dead plant or animal tissue). While trees cannot use atmospheric nitrogen directly, forests are generally fairly good at keeping nitrogen levels stable through internal recycling. Soil erosion is a key threat to this cycle, which effectively washes the nitrogen off the site, leaving the earth stripped of nutrients.

Nitrogen–fixing tree species form a unique symbiosis with certain types of bacteria and archaea called rhizobia within the nodules of their root systems. These organisms are able to transform atmospheric nitrogen into molecules such as ammonia that can then be used by trees. When the trees eventually die, the dead plant material is added to the overall nitrogen cycle of the site, effectively adding former atmospheric nitrogen into the soil.

Nitrogen in the Air

Microbes "fix" nitrogen in nodules on the roots of the tree
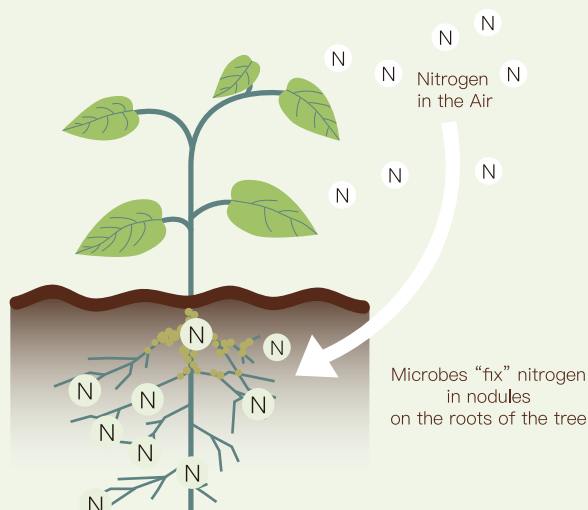
Home Gardens and Improving Local Livelihoods

Successful forest restoration is not only defined by whether the vegetation itself is restored but also whether the additional economic benefits for local people, who are dependent on forest resources, are provided.

This project provides benefits and income generation for the local community by establishing home gardens and providing alternate sources of energy in order to reduce pressures on forests. Normally, local households in rural villages live in wooden houses on small pieces of land (less than 1 ha and sometimes bigger for higher income families) on which several tree species, crops and vegetables grow. However, this setup can usually only cover the basic needs of a single household. Transforming these small patches of land into more productive home gardens can enable families to earn an income instead of only subsisting on their land.

The general concept of home gardens is to combine various trees in multiple stories with crops and sometimes domestic animals around the homestead. This project will interplant fruit trees that can provide short term income such as banana, papaya, coconut or cashew nut and combine it with the existing plants around local households. This will give local people both an opportunity to improve the food diversity for their own daily consumption and to sell at the local market.

Additionally, in order to avoid cutting trees from natural forests, the project will encourage local people to plant trees for firewood around their house. Furthermore, the installation of small scale solar equipment will provide adequate electricity to reduce overall expenses in the family. Finally, it is expected that the combination of alternative sources of income, the availability of alternate firewood resources and the general decrease in living costs will reduce pressure on the surrounding forests.

Local folkhouse (left) and home-garden (right)

Achievements and Outlook

Collaboration between APFNet and the national FA of MAFF began in 2011, and four projects have been initiated in various provinces including Kampong Thom, Siem Reap, Kampong Speu, and Takeo. The focus on restoring degraded forests is supporting the goal of the Cambodian government to reach 60% forest cover by 2029. These projects have significantly contributed to the improvement of local livelihoods. Forest communities who have long relied on timber and non–timber forest products have been given extensive knowledge, technical and other forms of support to rehabilitate degraded forests and become more economically secure.

While many accomplishments have been made, the impacts of APFNet's projects in Cambodia can be summarized in four key achievements:

1 Forest communities have been transformed in their understanding and approach towards sustainable forest management (e.g. through the adoption of landscape management, multi–functional approaches, home garden establishment, approaching forest restoration based on the severity of degradation) and have not only become new partners of the provincial FA and NGOs, but also reliable suppliers of seedlings and even trainers for other CFs.

2 Local communities have become more independent, both in terms of their livelihood as well as in determining the fates of their forests (e.g. through secure land tenure, sustainable extraction of non–timber forest products, participatory planning in CF management, the economic success seen in the seedling production of CF nurseries to supply both local and external demand).

3 The introduction and adoption of science–based rehabilitation techniques and technologies have been successful as well (e.g. forest watcher system for improved forest fire prevention and use of alternative fuels such as the solar equipment given to households).

4 The above achievements are reflected in the national and international attention that the projects have drawn. For instance, the European Union organized a visit of CF representatives across Cambodia to the O Soam CF, and the minister of MAFF also paid a visit to learn more about its successes. Furthermore, due to the success of the Prek Thnot watershed plan, a United Nations Development Programme–supported project sought collaboration with the project to utilize its insights.

Achievements and Outlook

While APFNet's projects in Cambodia have seen many successes, a lot of work remains to be done to restore all of Cambodia's degraded forests and advance sustainable forest management throughout the economy.

As this context, several key lessons have been learned as well:

- The actual engagement and involvement of the farmers are an effective means of transferring forest and agricultural technologies. Their farms provide ideal learning laboratories for testing new technologies. Practical learnings are further enhanced through the exposure to successful practices from other places or communities by means of exchange visits or study tours, distribution of extension materials, and community meetings.

- Replicating the successful interventions needs to be supported by enabling policies and financial support from the government. The success stories in the ground can be disseminated to the policymakers through publications, policy briefs, feature stories and lessons learned. The experience of the project needs to be disseminated to the government decision makers and the wider public through mass media (TV, radio, newspapers) and social media (FB, Instagram, etc.) to gain their support.

- Local knowledge is an important consideration in designing local development projects. The choice and selection of the crops and other project activities needs to be harmonized with the experience of local people, like the suitability of species based on the condition of the site.

- Developing sense of ownership from stakeholders is critical for sustainable development. This is achieved by seeking active involvement of the farmers in the selection of crops, planning of the home gardens and agroforestry systems, and involvement in actual work on the ground.

- Forest conservation requires a holistic approach. Projects need to address the immediate needs of the family. Home gardens and agroforestry, supported by a water distribution system, can minimize the pressure on the forest by improving livelihoods.

- State of the art technologies greatly contribute to the effective management of the forest resources. The pioneering Forest Watcher technology and geotagged photographs have not only prevented fires, but also improved the collection of field data that are very useful to decision making.

APFNet looks forward to further collaboration with the Cambodian government and other organizations to continue making progress in improving forest conditions in the economy.