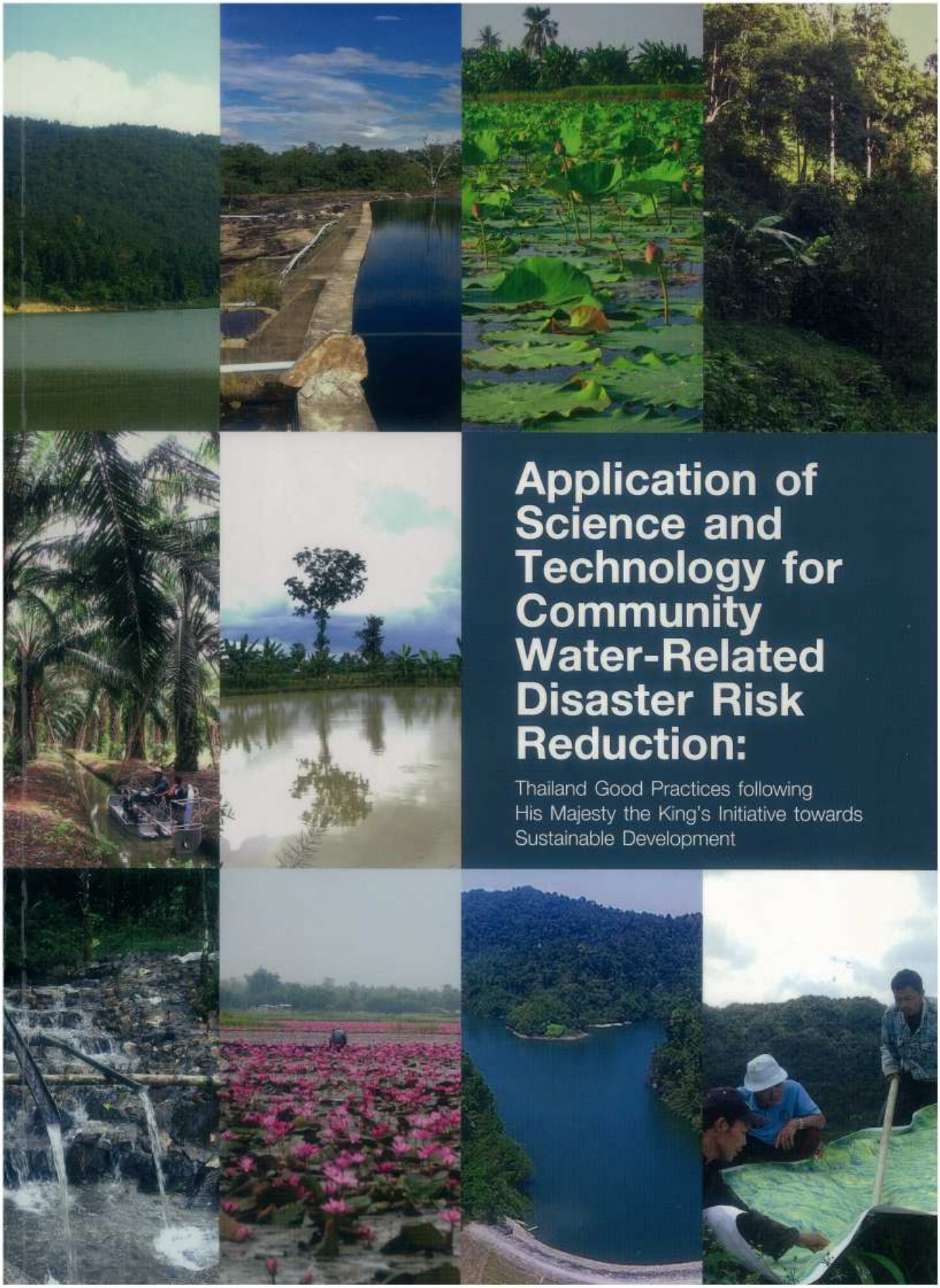

Application of Science and Technology for Community Water-Related Disaster Risk Reduction:

Thailand Good Practices following His Majesty the King's Initiative towards Sustainable Development

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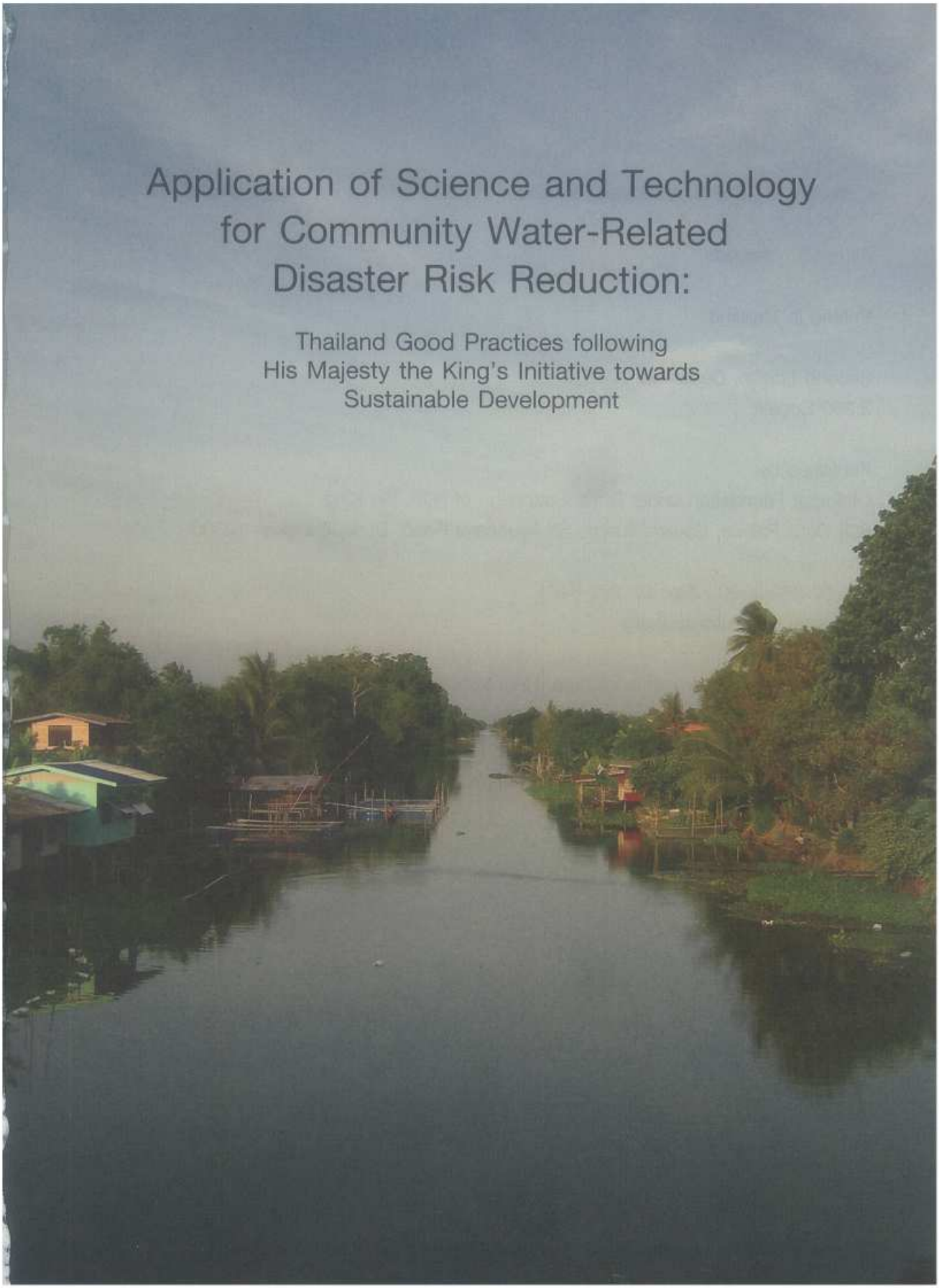

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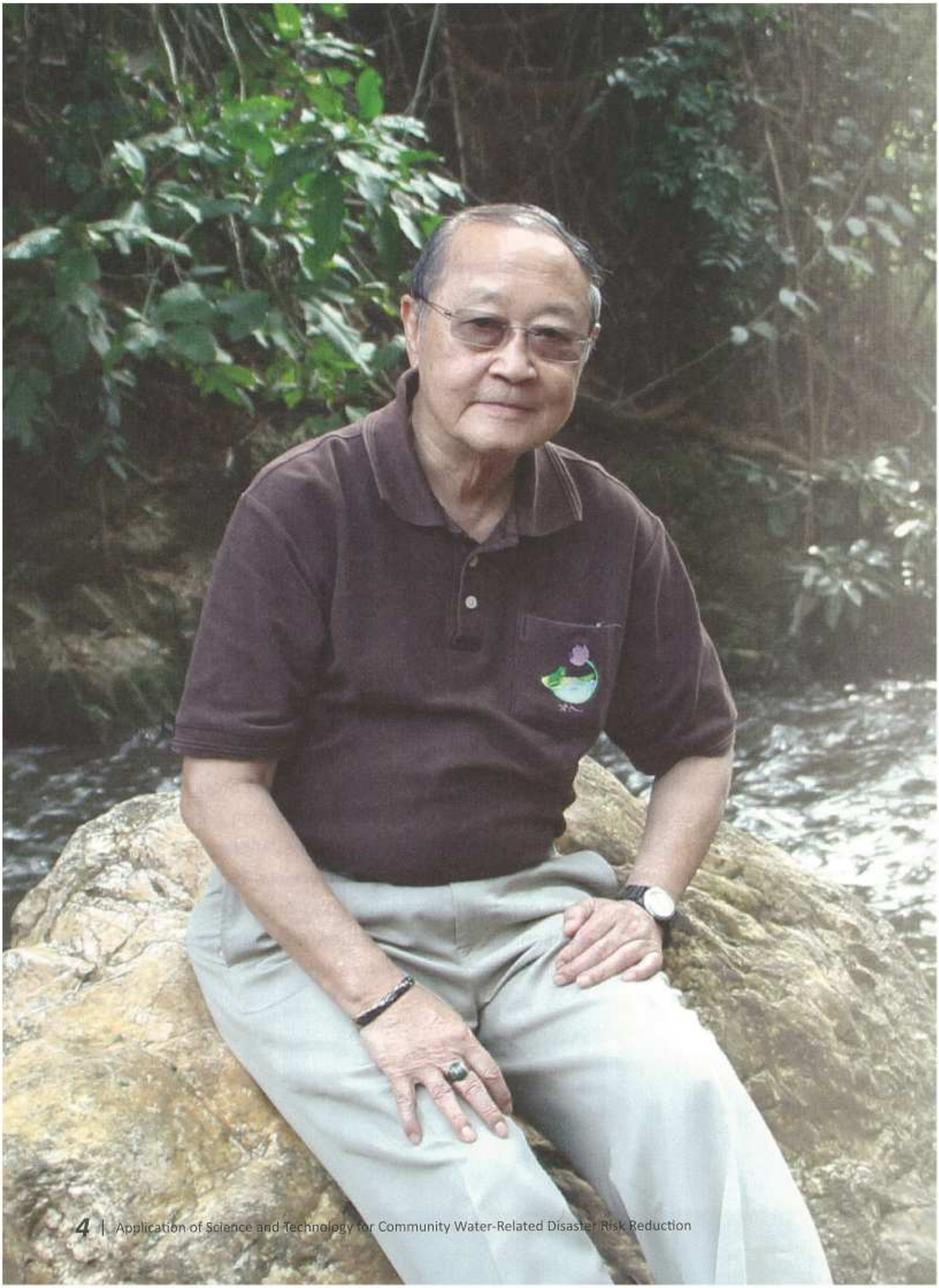
Foreword

In a predominantly agricultural country like Thailand, "**water is life**". However, water-related hazards such as flood and landslide, drought and saltwater intrusion affect people's lives and cause economic losses. In addition, wastewater caused by unsustainable practices at household level as well as agriculture and industrial sectors is increasingly a problem.

Through more than 12,000 trips to all parts of the country since ascending the throne in 1946, His Majesty King Bhumibol Adulyadej recognized the need for an integrated approach that brings together water, soil and other natural resources management to reduce flood and drought risk and improve agriculture for resilient livelihood.

Under H.M. the King Philosophy of Sufficiency Economy, he introduced the concept of "water cycle management". Following this, important initiatives were implemented: the royal rain making to increase rainfall in drought area, preservation of upstream areas to increase moisture in the forest, construction of dams, reservoirs, water storage (known in Thailand as "money cheek" – resembling the way monkeys keep bananas in their cheeks before eating) and small water retention to cope with excessive flood and store water for consumption in the dry season. Furthermore, wastewater from households and industrial areas is treated before release to the sea.



H.M. the King philosophy underscores the self-reliance of both for individuals and communities. This is built through people's participation, their application of knowledge and creating bonds to link people of all backgrounds and boost positive and creative forces to lead to unity, balance and sustainability.

Rehabilitation and conservation of various kinds of natural resources should be at the heart of development to be sustainable. Solutions should be tailored to the topographical and sociological characteristics of each area and supported by modern but simple and appropriate technology. Research and experiment, therefore, are at the heart to identify appropriate solutions. To this end, six development study cases have been established across Thailand to serve as 'laboratory' to identify local solutions and for people to learn good practices.

Following H.M. the King's approach, the Hydro-Agro Informatics Institute (HAII) of the Ministry of Science and Technology and the Utokapat Foundation have implemented many projects in all regions of Thailand over the last 20 years. This publication shares good practices generated from ten such projects. The good practices demonstrate successes in an integrated approach that promotes application of science and technology in community water resource management to reduce flood and drought risks while building sustainable agricultural production and resilient livelihoods. Public-Private-People Partnership has been the key to success.

The HAII and Utokapat Foundation are pleased to share these good practices. We hope that they will contribute to more innovative solutions for the challenges of increasing flood and drought risks to achieve the world's shared goals of ending poverty and hunger.

Dr. Sumet Tantivejkul

Honorary Chairman of
Hydro and Agro Informatics Institute and
Chairman of Utokapat Foundation

Acknowledgement

This Good Practice document is prepared with technical support from the United Nations Office for Disaster Risk Reduction (UNISDR) as part of a collaborative framework between the HAII and UNISDR's Regional Office for Asia-Pacific.

Under this collaborative framework, the HAII and UNISDR Asia-Pacific jointly promote the vital importance of Science and Technology in disaster risk reduction, especially in preventing creation of new risk, reducing existing risk and strengthening resilience – the goal set out by the Sendai Framework for Disaster Risk Reduction 2015-2030.

A particular focus is to promote successes of communities in applying Science and Technology to address disaster risks, natural resource management and sustainable agriculture in an integrated approach that build resilient and sustainable livelihoods. In so doing, the communities powerfully demonstrate how the Sendai Framework, the 2030 Agenda for Sustainable Development (or Sustainable Development Goals) and Climate Change Agreement can be implemented coherently at local level.

The document is published with financial support from the Coca Cola Foundation. The Foundation is a long-term partner of HAII which has provided generous financial support for many projects, some of which are presented in this document.

The selected Good Practices are the result of many years of fruitful collaboration between local authorities, research institutions, government agencies, community-based organizations as well as the private sector. Above all, villagers and communities have been the main drivers of the successes that have transformed their resilience and livelihoods.

The HAII is appreciative of the partnerships and are thankful to all partners' collaboration and support.

Contents

Common Framework

H.M. King concept of "**Understand – Access – Develop**" has been introduced to Thai people as a guideline for development. It requires an understanding of the context (geography, people and society), and explanation of the process to people to establish trust as pre-conditions for any local problem solving. Water data is of particular importance. The complete water data set including water maps, water tables, and water balance is required for water management analysis. This information will help technical experts determine local water quantity, water demand, and the amount of water to reserve.

With H.M. the King's vision, he has anticipated future challenges to natural resources namely soil, water and forest, driven by changes to geography, society as well as climate. Therefore, H.M. the King requested relevant government agencies to study and systematically collect data and introduce science and technology in natural resource management which aimed for sustainable development. The approach aims at results in 3 dimensions:

1. *Water security and water resource management*

- ***Water data, water map and water table***: To help analyze and create water resource development plan, these three data are important to cope with flood and drought risks, improve water infrastructure and community capacity to manage local water resources.
- ***Water security***: To improve water security, it benefits to increase water capital and sufficient water reservation for consumption and agriculture throughout the year.

2. *Food security and community economy*

- ***Food security***: To support community's harvest production, food security improvement through local water usage and cropping plan and an appropriate crop planning with local weather and climate conditions enable the community to harvest all year long. These lead to increase household income and decrease production expenses.

- ***Community economy***: To strengthen community's funds, community-based sustainable water development and management, village and sub-district levels' actions are important to improve the community's economy efficiency, society and health, and environment conditions.

3. *Public – Private – People Partnership (PPPP)*

- ***Public-Private-People Partnership (PPPP)***: To apply H.M. the King's working principle of "Understand – Access – Develop" to integrate soil, water and forest management and agriculture development, the PPPP is an instrumental to build the capacity and facilitate community networks through academia and technical experts as well as representing public sectors for people's implementation. The private sector provides funding, publishing, and support to agencies. The PPPP also helps expand successful practices from people to community level, sub-district level and river basin level.

Applying H.M. the King's initiatives, Hydro and Agro Informatics Institute (HAII) and Utokapat Foundation have developed a common framework that was applied by the Good Practices presented in this publication.

Under this common framework, the community will be empowered and trained to apply Science and Technology (S&T) to design simple and innovative solutions for CWRM that integrate water, land, forest management and sustainable agriculture development for water, food, and energy security, and improved community economy *(Figure 1)*.

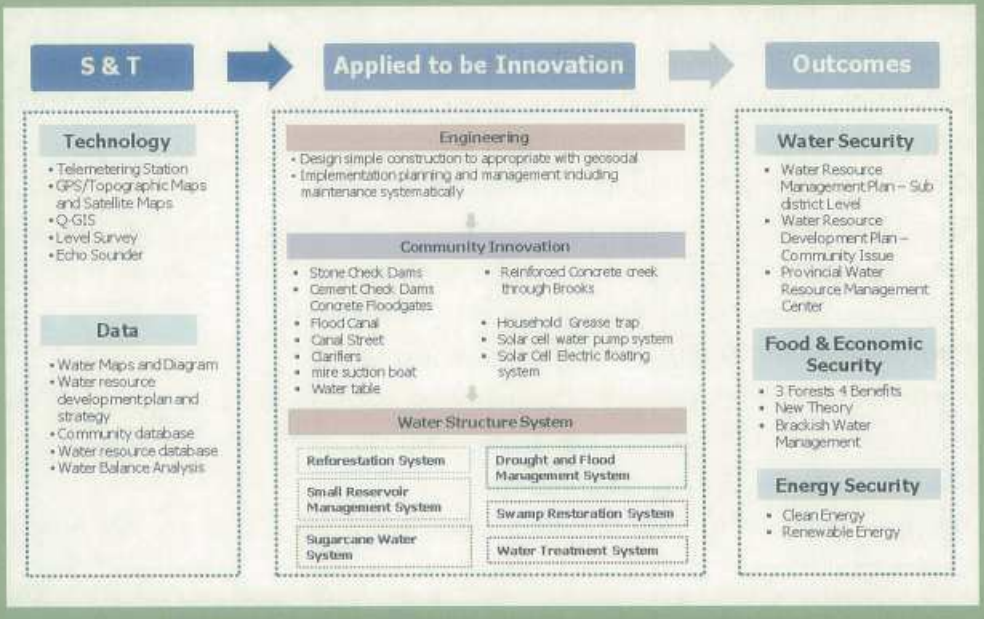


***Figure 1** : Apply Science and Technology to CWRM*

Application of Science and Technology (S&T) for Innovations

Adaptation of S&T and information systems helped communities to collect important data, identify the root causes for local problems and develop local planning that best suited their circumstances. Examples of community application of S&T include the following:

- ***Community Water Resource Management (CWRM)***
  The management of local water resource by local participants. CWRM is aimed to increase efficiency of the community in their local water management to sustain ably overcome flood and drought situations.
- ***Crop Planning***
  The Crop Calendar is a tool that provides timely information about seeds to promote local crop production. It contains information on planting, sowing and harvesting periods of locally adapted crops in specific agro-ecological zones. This tool supports farmers in taking appropriate decisions on crops production planning to promote yearlong income to be in line with the climate change and global warming situation.
- ***Echo Sounder***
  A device for determining the depth of the seabed or detecting objects in water by transmitting sound pulses into water and measuring the time interval between emission and return of a pulse.
- ***Geographic Information Systems (GIS)***
  A computer-based tool designed to capture, analyze, store, manipulate and visualize geographic information on a map.
- ***Global Positioning System (GPS) Receiver***
  An equipment using a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.
- ***Hydropneumatic Pumping Station (Air-ware)***
  A local wisdom innovation that developed to increase air pressure for delivery of water from lower to higher grounds over a long distance.
- ***Land and Water Survey Technologies***
  Technologies such as GPS receivers, satellite images and maps that have been used as tools for the community to understand their local context.

- ***Land Use Map***

  A map that shows the types and intensities of different land uses in a particular area. The application of land use maps helps clarify local land use. By surveying their local area, villagers understand their local context and have a visual guide to comprehensive future planning.

- ***Pond Network***

  A network of water storage and distribution system distributes water from an upstream reservoir to a small pond downstream.

- ***Satellite Images***

  An image of the whole or part of the earth taken using artificial satellites. These images have a variety of uses, including cartography, military intelligence and meteorology. Satellite image scan either be visible light images, water vapor images or infrared images.

- ***Telemetering Station***

  An equipment to measure water level, precipitation, temperature, humidity, atmospheric pressure, and solar radiation in the installed area. The collected data is automatically linked through the transmission system (3G, GPRS, or satellite) used for water modelling, weather forecast and to analyze for a disaster warning database.

- ***Wastewater Treatment System***

  The process of removing contaminants from wastewater, primarily from household sewage. There are some low-cost but suitable for community use such as a "Household Grease Trap" (containers that filter the disposal of cooking oil before it enters into the water) or "Solar Power Aerator" (an oxygen generator equipment powered by solar panels).

- ***Water Balance Analysis***

  The calculation of water demand and existing water supply enable local people to understand their current situation and the risk of potential loss from insufficient water supply for agriculture.

- ***Water Circulation***

  The movement of water before it flows to another area. An increase of water circulation will add value to the water and decrease demand from outer sources. Water can be circulated from the canal to store in farm ponds for an agricultural purpose, and then non-polluted water can be used in an organic paddy field before entering the canal.

- ***Water Chart***

  A graphic chart represents the direction of water flow in one area. It shows the direction of water from upstream to downstream including their tributaries, direction, water storages, and important structures along the way.

Water balance analysis is crucial. Imbalance between water demand and water supply can cause an undesirable situation that might escalate to a water scarcity. In addition, seasonal variation of rainfall over time and space as well as weather extremes can cause severe floods and droughts that aggravate poverty especially in agricultural communities in Thailand.

A monthly water balance analysis is an essential tool for the community to understand and describe monthly distribution of local supplies and demands in the community. By interpreting the monthly water balance results, farmers can understand the root cause of their water stress in the area and reasonably identify appropriate solutions to collect rainwater and allocate for their cropping. In addition, surveyed results of natural streams conducted by communities provide locations and possible water resources in their own areas. All surveyed data are recorded in GIS to have the correct and common understanding of resources availability. This is essential to cope with flood and drought and strengthen adaptability and resiliency of agricultural communities against future climate change.

The innovative solutions identified by communities lead to reduced flood and drought risks, increased water security, reforestation and other natural resources. The application of theories such as "3 Forests and 4 Benefits[1]" and the New Theory on Agriculture[2] helped communities improve their food security and economic self-reliance. The common framework aims at outcomes in 3 dimensions of improved water security, food and economic security as well as energy security for resilient and sustainable livelihoods of people.

The good practices have self-expanded. As of 2016, 60 CWRM core communities and 603 networks are presented in 19 river basins of Thailand (Figure 2).

[1] The theory concerns the planting of three types of forests: for timber, for fruits and for firewood, all of which would yield benefits to the people in a symbiotic manner. Besides, it also assists in the conservation of soil and water.

[2] A system of integrated and sustainable agriculture with the aim to optimize farmland and to build stability at the household level, dividing land into four parts with the ratio of 30:30:30:10 which can be adjusted according to the area's condition: pond 30%, rice cultivation 30%, multiple cropping 30%, and residential area 10% .

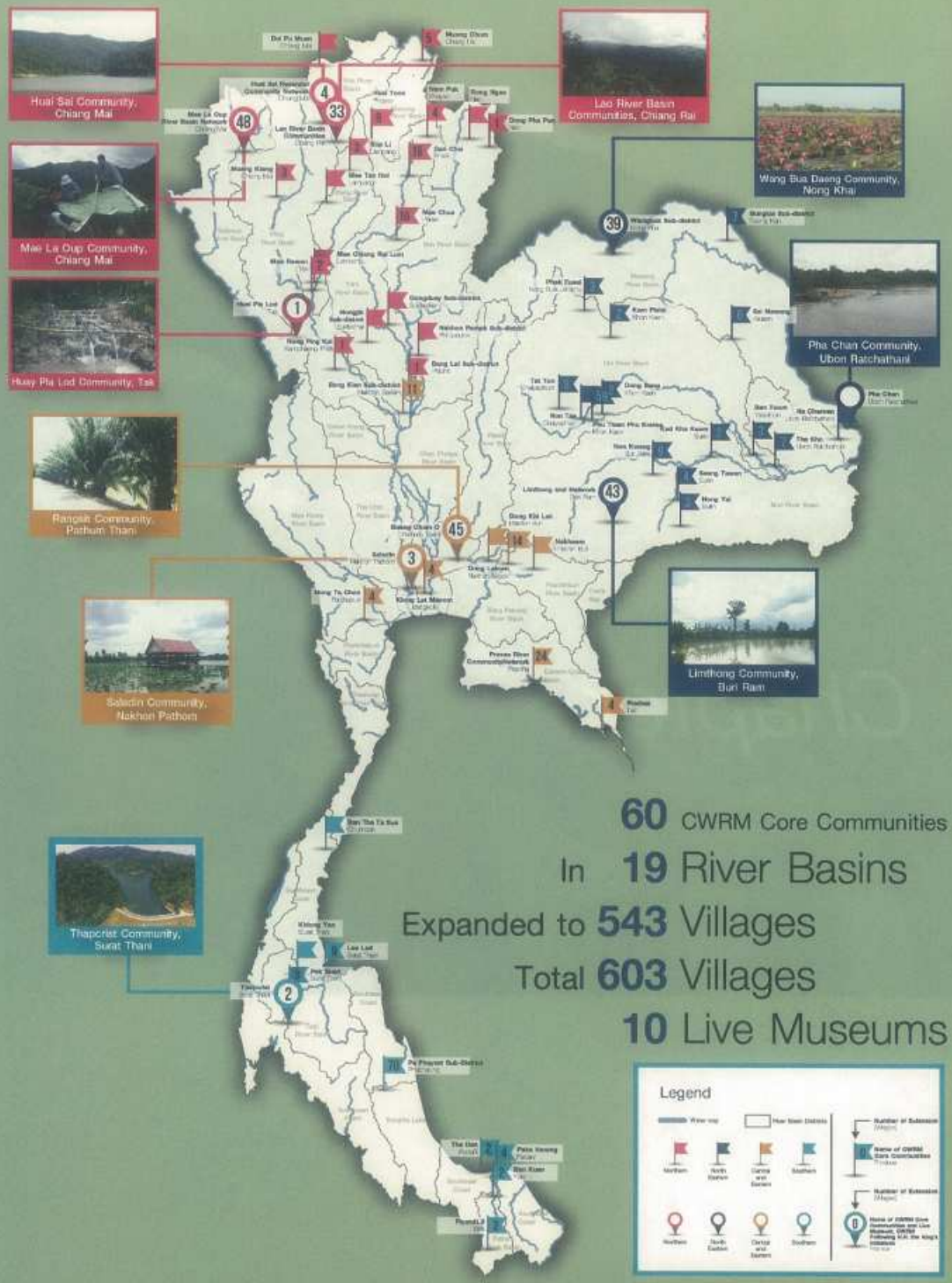
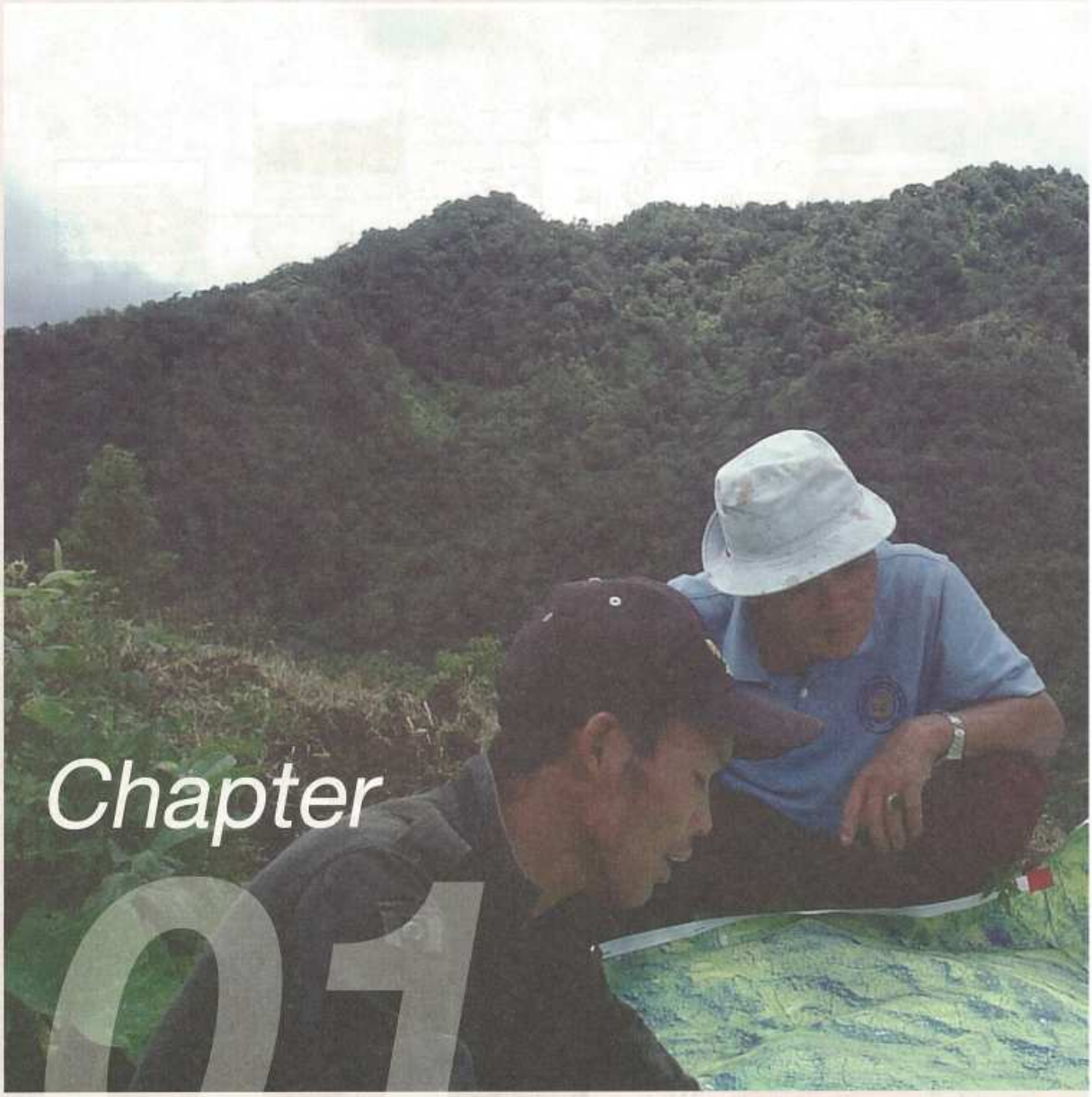


Figure 2 : *CWRM Networks in Thailand*


Chapter
01

Strengthen Water Management Technology
for Landslide and Sustain Agriculture

Mae La Oup Community

Galayani Vadhana District, Chiang Mai Province

Good Practices

- Empower people to combine indigenous knowledge with modern technologies for locally appropriate solutions
- Strengthen land ownership for sustainable management of natural resources
- Integrate water, forest and agriculture to achieve balanced conservation and development

The Challenge

Mae La Oup community is located in an area of 521.52 km^2 in Jam Luang, Ban Chan, Mae Daet sub-district, Galayani Vadhana District, Chiang Mai province. Here 2,932 people of ethnic group (called Paka-Kyaw) have lived for centuries. More than 97% of the land (509.34 km^2) is protected the forest while agricultural land accounts for 2.28% (11.9 km^2) and only and 0.28 km^2 (0.05%) is for habitat. Currently, the CWRM implementation is expanded to 644 Km^2

Since Paka-Kyaw had no title deed, the boundary between their arable areas and protected forest was unclear. Population growth and migration caused excessive consumption of natural resources and thus encroachment of conservation forest. Moreover, capitalists came to the area and hired people to cut down the trees. This led to forest deterioration, reduction of wildlife and aquatic animals and increasing risk of wildfire. Forest deterioration worsens the water shortages faced by the community. Conflict over water was for long present in the community as people seized water for consumption, especially for agricultural production. Furthermore, in the past few years (2009), soil erosion and landslide problem caused by heavy rainfall had become critical natural disaster concern that devastated the community.


PILOT

The Approach

In 2009, Community Water Resource Management (CWRM) was introduced to Mae La Oup community. The community then were trained to apply Science and Technology to prepare water maps, undertake water balance analysis to design and develop check dams and water distribution systems. Land use plans were created by the community and land use titles were provided, enabling collaborative upstream reforestation. The canal street was introduced to solve landslide problem by constructing street along the ridge area. In normal situation, the street will be function normally. While, during rainy season, the street will function as a canal to control flash flood and transport water to reserve at the retention pond (monkey cheek). Indigenous knowledge was applied to design the water storage dams and local irrigation system. In addition, local traditions such as the River Goddess Worship Ceremony or 'Natee Khunnam' and traditional rhymes were revived to teach people to preserve the nature.

"We learned how to survey and develop our own Land Use Map. We are the first district in Thailand to do that", said Mr. Decha Nateethai, villager of Mae La Oup Community.

With improved water resource management, people shifted from monocrop and nomadism to integrated agriculture. Household incomes has been boosted by developing organic farming and agroforestry.

Above: *Before constructing canal street*

Below: *After constructing canal street*

The Impacts

Land use maps were developed for 37 communities in 3 sub-districts and 4 river basins for a total of 644 km^2. Land use titles were issued for 6,282 plots, giving people opportunities to earn a living in their land and stop encroachment into the preserved forest. Mae La Oup community developed their own regulations and plans to jointly manage the forest. The canal street length 920 meters was constructed to drain flash water from the street.

The landslide problem in this area was completely solved. In addition, amount of reserve water in retention area were increased. Also, the water crisis has been resolved through the network of check dams. The success of canal street was expanded to their network communities in the higher mountain area.

Past

Present

The forest was restored. It became more fertile with animals such as gibbons, barking deer, jungle fowls and dwarf snakehead. Integrated agriculture, agroforestry and organic farms have been established.

Annual household expenses decreased approximately 93% (THB 53,900 per year) while household income increased by 64% (THB 191,600 per year).

Success factors

Respect of indigenous knowledge and culture

The HAII and Utokapat Foundation's technical experts and local coordinators spent great efforts to understand the Paka-Kyaw's beliefs, indigenous knowledge and water resource management practices, which are important for community solidarity. This included significant time for local coordinators to master Paka-Kyaw language for successful transfer of modern technologies and skills to them. People were facilitated to use local knowledge and wisdom to understand their natural resources base and design appropriate water resource management system to complement technologies.

Empowering community-based networks

Committees and networks established by the communities have been critical for success. The Mae La Oup River Basin Water Resource Management Committee and sub-working group structure in the community have led the design and implementation of water resource management system and water distribution. The Ae-Pa-Dou Upstream Forest Conservation Youth Group led on the learning and application of science and technology for natural resource conservation.

Good Practices

1 Empower people to combine indigenous knowledge with modern technologies for locally appropriate solutions

Recognizing the importance of indigenous knowledge for Paka-Kyaw, the HAII and Utokapat Foundation paid special attention in facilitating the community's sharing of this knowledge and these traditions and promoting their application while transferring modern technologies.

Land Use Maps by Community

Training was provided to Paka-Kyaw community to develop their own land use maps in local language, using their knowledge of the area. They were introduced to new technologies such as satellite map, Geographic Information System, (GIS), and Global Positioning System (GPS) to map and create vivid boundaries of community, preserved forest, usable forest, rehabilitating forest, crop rotation area and arable land. They surveyed the communities and networks in the area, collected data and created their land use maps. The maps were endorsed by the community as the basis for providing land use titles for people.

Three-level filter check dams

The Mae La Oup community was supported to build check dams with three levels of filter system: primary, secondary and tertiary, based on their topography and geography. The primary and secondary levels help to retard and impound water until the forest can

absorb the dampness, help promote upstream reforestation whereas the tertiary level helps increase water storage for using in the community during dry season. Now, 383 check dams were built to provide water for 19 brooks to flow throughout the year.

Local irrigation system

Household water supplies in high land areas and rice terraces were a great challenge. A local irrigation system, using indigenous knowledge was the solution for this. Communities dredged ditches and built dams for impounding water which was then distributed to the rice terrace areas. These areas were used as a monkey cheek before further distributing water for reuse 4-5 times. The water from upstream to downstream areas is managed more effectively.

In addition, Paka-Kyaw's traditions for water resource management such as Natee Khunnam (river goddess worship ceremony) and traditional rhymes were revitalized to teach people to preserve the nature.

2 Strengthen land ownership for sustainable management of natural resources

Engaging Paka-Kyaw in developing land use maps helped them realize the importance of protecting upstream forest and better management of other natural resources. With land use maps, endorsed by the community, land use titles of 6,282 plots were given to the communities. This was instrumental for Paka-Kyaw to set clear boundaries of conservation forest. They reached agreements on required actions, adopted regulations and implemented collaborative plans to restore the upstream forest and manage water resources.

3 *Integrate water and forest management and agriculture improvement to achieve balanced conservation and development*

Conflict over water, deteriorating forest and other natural resource, coupled with insufficient income for a growing population had led to a severe strain on social relationships among local people in Mae La Oup community.

There was the need to demonstrate how better management of forest and water would help the community food security, agricultural production and livelihoods.

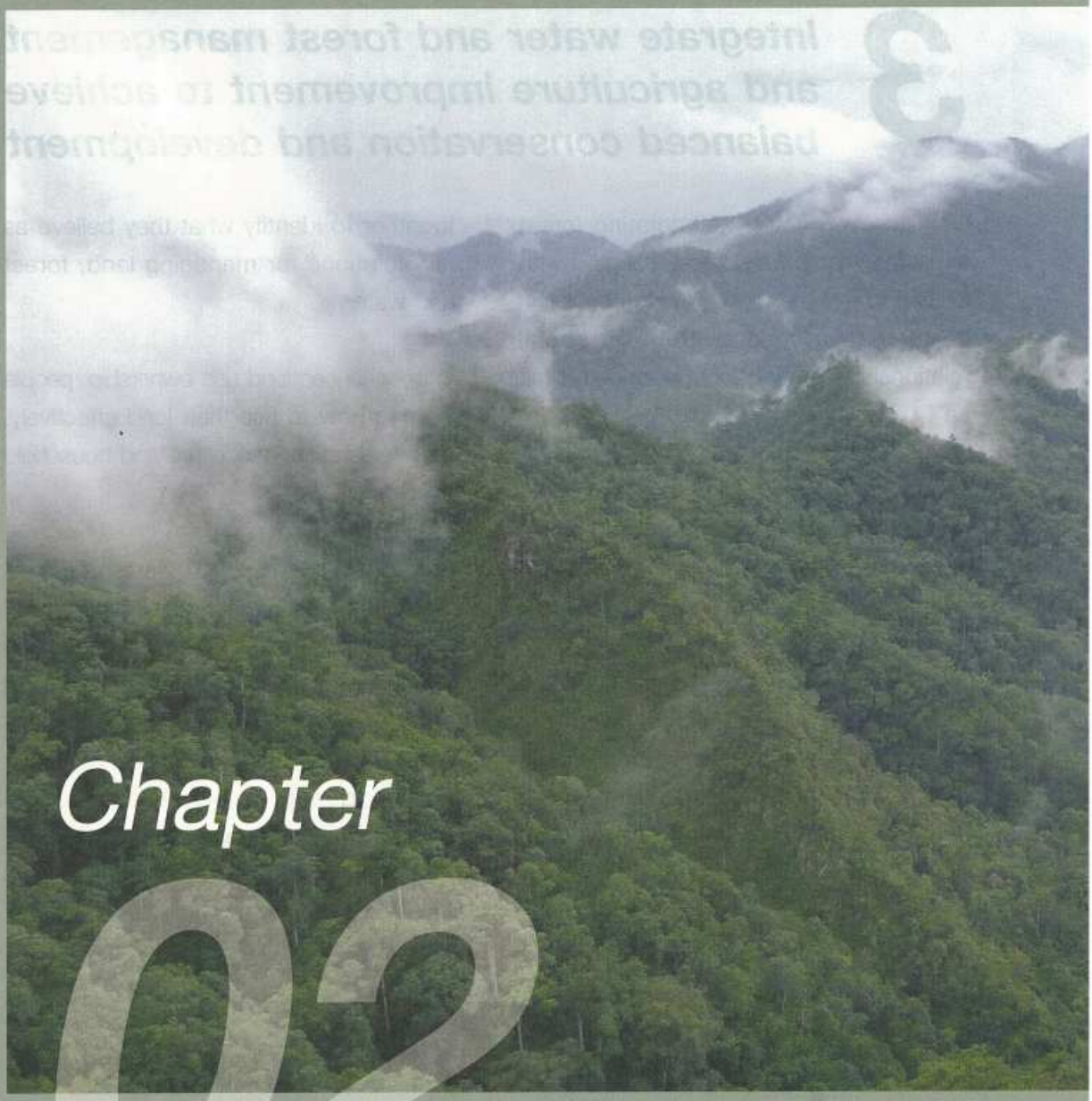
The process to bring community members together to learn about their land and natural resources base was extremely useful. Paka-Kyaw understood the root causes of their problems and worked together to identify what they believe as fair solutions for managing land, forest and water.

With enhanced land use ownership, people learned how to use their land effectively, for afforestation, agriculture and household use.

Supported by improved water management, Paka-Kyaw increased agricultural production, shifting to organic farming for better cash crops. This brings food security, agricultural employment and a better life for people. Paka-Kyaw no longer wanted to move to other places to find new land and livelihood opportunities.

Replication

The Mae La Oup River Basin Network has been expanded to 3 sub-districts, namely, Jam Luang, Mae Daet and Wat Jan. Working Groups on Land Management and Regulation have also been established. The "Ae-Pa-Dou" a Youth Network of CWRM has been established in 8 communities consisting of 105 members.



Chapter 02

Forestry-based Disaster Risk Reduction

Builds Resilient Livelihoods

Lao River Basin Communities

Wiang Pa Pao District, Chiang Rai Province

Good Practices

- Integrate multi-hazard risk reduction and natural resource management through ecosystem-based approach
- Strengthen community collaboration to increase market value of agro-forestry products

The Challenge

Lao River Basin communities locate in Mae Chedi Mai sub-district, Wiang Pa Pao district, Chiang Rai province. Covering an area of 256.03 km^2 in the Kok river basin, there is 51.50 km^2 of land use for agricultural purpose. Land use comprises of 8.24 km^2 (16.0%) rice fields, 32.08 km^2 (62.3%) farm crops, 10.39 km^2 (20.2%) fruit crops-perennial plants and vegetable crops of 0.79 km^2 (1.5%). Currently, the CWRM implementation is expanded to cover 413.77 km^2.

In 1984, as tin mine concessions started in the area, the forest was ravaged and the Me Tho upstream waterway, the water source of Lao River, became muddy and could not be consumed. At the same time, the communities encroached on the forest for corn farming. Deforestation caused flood, river bank erosion and landslide during the monsoon, and damaging agricultural fields. In the dry season, drought and wildfire led to food and income insecurity.

The Approach

In 2005, some communities in the Mae Lao River basin established a "Forest Conservation Group". Building on this initiative, HAII and Utokapat Foundation introduced the concept of Community Water Resource Management (CWRM) to help communities address multiple challenges, including deforestation, flood, drought and wildfire and the needs to improve agriculture for more resilient livelihoods. The Forest Conservation Group has become the "Lao River Basin Communities Network".

The communities were trained to apply science and technology to map their water, forest and other natural resources. The Lao River Basin Communities Network set rules and regulations for upstream reforestation. Analysis of water balance pointed to the water storage system development that linked upstream weirs to check dams as storage tanks and subsequently to water purifying systems in communities. These systems help restore moisture of the forest, trap sediment, store excessive flood for use in dry season for agricultural production. A Disaster Monitoring Network was established to collect data and report weekly on the water situation. The "3 Forests and 4 Benefits" concept was introduced to replace the monocrop. A Planting of tea, coffee, herbs and other vegetables throughout the year generates extra household's incomes.

Past

Present

The Impacts

With its committee and working groups comprising community representatives, the Lao River Basin Communities Network has led community collaborative efforts to develop a water management system, restore upstream forest, and reduce disaster risks. A total of 2,528 check dams have been constructed, providing water to 881 households and 2,740 people in 41 communities, 3 sub-districts. Local young plants have grown, 70% of which are wildwood and 30% economic crops. More than 6,400 trees have been planted. Firebreaks were installed for an area of 103 km^2. A Disaster Monitoring Network has been established, reporting on the water situation and providing early warning.

A youth group named "La-On-Hug-Nam-Lao" was established and applies science and technologies to collect data, report on the water situation and maintain the Disaster Monitoring Network.

Success factors

Recognize the importance of disaster risk reduction as an integrated part of natural resource management

Lao River Basin communities recognized the need to address flood, landslide, drought, and wildfire. They thus integrated the management of these disaster risks in their forest conservation and water resource management systems and activities. The water storage systems are based on natural conditions and help reduce flood and drought risks while improving water supply for communities.

Local leadership of Lao River Basin Communities Network

Communities were facilitated to select their own committee and sub-working groups of the Lao River Basin Communities Network. These bodies, consisting of community representatives, develop their own rules to work in all related areas: conservation and development of upstream forest, building the water storage systems and maintaining the Disaster Monitoring Network. Regulations set by the committee are applied by all communities.

Community leadership has been instrumental in self-managing the Network and its sustainable

Good Practices

1 *Integrate multi-hazard risk reduction and natural resource management through ecosystem-based approach*

The multiple challenges that Lao River Basin communities faced required an integrated approach that respects the ecosystem in the area. CWRM provided this solution by improving water management to reduce flood, drought, landslide and wildfire risks while supporting reforestation and improving agricultural production and agro-forestry.

Water storage systems rehabilitate upstream forest and reduce flood, drought and landslide risk

A total of 2,528 check dams linked with weirs upstream were built. The weirs prevent flash flood during rainy season and release water downstream during dry season. The check dams slow down the water flow to allow water to be absorbed into the soil to restore the dampness of the forest. Sediment was trapped which be nutrients for the trees. A reduced flow and extended flow period help reduce river bank erosion. Moreover, the check dams also act as firebreaks since they increase the moisture through the air.

A better water resource management helped communities implement the 3 forests and 4 benefits for both reforestation

and improved livelihood. Seventy percent (70%) of the whole Lao River upstream area of 413.77 km^2 is planted with the wildwood whereas thirty percent (30%) has been harvested with economic crops. As a result, more than 6,400 trees have been planted.

The water storage systems also help improve water supply to communities through the purifying systems linked with check dams. 2,740 people in 881 households of 14 communities have sufficient water including during dry season.

Disaster Monitoring Network helps monitor water condition and provide early warning

A Disaster Monitoring Network was established in three main brooks. The "La-On-Hug-Nam-Lao" network was established with 20 teenagers from each community. These young group were trained to apply science and technologies to collect data, monitor and report every Monday on the current condition of soils, water levels and forests.

The communities also built and connected the firebreaks over an area of 103 km^2.

Promoting local knowledge and practices have been an important part in the process to complement modern technologies such as telemetering, media box, and water level monitoring. The communities have applied this invaluable local knowledge in the design of the water storage systems and forest conservation plans.

2 *Strengthen community collaboration to increase market value of agro-forestry products*

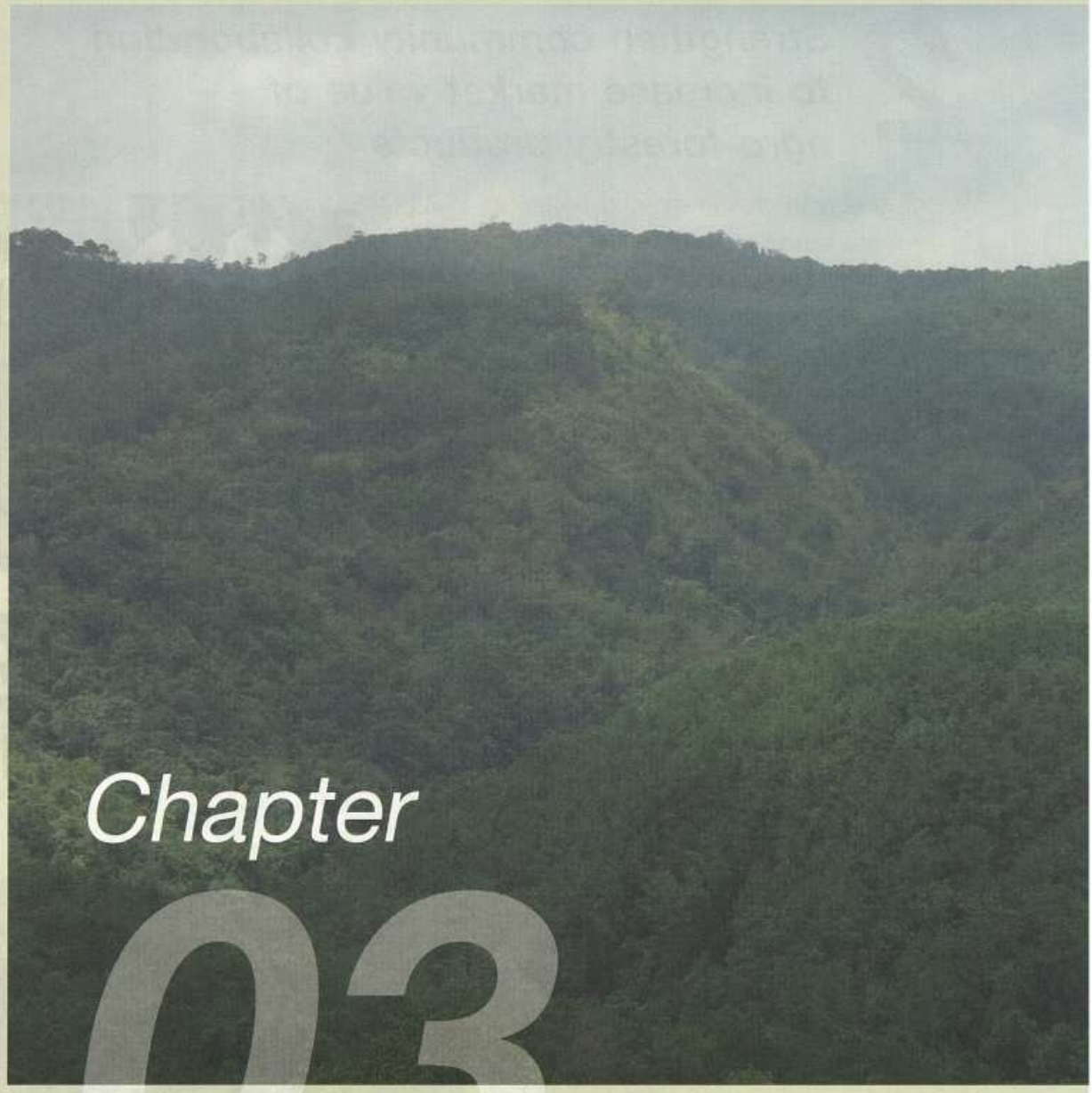
Water supply improvement and better forest management allowed the Lao River Basin communities to apply the concept of "3 Forests and 4 Benefits". The communities have shifted from monocrop culture to grow 58 types of plants such as teas, coffee and herbs, especially corn at foothills.

However, new challenges appeared. The communities now need to learn how to plan production in a way that minimizes expenditure and maximizes income. They were trained to allocate their land for different uses and develop production plans accordingly. They learned how to understand water situation reports and other warning messages to determine the crop planning as well as to record household accounts.

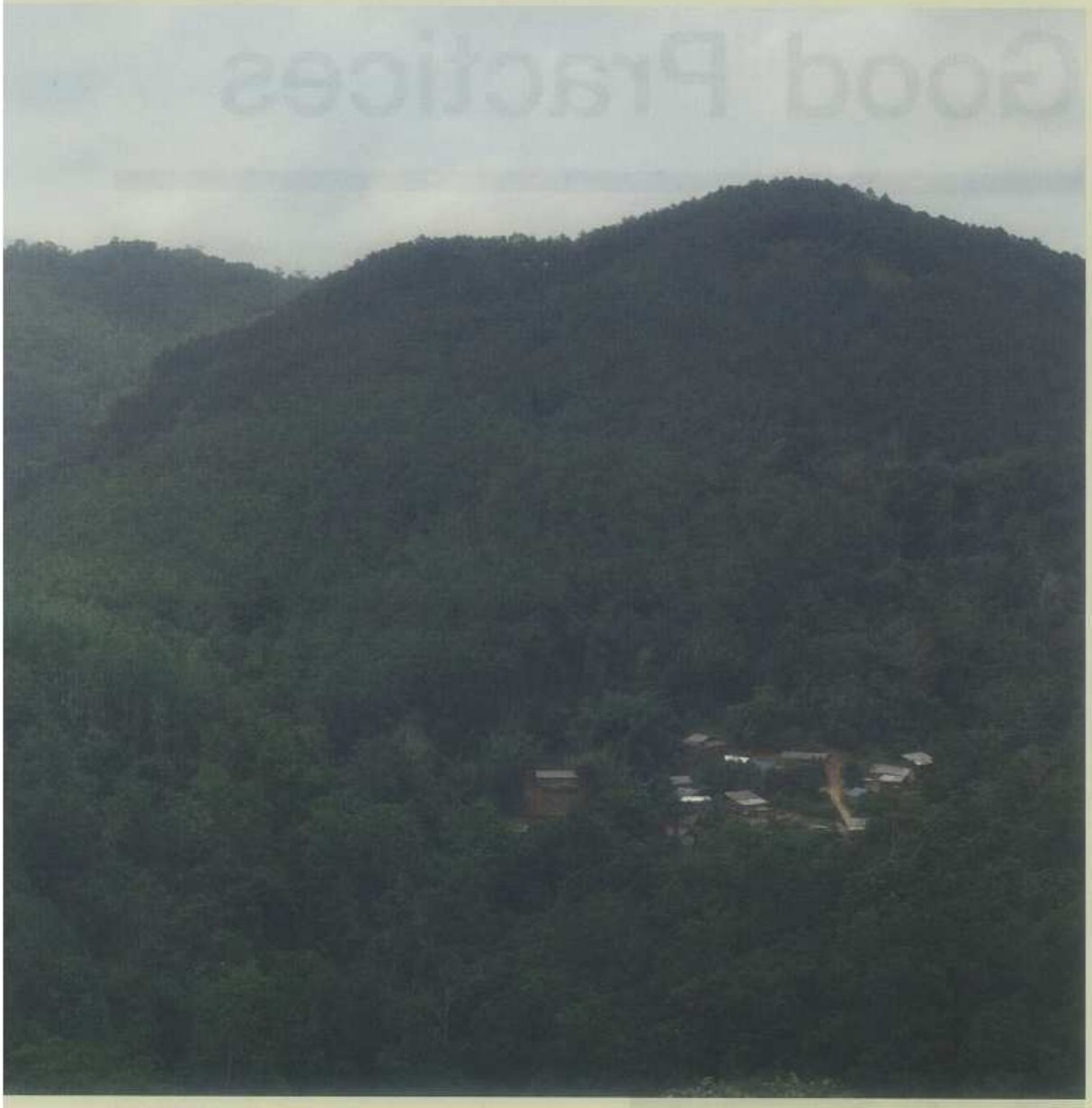
With more products, communities will be faced with the risk of oversupply. They worked together to coordinate selling to the market to maximize their product values and to deal with traders who would otherwise take advantage to push the price down.

Replication

Beginning with 10 communities in 2007, Lao River Basin Communities Network has been expanded to 41 communities in 4 sub-districts of Mae Chedi, Mae Chedi Mai, Pa Ngew and San Sali, covering the whole upstream forest area of the Lao river of 413 km^2 and 291 brooks.



Chapter 03



Suitable Crop Calendars

for Natural-Rich Life

Huai Pla Lod Community

Mae Sod District, Tak Province

Good Practices

- Build local capacity to apply science and technology for integrated water resource and forest management
- Strengthen Public-Private and Community Partnership

The Challenge

The Huai Pla Lod community of 1,013 people lives in Dan Mae Lamao sub-district, Mae Sod district, Tak province. Covering an area of 237.06 km^2 in the Salawin river basin, there is 24.74 km^2 of land use for agricultural purpose. The community uses 1.27 km^2 (5.2%) for habitat, 0.59 km^2 (2.4%) for graveyard, 6.63 km^2 (26.82%) for farming and 6.55 km^2 (26.5%) for agroforestry while preserving 9.68 km^2 (39.1%) of forest.

In the past, the Black Muser people in Huai Pla Lod Community did not value the forest where they lived. They cut down trees to grow opium, practiced monocrop and shifting cultivation. As a result, they suffered from deforestation, barren soil and regular drought. People disputed over water for consumption and agricultural production.

In 1981, when King Taksin National Park was announced, Huai Pla Lod community started to realize the need of reforestation otherwise their land would be expropriated.

However, despite community afforestation efforts, people still suffered from lack of water, soil degradation and insufficient income.

The Approach

In 2008, HAII and Utokapat Foundation introduced H.M the King's initiative in upstream forest rehabilitation and Community Water Resource Management (CWRM) to Huai Pla Lod. People were trained to apply science and technologies to map their water resources and carry out water balance analysis. They designed and developed check dam and impounding dam system to increase the water storage capacity.

Huai Pla Lod people were assisted to create maps that divide boundaries between community forest and conservation forest. The maps were used to develop an upstream forest conservation framework and regulations. The community was also introduced to the "3 Forests and 4 Benefits" to help them improve their lives in harmony with the forest. Household income started to increase as people could earn a living from the restored forest while planting vegetables and winter fruit in foothill areas, thanks to improved water resource management.

The Impacts

An upstream forest area of more than 0.8 km^2 in King Taksin National Park has been restored, benefiting 195 households and 863 people. Huai Pla Lod community forest is the most plentiful forest in Tak province. Water reservation in the upstream forest and through the check dam system can now supply 84.4 km^2 of agricultural area.

Past

Present

Villagers can generate monthly income of THB 20,000-35,000 per household. Cash flow of at least THB 14.4 million per year is generated in the community agricultural market (Muser market) with new products such as coffee, bamboo shoot, Archidendrom Jiringa, Indian gooseberry and chayote. Huai Pla Lod community have become the center of Tak province for these non-timber products.

Forest and water resource management became the way of live for Huai Pla Lod's community. People have gradually shifted to organic farming, also with the recognition of the need to protect the head of watershed.

Success factors

Building ownership of people

Community consultations helped Huai Pla Lod villagers understand the root causes of problems they faced and build consensus on their responsibility to better manage the forest and water resources. Villagers voluntarily participated in surveys and mapping of resources. They defined their own rules and regulations for water and forest management. In the process, building capacity for people to apply new technologies while promoting local wisdom was instrumental. The role of community leaders from different generations was promoted.

Stronger collaboration

Great efforts have been made to enhance collaboration between the community, sub-district government the King Taksin National Park office, and the private sector. With improved awareness of reforestation among the community, cooperation has been established between villagers and King Taksin National Park for annual plantation of seedlings for reforestation.

Good Practices

1 Build local capacity to apply science and technology

Huai Pla Lod community was trained to apply technologies such as Global Positioning System (GPS) to map water resources and water infrastructures. They designed a water resource management system from upstream to downstream.

In upstream areas, over 400 check dams were built to slow down the water flow in order to increase absorption of water by the forest. At the same time, local regulations were developed to set clear boundaries between community and conservation forest. The moisture brought by the check dams to the upstream forest helped to revitalize the plentiful ecosystem and habitat of rare wildlife: wild birds, barking deer, monkeys, and rare frogs. 22.04 km^2 of community forest was rehabilitated.

In the midstream, impounding weirs increased the water supply for agriculture and consumption by 1,013 people in 255 households.

At downstream, water is supplied for 2.39 km^2 of agricultural areas throughout the year.

In addition, the community diverts water to produce electricity via night operation of a 3-kilowatt hydroelectric power dam to supply electricity to community public areas.

People were introduced to the "3 Forests and 4 Benefits" to restore forest and maintain balance of nature while planting trees for industrial use and cultivating agricultural products for food and income.

Huai Pla Lod community forest became a source of food and usable wood for local people. The balance of nature also brings a better quality of life.

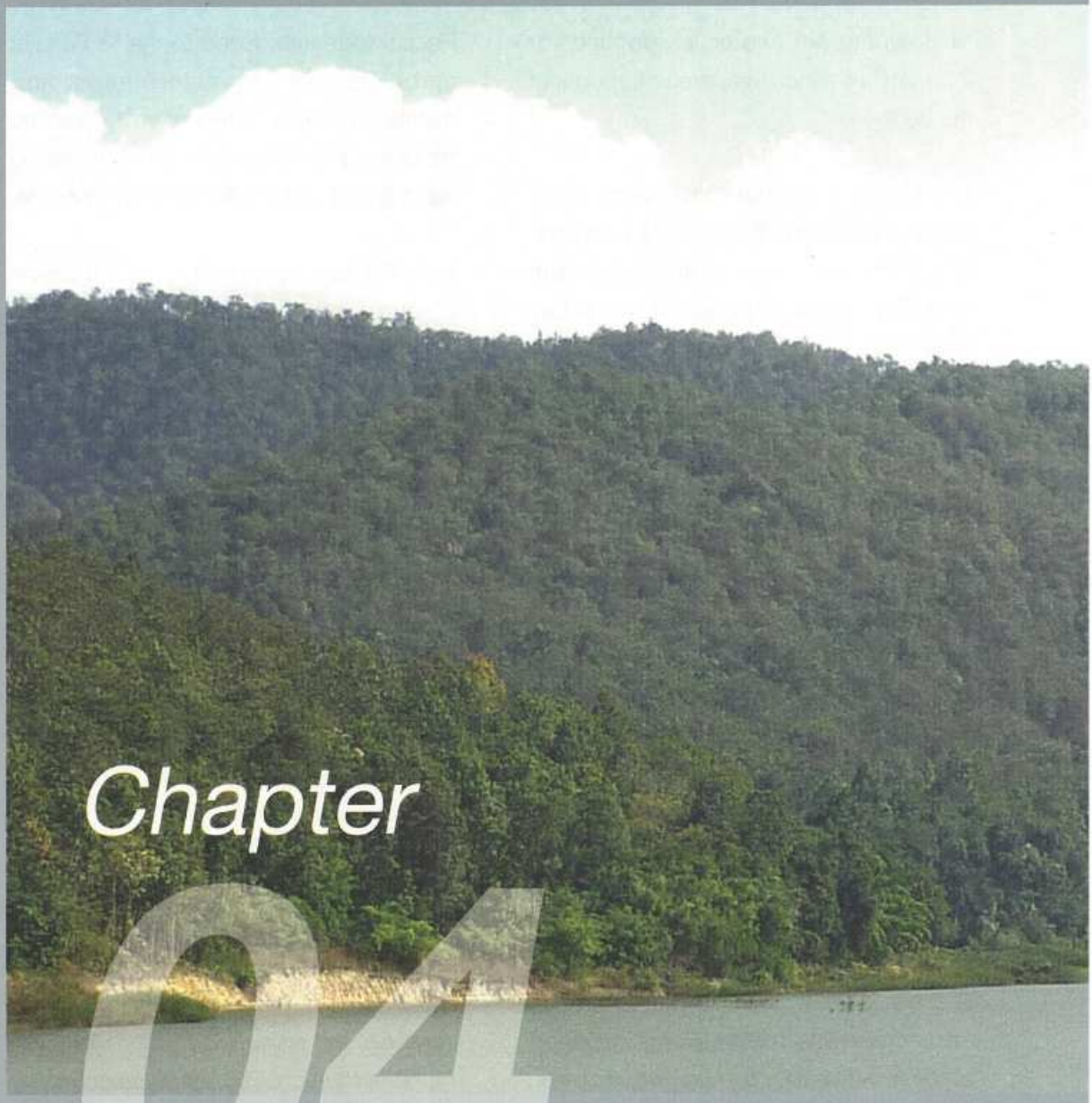
2 *Strengthen Public-Private and Community Partnership*

The Huai Pla Lod community established mechanisms to work together in managing water resources and the forest.

The community defined clear roles and responsibilities for the members, Muser, to rehabilitate and conserve upstream forest. Regulations were issued for fair and equitable use of timber products. Agreement was reached on the period of forest harvesting to allow reforestation without planting in such period. The villagers also conducted seasonal crop rotation to replace their past monoculture.

The community enterprises were established that helped villagers generate income from agricultural products and strengthened community networks.

The community collaborated with King Taksin National Park for annual plantation of seedlings for reforestation. People applied local wisdom to naturally conserve soil, water and forest. Moreover, Muser organic coffee was selected by Air Asia Airways as a premium product to sell on their flights.



Chapter 04

Farmers Manage Water to Increase Productivity

and Reduce Drought Risk

Huai Sai Community

Prao District, Chiang Mai Province

Good Practices

- Apply science and technology to improve integrated water, forest and drought risk management
- Empower community networks to foster shared responsibilities and equity for sustained results and social cohesion

The Challenge

The Huai Sai Community of 2,104 people lives in four villages in Khuan Phak sub-district, Prao district, Chiang Mai province, by the Ping River. Most of this area is dry and hilly. Huai Sai, a small river, provides water for the communities but there was lack of water for agriculture. Social conflicts occurred over water shortages.

In 1991, in response to a request from the Huai Sai community, H.R.H. Princess Maha Chakri Sirindhorn started a project to construct Huai Sai Reservoir with a capacity of 225,000 m^3 that can provide water through ditches for 0.64 km^2 of farming area. Huai Sai Reservoir Community was established to manage water distribution. However, the water management system was inefficient and water demand continued to rise for 12.68 km^2 which 4.72 km^2 of land use is for agricultural purpose. The majority of which is used for fruit crops-perennial plants 3.62 km^2 (76.7%), 0.067 km^2 (1.4%) for rice field and 1.03 km^2 (21.9%) farm crops.

Water shortage persisted. In addition, due to forest concession, the upstream forest where the main water source for the reservoir deteriorated. This led the community suffered from severe water scarcity.

The Approach

Introducing Community Water Resource Management (CWRM) to Huai Sai Reservoir community, HAII and Utokapat Foundation aimed to help the community improve water resource management and distribution. Community members learned how to analyze water balance and use technologies to identify the right locations of water pipelines to place in map for improved distribution. They developed mechanisms for land-owners to pay for the cost, learn and place the water pipes themselves, and manage water allocation to their land. At the same time, the community worked together to restore the upstream forest. A conservation map was made to set boundaries between preserved forest and arable areas. Community regulations were developed to equitably manage water resources and the forest.

Villagers also shifted from monocrop to integrated agriculture. They established groups such as rice farming, mushroom growing, and organic vegetables to share knowledge and support each other in improving production and income. The Huai Sai Reservoir Community rebuilt social cohesion and unity.

The Impacts

Past

Present

From one pilot water dispenser line that supplied water to 0.64 km^2 agricultural area in 1998. The Huai Sai Reservoir community installed 20 lines themselves, distributing water for 224 households and 3.43 km^2 of agricultural land. The system is further extended with two more lines, supplying water for a village of 336 people. The community applied technologies of GPS to clarify the routes of pipeline to identify on the map. This enables the villagers manage water resources in their area systematically. They also set rules and regulations for equitable water distribution and maintenance of the system. The challenge of drought has been tackled as water is available for agricultural production throughout the year.

Huai Sai Reservoir community's conservation map covers a total area of 10.632 km^2. Villagers protected and restored the upstream forest including forest areas in 4 communities and demarcated 7.2 km^2 of preserved area.

The shift to integrated agriculture following the New Theory has helped the communities increase their income. Rice parachute farmers can earn an average annual income of THB 40,000-50,000 per household. Household average annual income increased to THB 20,000 while annual household expenditure reduced by THB 9,600.

Success factors

Empowered community for self-management

The Huai Sai Reservoir Community was facilitated to identify and implement their own solutions such as sharing cost and responsibilities to expand the water dispenser lines that improve distribution. They were empowered to set their own governance structure such as through the Community Water Resource Management Committee, the Forest Conservation Council and agricultural groups. Based on the principles of shared responsibilities, fairness and collaboration, the community has learned together, including through trial and error. It became confident in managing the system and embarked on new initiatives such as diversified agriculture and marketing their products.

Promote continuous learning and innovation

The Youth group with their learning ability was trained to use technologies for data collection and design of water resource management system. Villagers learned not only new technologies but also crop planning and household accounting skills. Huai Sai Reservoir community was self-motivated to learn new things such as organic agricultural production and marketing.

Good Practices

1 Apply science and technology to improve integrated water, forest, and drought risk management

The application of science and technology was instrumental for Huai Sai Reservoir community to identify their own solutions.

Water outlet pipelines to improve allocation

Villagers were trained to do the survey, collect data by using advanced technologies such as satellite maps, Quantum Geographic Information System (QGIS), and Global Positioning System (GPS) for mapping. They developed a water resource account, and water balance to understand and analyze the topography. The GPS was used to indicate the position of the pipes at the right height before the water was sent through them to the farming land.

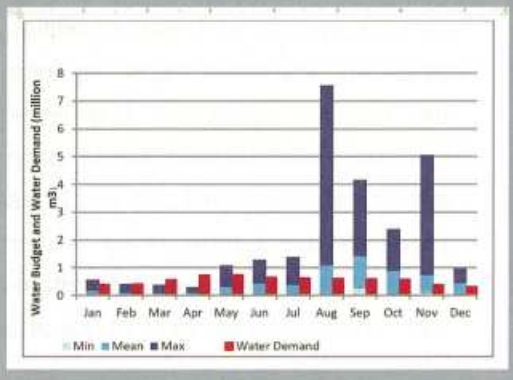


Figure 3: *Water balance analysis in Huai Sai community area*

The water balance analysis (Figure 3) shows that the average water availability is 2.5 MCM per year less than the demand, resulting in a water shortage for 7 consecutive months (January-July).

Since the Huai Sai Reservoir could only distribute water for 0.64 km^2 of farming area, in 1998, the HAII and Utokapat Foundation introduced the technology of water outlet pipelines to expand distribution.

Huai Sai villagers learned how to survey the ground and place the water pipes appropriately. Twenty water outlet lines were installed by land-owners to convey water throughout the communities and 3.43 km^2 agricultural area.

Forest restoration

Villagers applied technologies to undertake survey and develop conservation map with clear boundaries of forest to be protected and the areas for agricultural farming. They worked together to restore the upstream forest above the reservoir.

A "Forest Conservation Council of Huai Sai Network" was formed from the representatives of 7 communities. They collaboratively developed a community law and enforced it to protect the forest.

Integrated agriculture for resilient livelihood

The HAII and Utokapat Foundation introduced the Huai Sai Reservoir community to integrated agriculture under the New Theory and Self Sufficiency Philosophy of H.M. the King. Community learned to shift from monocrop of rice farming to diversified crops in different seasons. They established agricultural groups to share information and knowledge and learn new technologies such as growing mushroom or organic products.

Moreover, the villagers also learned techniques to develop crop planning and to record their households account. The agricultural groups also developed group accounting to monitor revenue. Crop planning, household expenditure and income accounts helped the groups track changes in occupation and families' income towards better economic development.

2 Empower community networks to foster shared responsibilities and equity for sustained results and social cohesion

Based on H.M. the King's philosophy of self-management and self-reliance, the HAII and Utokapat Foundation facilitated the communities to work together to strengthen their sense of belonging. The principle of shared cost and responsibilities has been well applied. Villagers who want the water line dispenser to go through their land had to pay for the cost and learn how to install the water pipes by themselves. The Community Water Resource Management Committee and heads of water pipelines were established among selected local people. These institutionalized bodies take the lead in ensuring equal water distribution, based

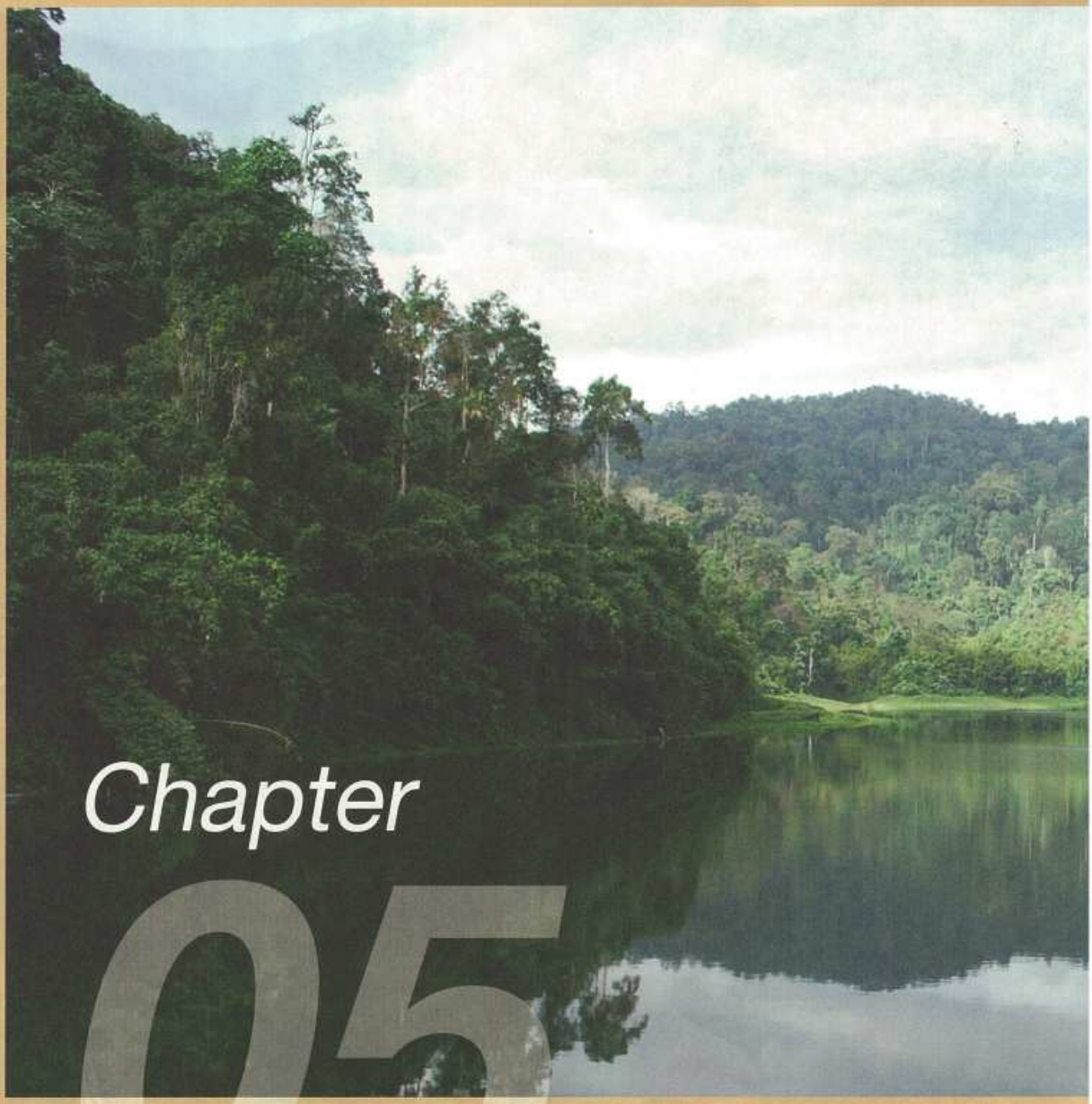
on demand and availability. Cooperation and clear division of labour were key success factors for the Huai Sai Reservoir community. Working groups were also established to take responsibility for various aspects, in consultation and with the consent of all community members. Villagers and youth were encouraged to set up their own groups for common interests.

Villagers selected their own representatives from each community to participate in the Forest Conservation Council that develop rules and regulations for enforcement of law to protect the forest.

The agricultural groups support farmers to learn the know-how and invest in different crops to increase their income as well as acting to strengthen the social bonds.

Replication

The Huai Sai Reservoir Community management model was replicated at Huai Luek reservoir where a new cooperation was created to allocate water for 220 households and 2.08 km^2 of agricultural area in two villages. A youth group of 25 members (called Yaowa Chon Rak Dee) started to collect data, prepare maps and develop water resource management system for their community.



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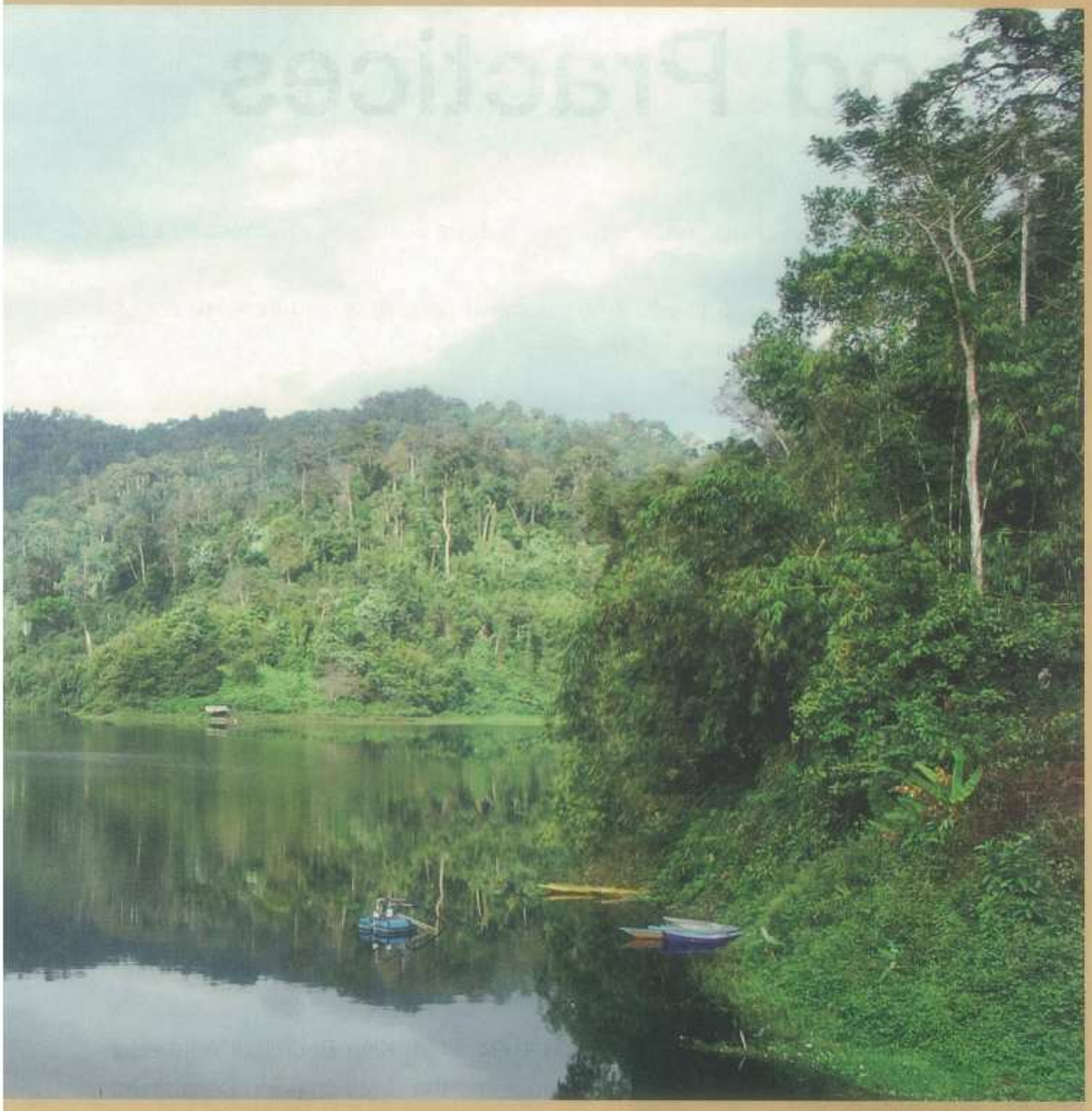


Holistic Management of Reservoir and Ponds to
Reduce Drought Risk and Increase Productivity

Thapcrist Community

Phanom District, Surat Thani Province

Good Practices

- Integrate water-related risk reduction and natural resource management for improved agriculture.
- Build community enterprises to boost collaborative agriculture and increase values of products.

The Challenge

Thapcrist Community migrated from central region of Thailand to locate in Tapi river basin, Khlong Cha Un Sub-district, Phanom District, Surat Thani Province. The total population of 1,050 people lives in an area of 15.11 km^2 which 9.36 km^2 is used for agricultural activities which majority of land use allocation comprises is the fruit crops- perennial plants and 0.18 km^2 (2%) farming.

Monoculture that was challenged by flood and drought had not provided Thapcrist people with enough food and income throughout the year.

In 1984, H.M. King Bhumibol Adulyadej requested the Royal Irrigation Department to build Khlong Bang Sai Nuan Reservoir in Phanom District. However, lacking of water management system, Thapcrist people who lived in downstream of the reservoir still suffered from water shortage during dry season. They also had to buy drinking water as the water quality is poor. On the other hand, monsoon flood kept damaging agricultural production.

The Approach

The HAII and Utokapat Foundation assisted the Thapcrist community to establish "Bang Sai Nuan Water Management Group" to improve water management and distribution. The check dam built by the community helped trap sediment and retain moisture to restore the ecosystem in the upstream forest. Water storage and distribution systems with a pond network were established to reduce flood level and store water for dry season use. The community set their own regulations to distribute water to households through outlets and spillways.

Improved water management helped farmers to shift from monocrop to integrated agriculture, following the New Theory. New partnerships, such as the Plant Genetic Conservation Project, provided local seedling. Community members also established their own enterprises to support agricultural production and trading of products. People's quality of life has been improved with increased income, clearance of debt and reduced expenses of buying the drinking water.

Past

Present

The Impacts

A reservation of 3.2 km^2 upstream forest near Bang Sai Nuan Reservoir has been improved with increased dampness and removal of weedy vines to protect the trees. The water storage system has the total capacity of 2.43 MCM. The network of 160 ponds can store 230,000 m^3.

Downstream flood risk has been reduced for an agricultural area of 0.21 km^2.

Potential loss from dry spell, estimated at THB 13.83 million has been reduced for an area of 0.27 km^2

Regulations and rules, set up by the community, fairly distribute water to 160 households for consumption and agriculture in an area of 5.76 km^2.

Improved water quality and water filters installed by the community have helped people save approx. THB 972,000 per year from buying the drinking water. The community has applied integrated agriculture, growing flowers, fruits, rubber trees and oil palm trees. Minimum annual household income has increased to approximately THB 591,000. Community Agriculture Enterprises are established to provide mutual support to farmers. The Community Flower Revolving Fund creates an annual income of THB 1.2 million for the community.

Success factors

Building capacity to apply new knowledge and skills

Acquiring knowledge on water management and learning new technologies such as satellite mapping, GPS, and telemetering was not easy for Thapcrist villagers. The HAII and Utokapat Foundation paid a special attention for training of community members and efforts have paid off. Thapcrist villagers have been able to apply the technologies to collect data, analyze water balance and jointly develop their water storage and distribution systems. Learning skills for crop planning and household accounting, the community invented innovations such as community enterprises and the Flower Revolving Fund. These show the value of capacity building to maximize potentials of farmers, who can eliminate poverty and build sustainable livelihoods.

Collaboration between community, academia and government

With support from HAII, the Thapcrist community built partnership with local government and the Royal Irrigation Department. The community was assisted in developing regulations and rules for water management and distribution, in line with government reservoir management and local government's procedures. Similar support was obtained for community enterprises and the Flower Revolving Fund. Community members received guidance, technical support for effective management of the Fund and market connection.

Good Practices

1 *Integrate water-related risk reduction and natural resource management for improved agriculture.*

Thapcrist community shows the successful integration of upstream and downstream water management that reduces flood and drought risk and supports agricultural production.

Upstream water and forest rehabilitation

The check dams were built by the Thapcrist community to trap the sediment and retain dampness for the upstream forest of Bang Sai Nuan Reservoir that is their main water resource. In addition, weedy vines were removed to protect the trees.

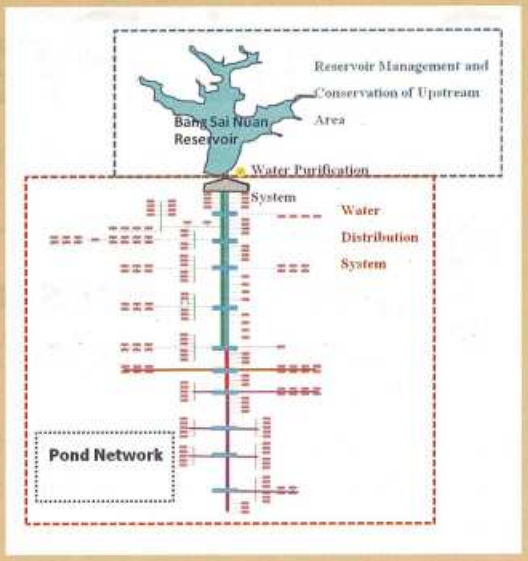
Downstream water distribution system and pond network increase water storage and reduce flood and drought risk

Water balance analysis (Figure 4) shows that water budgeting is still not adequate for water demand around 0.3 MCM during the dry season (April –May). Therefore, the reservoir water needs to be managed and distributed to agricultural areas appropriately.

A water distribution system was established to distribute water from the Bang Sai Nuan Reservoir Canal to 160 households over a total area of 5.76 km^2 through outlets and spillways.

A pond network connects all water sources and distributes water through sub-canals to be stored in 160 farmers' ponds. This helps reduce excessive flood water and stores water for dry season. The network can store a total of 230,000 m^3, enabling water for planting up to 3-7 days during dry spell periods.

An area of 0.21 km^2 is now protected from flood. Potential loss due to drought is reduced for an area 0.27 km^2.



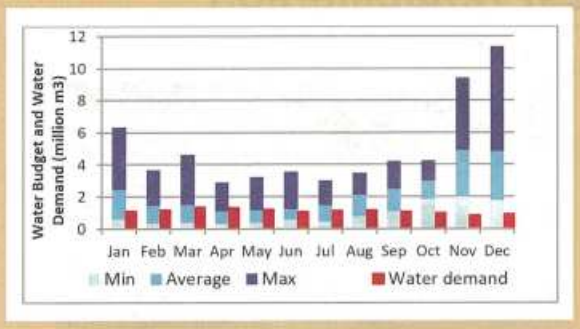


Figure 4: *Water balance analysis in Thapcrist community area*

Figure 5: *Pond networks in Thapcrist community area*

Improved water quality

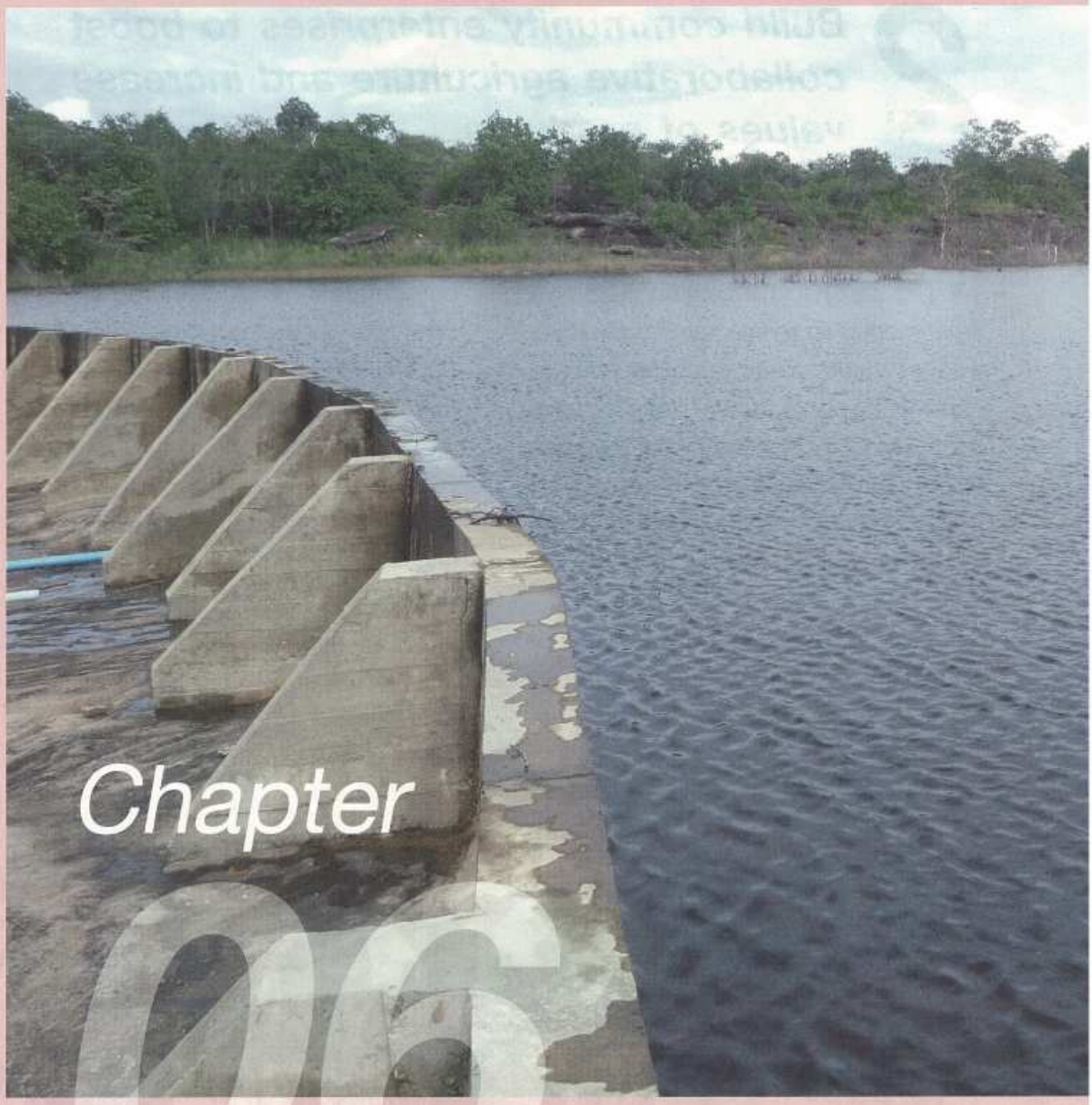
In addition, the Thapcrist community also found a solution to improve water quality. With sufficient water supply, community water purification system was installed. These provide villagers with drinking water at reasonable price and help them save money from buying the drinking water.

The community set regulations and rules to ensure equitable distribution and sustainable use of water. These regulations are realistic, practical, and fair. There are maps of water distribution and a time schedule of distribution. This has been recognized as the best practice of irrigating reservoir management in Thailand.

2 Build community enterprises to boost collaborative agriculture and increase values of products.

Better control of flood and sufficient water supply, during dry season has allowed the Thapcrist community to shift from monocrop to integrated agriculture. Higher value crops such as flowers, ornamental plants, rubber trees, oil palm trees, and others bring higher incomes. An annual minimum revenue of approximately THB 591,000 per household helped people clear their debts and have better livelihood.

Learning from their positive experience with the water management group, the Thapcrist community established Community Agriculture Enterprises to help them collaborate in production and increase the market value of products. The "Flower Revolving Fund" is a good example. The Fund helps Thapcrist farmers to save money and obtain necessary capital to invest in production. It also helps farmers sell the flowers together, increasing their price bargaining power. The Fund creates an annual income of THB 1.2 million and saving of THB 110,800.



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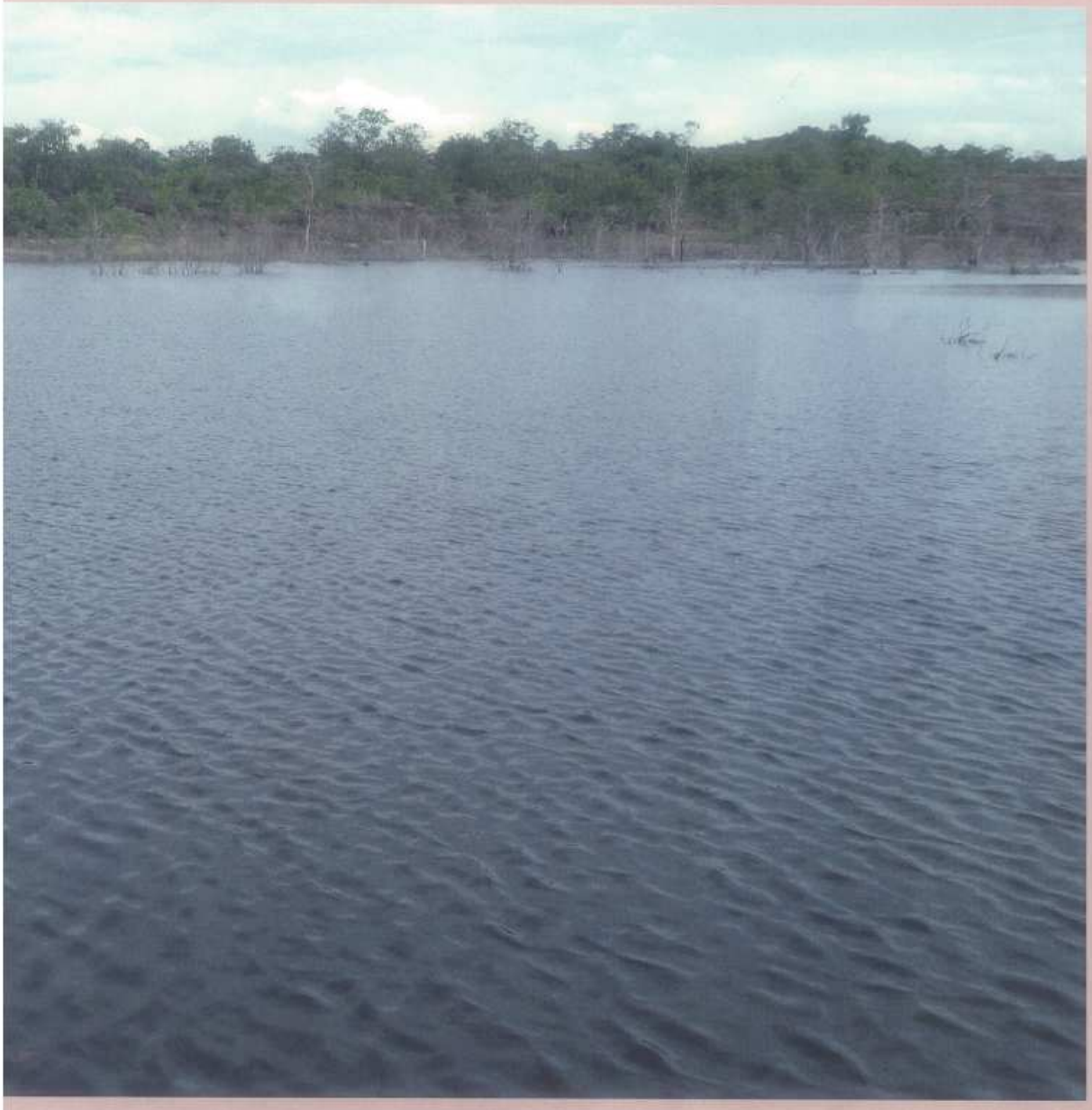


Community Based Technologies

for Flood and Drought Resilience

Pha Chan Community

Pho Sai District, Ubon Ratchathani Province

Good Practices

- Promote community water resource management innovations
- Apply integrated agricultural production to utilize water supply

The Challenge

The Pha Chan community is located in Samrong sub-district, Pho Sai district, Ubon Ratchathani province, by the Mekhong river basin which covers 51.35 km^2. The total population is 1,174 people. 1.53 km^2 of land have been used for agricultural purpose. Land use comprises of rice field (1.52 km^2 or 99.6%) and fruit crops-perennial plants (0.0048 km^2 or 0.4%).

The community is located between the Pha Taem National Park and Mekong River bank. With a geology of alternating stone and shale mountain, retaining water before it drains to the Mekong river was a great challenge. Mono rainfed rice cultivation and fishery were the main source of living for Pha Chan community people. For over 20 years, villagers suffered from water shortages during dry season (November-May). Poor villagers had to pump water from groundwater or buy drinking water to survive. Individual attempts for groundwater suction further challenged water resources. On the other hand, overflow flood from the Mekong river during rainy season damaged rice fields.

The Approach

Applying Community Water Resource Management (CWRM), the HAII and Utokapat Foundation supported Pha Chan community in combining local wisdom and modern technologies to identify their own solutions for their multiple water challenges: how to reserve and equitably distribute water for household consumption and increase water availability for agriculture, especially in upland areas.

Indigenous knowledge was used to establish a reservoir system of two main dams that connect with 7 community dams in 5 brooks to store floodwater for use during the dry season. Local innovation of an "Air-ware" system was developed to increase air pressure for delivering water from lower to higher grounds through a long distance. Pha Chan community CWRM Committee was established. The Committee defined water use zones, developed regulations for household consumption and defined responsibilities for maintenance of the system. Villagers invented household water saving models such as reuse of water from bathing and laundry. Water consumption was reduced by 50%. They also shifted to integrated agriculture, maximizing land around their houses for different crops. Secondary vegetable crops along the Mekong river bank during dry season generate higher cash income with less water demand.

The Impacts

The two main dams with total capacity of 68,000 m^3 provide water for consumption by 151 households throughout the year and supply water for 0.92 km^2 of agricultural land, benefiting 55 households. Seven community dams with a capacity of 6,502 m^3 protect 44 households and 0.65 km^2 agricultural area from flood. On the other hand, water is provided for dry season agricultural production by 76 households in an area of 1.25 km^2.

Present

Past

Pha Chan community villagers save THB 24,000 per year from water suction or buying the drinking water. Household water saving models also reduce the household expenditures for water by THB 1,200 per year. More crops doubled the income while integrated agricultural techniques and household accounting helped reduce expenditures by THB 14,000 per year. Dry season vegetable farming by 80 households along the Mekong river bank from November to February brings an annual income of THB 6.6 million.

Success factors

Combining local wisdom with innovation

The Pha Chan community used modern technologies and their indigenous knowledge to devise innovative ways to improve water resource management and reduce flood and drought risk. This ranged from design and implementation of a reservoir system, to use of air pressure to push water from lower to higher ground, to model for household water saving. This is the result of the due respect to and encouragement of community people to use their indigenous knowledge of their natural resources base and local practices.

Empower community for self-management

Active participation of communities and leadership of the CWRM Committee were instrumental for the success in Pha Chan community.

With trust and respect of the community, the CWRM Committee managed to reinforce community regulations and rules for water use and management. Responsibilities were defined for community members for the maintenance of water storage and distribution system to ensure its effective operation and fair utilization. The committee also effectively promoted community collaboration for more productive agriculture.

Good Practices

1 Promote Community Water Resource Management Innovations

Pha Chan community's specific geological condition of mixed stone and shale mountain required locally suitable approaches to water resource management. More importantly, the community was lacking of water management and water reservation system despite the water balance analysis showing that the quantity of water budget is sufficient to water demand for all year.

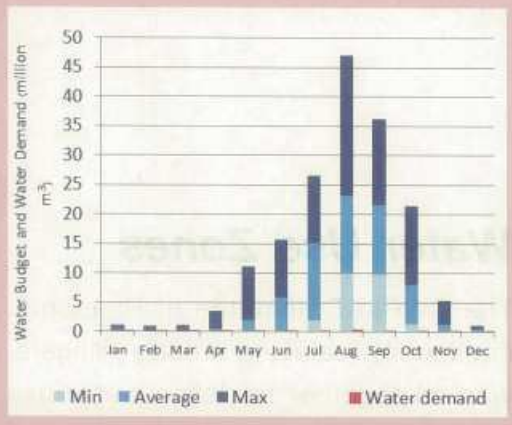


Figure 6: *Water balance analysis in Pha Chan community area*

Recognizing this crucial need, the HAII has put a special focus on maximizing local knowledge and wisdom while introducing science and technologies to help the communities identify their own solutions.

Wang E Rang1 Dam

Wang E Rang2 Dam

Community reservoir system

Villagers learned how to use GIS maps, GPS, and other tools to undertake survey and estimate water balance. They were also facilitated to share their own knowledge of the natural water flows, weather patterns as well as types of soil in different zones of the village. While contributing to the building of the two big dams, the communities identified locations and built the 7 dams on the 5 brooks, using their local knowledge.

Air-Ware system

Local communities invented the "Air-Ware" system that uses air pressure to push water from lower to higher ground, saving energy for water pumping.

Water Use Zones

The CWRM Committee of Pha Chan community, selected among villagers, worked together to define water use zones, drawing on their knowledge of the population, agriculture activities and water demands.

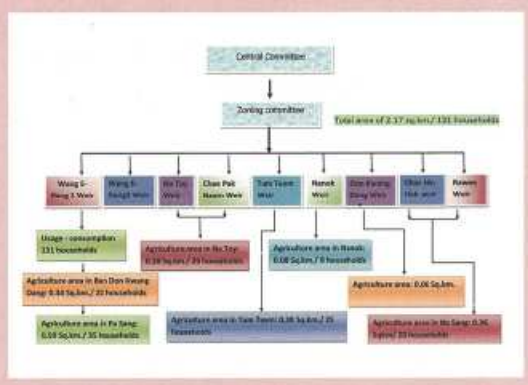


Figure 7: Water Distribution Plan

Household Water Saving Models

Understanding Pha Chan community's culture and water consumption habits, the CWRM Committee promoted Household Water Saving Models. This encouraged families to come up with innovative ways of saving water in household uses. The models helped the community save the water consumption over 50%.

2 *Apply integrated agricultural production to utilize water supply.*

With improved water supply and household water saving models, additional crops during the dry season became possible for Pha Chan community villagers. Learning the New Theory, the villagers allocated their farm land and utilized land surrounding their houses for different crops. They shifted to vegetable and other cash crops that demand less water but provide better income. They prepared a crop planning and managed household accounting to monitor investment and income.

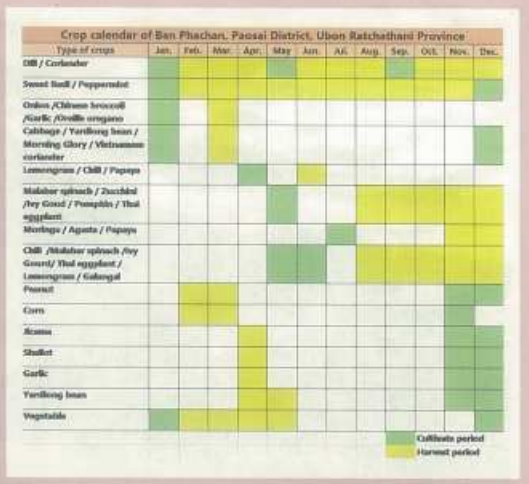
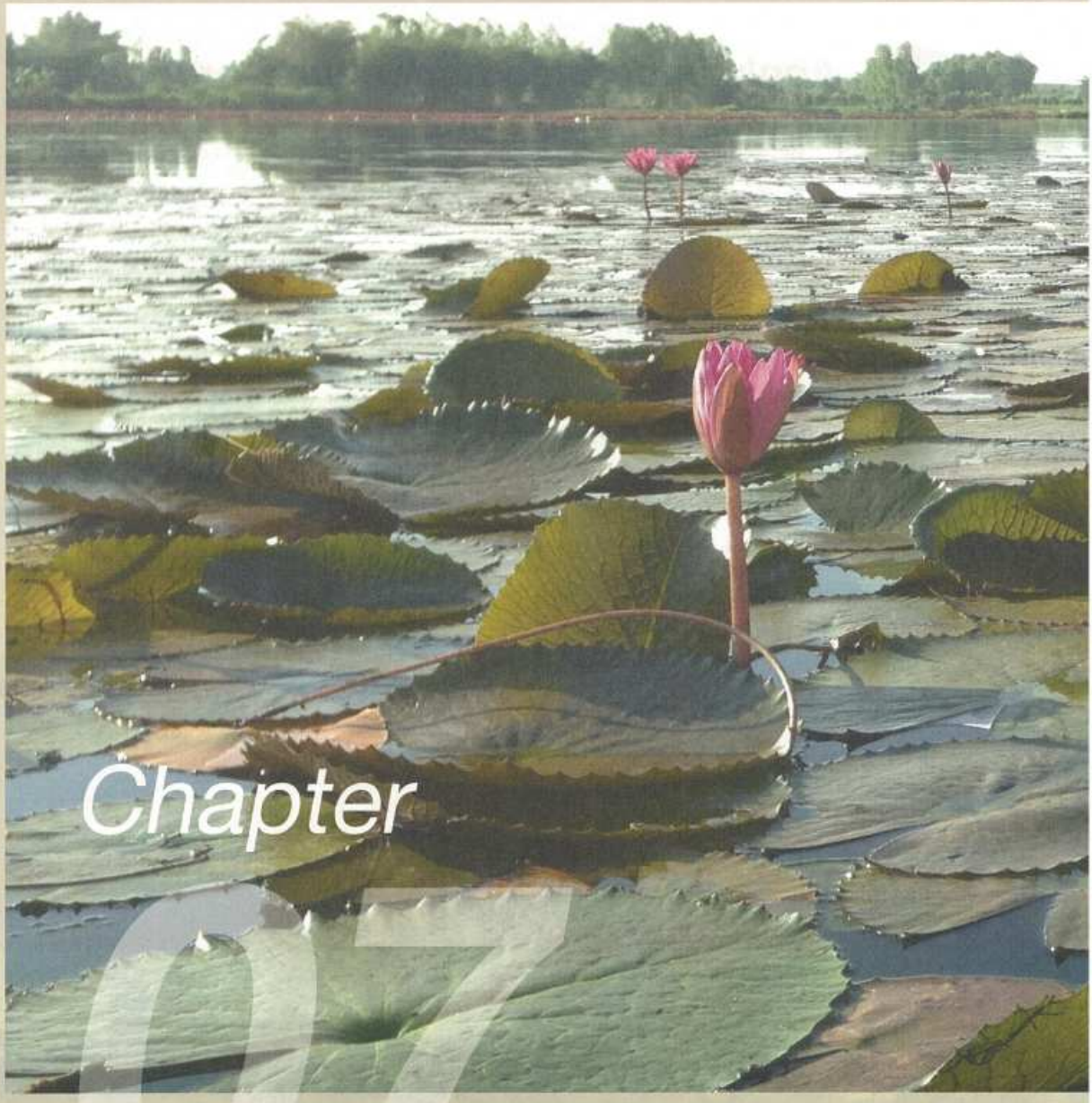


Figure 8: *Crop Planning*

The Mekong river bank was also utilized for cultivation. Vegetable farming in the Mekong river bank provides a significant income for the community.



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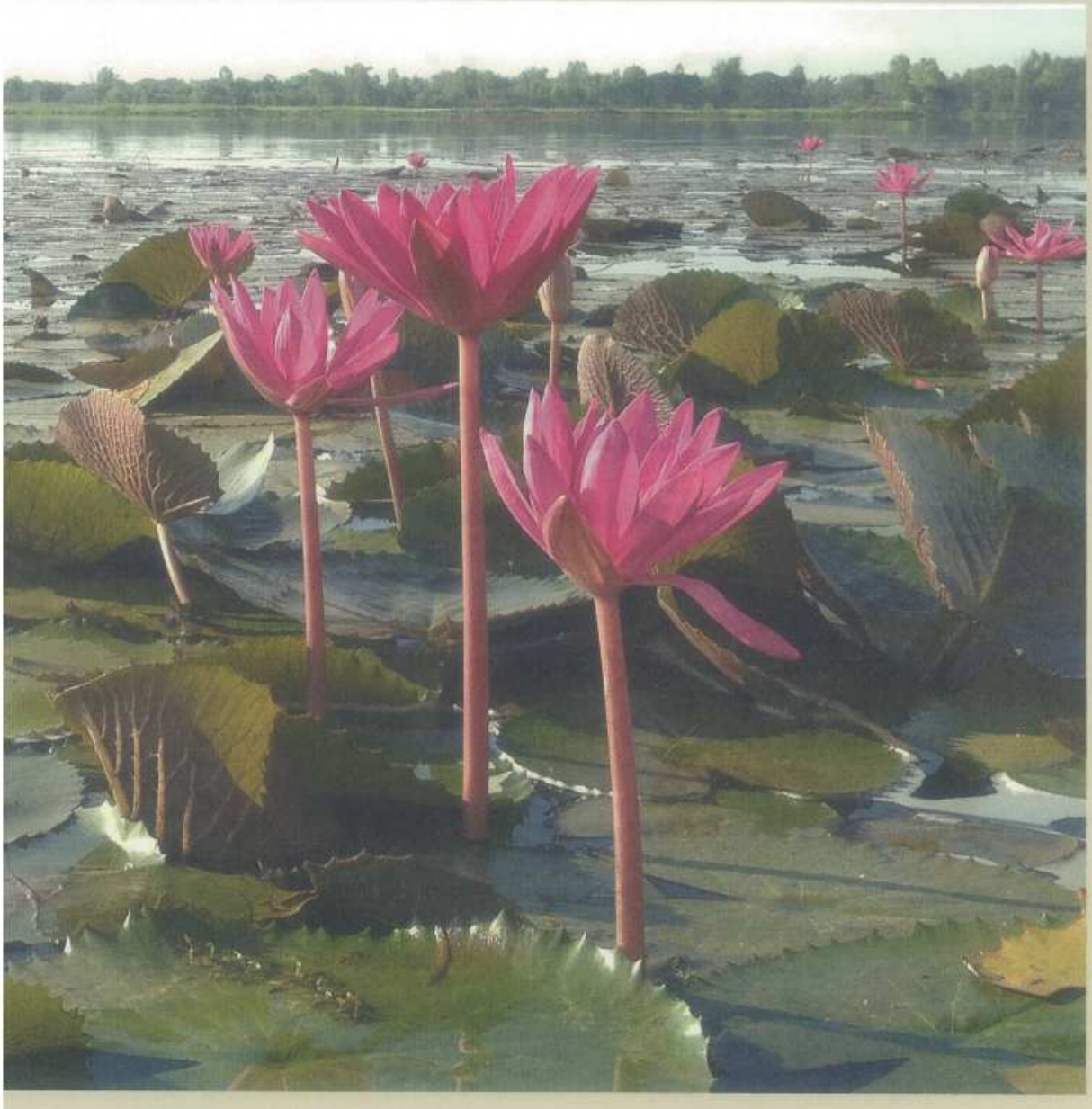


Tourism Blooms after Community

Build-Back-Better Habitat

Wiangkuk Sub-district Community

Mueang District, Nong Khai Province

Good Practices

- Reduce disaster risk through ecosystem restoration
- Build community ownership for expansion and sustainable results

The Challenge

The Wiangkuk Sub-district community is located in Wiangkuk sub-district, Mueang district, Nong Khai province by Mekong river basin. Here 6,112 people live in an area of 15.44 km^2, while the area of 5.65 km^2 is utilized for agriculture activities. 81.0% (or 4.58 km^2) of the land is used for rice fields, 16.0% (0.90 km^2) for farm crops, 2.6% (0.14 km^2) are fruit crops. Perennial plants and vegetable crops account for 0.02 km^2 (0.4%).

Wang Bua Daeng (a red lotus pond), locates in Wiangkuk and Pa Ko Sub-districts, previously was a wetland ecosystem (or Pa Boong-Pa Tham as called by local people). It was originated water flowing from Phu Kao-Phu Phan Kham Mountains through small to large swamps before draining into the Mekong River. The ecosystem was rich with many species of fish, bird and water plants.

However, the abundant ecosystem of Pa Boong-Pa Tham forest was lost. In upstream areas, forest was cut off for rice production. In 1958, the construction of highway 211 invaded the natural water flow. In 1966, a great amount of water hyacinth took over red lotus in Wang Bua Daeng pond. No maintenance of brooks and lack of drainage system caused 30 inundation days in the area during flood season. At the same time, shallow water caused by sediment and weeds reduced the efficiency of water storage and made water dry up rapidly in dry season. Local fish such as the giant snakehead, clown knifefish, and featherback fish disappeared and were replaced by alien species such as the mango fish and seven-striped barb. For more than 40 years, recurrent floods and droughts had challenged Wiangkuk Sub-district people, who had to rely on government aid, to restore Wang Bua-Daeng.

The Approach

In 2011, with the HAII and Utokapat Foundation's support, Wiangkuk sub-district community adopted Community Water Resource Management (CWRM) to restore the ecosystem. More than 5 kilometers of canal around Wang Bua Daeng, brooks and levee were dredged to increase water storage capacity and to link water sources. The water inflow and outflow network system helped drain floodwater to the Mekong River and retain water for agriculture in dry season. Flood impacts were reduced while there was sufficient water supply throughout the year. Local dredging methods were applied to maintain water level while protecting the ecosystem. Swamp boundaries were clearly defined to prevent invasion and build-back-better habitat. The community also established Mekong river fish spawning and restored local fish such as the giant snakehead and feather-back fish.

Past

Present

The Impacts

With improved drainage system, Wiangkuk Sub-district community reduced the number of inundation days during flood season from 30 to 15 days. Flood impacts have reduced for 2,000 households and 4.8 km^2 agricultural fields in 4 sub-districts of Phra That Bang-Phuan, Ban Thon, Pa Ko and Wiengkuk. Improved water supply is provided for an agricultural area of 19.91 km^2. Local people also increased agricultural production area by 0.56 km^2.

The Wang Bua Daeng ecosystem has been restored. The massive of red lotuses have been reoccurred. Gradually, local birds and waterfowl such as the water goose, open-billed stork return to the area. This includes Mekong river indigenous species such as the clown featherback fish which is listed in the IUCN Red List of Threatened Species[3]. Every year from November to February, millions of lotus flowers stretch above the water reflecting the incomparable picturesque scenery and the rich history of Wang Bua Daeng. Lotus blossoms attraction increase tourism, bring a new source of income for local communities. The local fishery are placed for additional income for community. Average annual household expenditures were decreased by approximately THB 6,000 whereas annual income was increased about THB 118,000.

Wiangkuk Sub-district community have solved their 40 years challenge of recurrent flood and drought. They have also restored the valuable ecosystem of Wang Bua Daeng, which is significant for the whole ecosystem of the Lower Mekong River Basin - home to more than 60 million people from Lao PDR, Thailand, Cambodia and Vietnam.

[3]IUCN Red List of Threatened Species, Guiding Conservation for 50 years, 2012.
Source: http://www.iucnredlist.org/details/181056/0

Success factors

Awareness of ecosystem-based disaster risk reduction

Wiangkuk Sub-district community suffered from annual floods and droughts for more than 40 years. They have also seen the link between degradation of natural water flow, upstream forest and swamps and increasing disaster impacts that affected their life and livelihood.

This awareness was instrumental for local community to change their mindset and decide to work together to restore the ecosystem as the way to reduce flood and drought risks. This approach has proven successful.

Cooperation between community network, local government and the private sector

Local community played a leading role in every stage of the process. They also established collaboration with local government and public organizations in the area. Royal Thai Army, which has the necessary equipment and labour force, has supported the dredging of the canals.

Good Practices

1 Reduce disaster risk through restoring the ecosystem

Recognizing the link between poor water resource management, ecosystem degradation of Wang Bua-Daeng and flood and drought problems, community worked to identify the solutions to restore the Wang Bua-Daeng habitat. They learned to map their water resources and water structures, using decision-making support equipment such as telemetering and echo sounder for water level monitoring. Water balance analysis (Figure 9) showed insufficient water for 4 consecutive months from January to April with a total water shortage of 100,000 m^3 despite the fact that the average annual water supply is greater than demand by 2.8 MCM. This pointed to the need to increase water storage potential in the area.

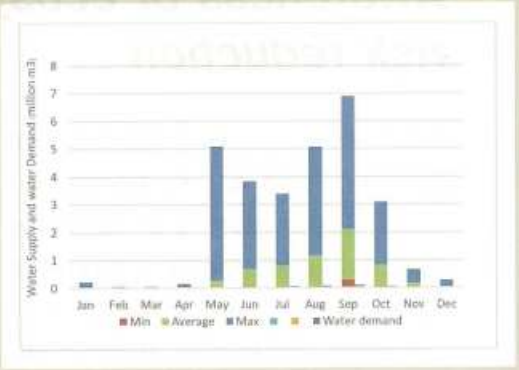


Figure 9: *Water balance analysis in Wang Bua Daeng community area*

Hence, CWRM plan was developed, indicating the channels, inflow and outflow network system and levee to be improved.

Map of channels, inflow and outflow network system and levee

The canal around Wang Bua Daeng and brooks were dredged in phases, connecting water sources in order to improve the inflow and outflow network system.

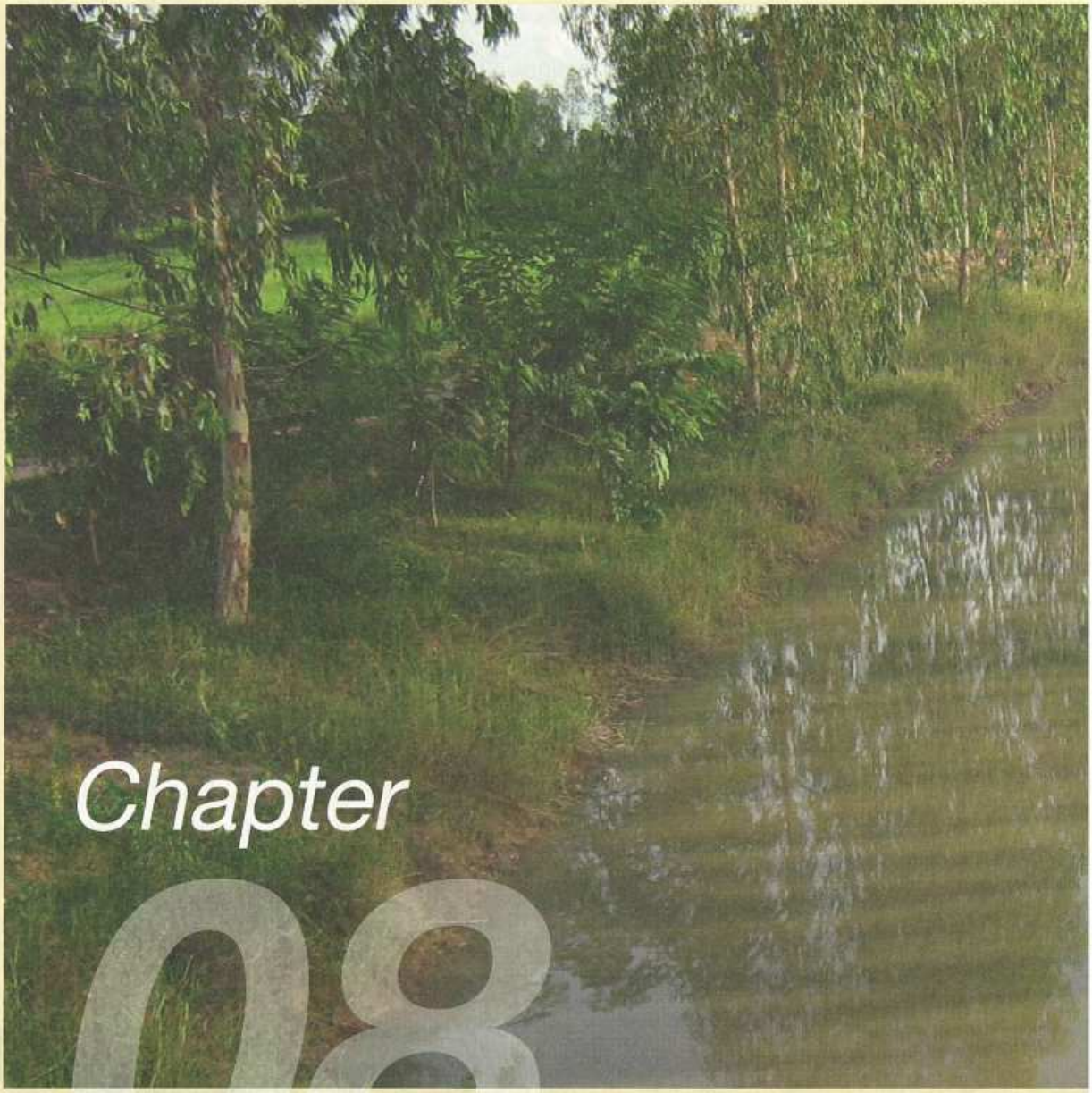
Community worked together to define clear boundaries of the swamps to prevent intrusion. Deep canals surrounding the swamps were dredged to ensure maintenance of water level in the inner area of the swamps and to increase water retention areas that are connected with other ponds and local water sources. The dredged soil was used as levee to prevent the flood season overflow as well as for the borderline of the public swamp areas. At the same time, build-back-better habitat took place.

2 *Build community ownership for expansion and sustainable results*

Community-established networks have been instrumental in disseminating information and engaging other communities. In 2011 only 2,650 meters of the canal around the Ben swamp was dredged to link with a pumping station. With the network development plan, the CWRM Committee of Wiangkuk Sub-district engaged other sub-districts.

In 2012, the network was expanded to Pa Ko sub-district. 2,720 meters of the canal around Wang Bua Daeng pond were dredged up to increase water storage capacity.

In 2013, the network was expanded to Phra That Bang-Phuan sub-district, the Huai Phai Ban brook was dredged up for 620 meters for distribution and restoration system. From this year, plenty of red lotuses grew in Wang Bua Daeng.



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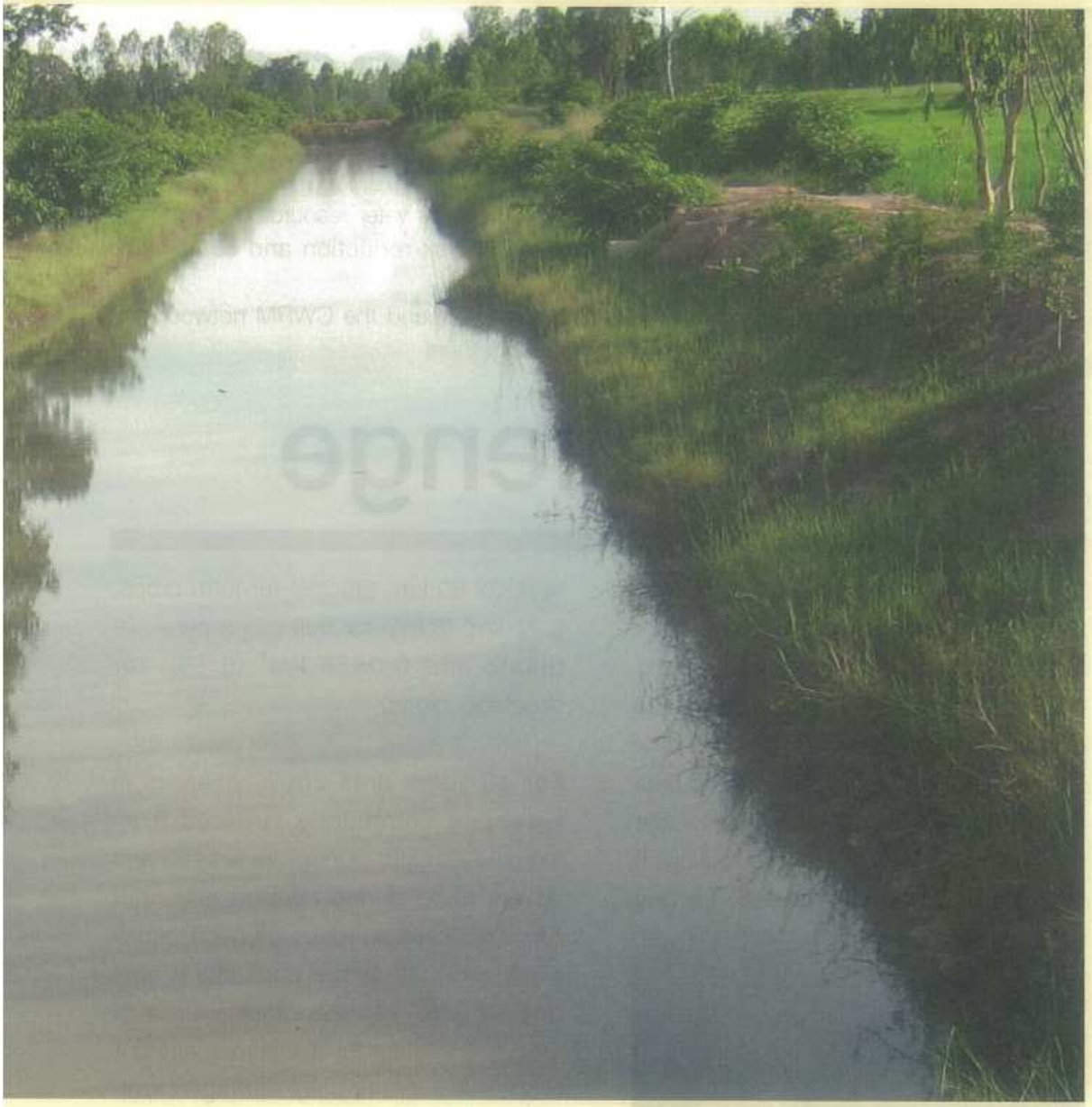


Hardy Community Builds 'Canal Street'

as It Adapts to Climate Change

Limthong Community

Nang Rong District, Buri Ram Province

Good Practices

- Empower community to apply science and technology in water resource management
- Integrate water resource management, disaster risk reduction and sustainable agriculture for resilient livelihoods
- Promote community leadership and innovations to expand the CWRM network and enhance cooperation for natural resource management

The Challenge

Limthong community and its community water resource management network locate in 3 sub-districts (Nong Bode, Chum Saeng and Thung Saeng Thong) of Nang Rong district, Buri Ram province, by the Mun river basin. Covering an area of 113.9 km^2, 15,788 people here use 93.03 km^2 for agricultural production. It consists of 56.90 km^2 (61.2%) for rice field, 32.80 km^2 (35.2%) for farm crops, 3.27 km^2 (3.5%) for fruit crops-perennial plants and 0.0528 km^2 (0.1%) for vegetable crops.

For 40 years until 2007, villagers in Limthong community suffered from extreme drought during dry season and severe flood during rainy season that damaged houses, roads and agricultural production. A rainfed agricultural area of 5.92 km^2 was the main source of food and income for the community but crops were continually damaged with very low productive yields of only 10 buckets of rice per 0.0016 km^2. As a result, household debt was rising and villagers migranted to seek income and a better life. There is a proverb "Pounding water to survive in Buri Ram" (Thai idiom: Buri Ram villagers have to gather dirt mud and pound it to extract water for consumption).

The Approach

In 2006, HAII and Utokapat Foundation introduced the concept of Community Water Resource Management (CWRM) in Limthong community. Rooted in the belief of self-reliance, HAII facilitated community joint thinking and working together while transferring knowledge and technology for villagers to analyze, develop, and implement CWRM solutions and more resilient agricultural production. The community was supported to apply technology (i.e. satellite image, GPS etc.) to analyze water flow and balance, and develop a water resource map. The innovative water solutions, such as Monkey Cheek and the Pond Network System, were implemented to reduce flood in rainy season and increase water storage in dry season. "Canal streets", were used as a waterway and a distribution system adopted, which conveyed floodwater retained in canal street to Monkey Cheek ponds. Moreover, community-based agriculture is applied to better use farmland, strengthen crop planning and set up cooperatives for mutual support of farmers in planting, distribution, and selling.

Increased water storage supported agricultural production in the dry season, allowing integrated agriculture and a 2.5-fold increase of household income.

Since we work with HAII and Utokapat Foundation, we have learned ourselves what were water problems and how to find solutions. When everyone cooperated with each other, we succeeded in solving the problem and have better living.

Mrs. Sanit Tipnangrong, villager of Limthong community.

The Impacts

The 42.2 kilometers of water canals that connect with a network of more than 100 water retention ponds and farmers' ponds have increased water storage by 1.16 MCM. There is enough water supply for 78 km^2 (or 68% of the total 114.5 km^2) of agricultural land. An area of 11.76 km^2 is now fully protected from flood and drought while the risk of these disasters is reduced in another 21.34 km^2.

Past

Present

This is significant as a climate change projection[4] shows that the Mun River basin, the main source of water resources for districts in Buri Ram province, will generally experience a shorter rainy season and longer dry season by about 2 months.

Since runoff management has been developed, local flood and drought has not occurred. Limthong community farmers have been able to shift from monocrop to integrated agriculture and increase the added-value of their agriculture to THB 9.2 million per year. Household income has increased by 2.5 times and the value of assets 1.5 times. Seeing these changes, people who had migrated have returned for a better life in their own land.

[4]Impact of Climate Change on Water and Wetland Resources in Mekong River Basin: Directions for Preparedness and Action, by IUCN and Southeast Asia STRAT Regional Center, 2003

Success factors

Understanding the local context and availability of information

The topography studies collected by HAII show the runoff direction from high area to Limthong community which is proofed by actual flood in the area. More detail sources have been conducted by villagers using trained technologies from HAII and stored results in GIS. Validated through community surveys and analyses, the studies also guided the technical design of the most appropriate Pond Network System, Canal Street structure and sustainable agricultural practices.

Building trust

Trust was built among community, experts, local government and other stakeholders through open discussions, developing a shared understanding and transparent decision making mechanisms. Building communication, facilitation and problem-solving skills of project coordinators who were selected from the community was important to ensure effective communication and information sharing between community, local government and other stakeholders. Through the process, local government better considered the community's views and partnerships with NGOs and the private sector in its decision making.

Good Practices

1 Empower community to apply science and technology in water resource management

In the initial stage, it was difficult for some group of villagers to learn and understand the new technologies. The HAII then focused on basic training with observations of how different groups of people learned and how they could help each other.

The HAII encouraged villagers to discuss their problems to identify root causes and solutions. Local wisdom was promoted. For example, elderly people were facilitated to provide information on past rainfall and water use to help the community understand the water shortage problem they faced. At the same time, this helped the HAII expert team validate the scientific analyses undertaken as preparation for the project.

For the first time, Limthong community villagers were trained to use technologies such as Global Positioning System (GPS) receivers, a telemetering station, satellite images and maps to carry out survey, collect data and undertake important analyses such as water balance, area-based analyses and water resources mapping themselves.

Water balance analysis (Figure 10) shows that there is a potential massive amount of rainfall that may flooded the community during rainy season (July – October), but people still facing water scarcity problems during dry season.

The building of water retention ponds for storage and the linking of water sources will be needed to reduce flood and increase supplies and storage for dry season.

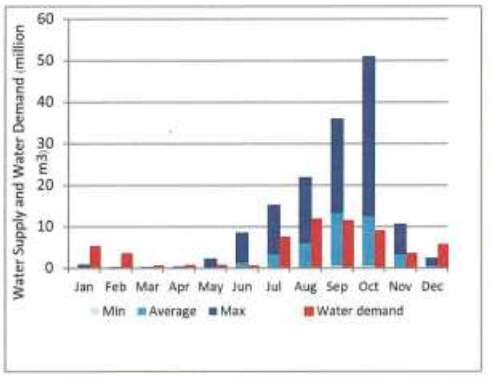


Figure 10: *Water balance analysis in Limthong community and networks area*

Regarding this, the HAII experts provided a simple infrastructure design that was suitable for the geo-social condition of the village. The work process was also carefully designed to enable the community to best use their local knowledge and experience.

These were instrumental for the community to jointly develop the Pond Network System and Canal Street to store excess flood for irrigated agriculture production in dry season.

Pond Network System

A network of ponds was designed and developed to connect flood channels with Lum-mard (the major waterway in the region, located in lower Mun River basin connected to Mekong River). It consisted of 61 water retention ponds (known in local term as "monkey cheeks") that serve as water retention before it runs through to agricultural area, sub-canals and finally to more than 50 farmer's ponds. The network expansion has been promoted by villagers themselves.

This Pond Network System serves as a water reservoir for use in dry season. Vetiver grasses were planted to trap sediment, which provide a valuable source of nutrients for agricultural production.

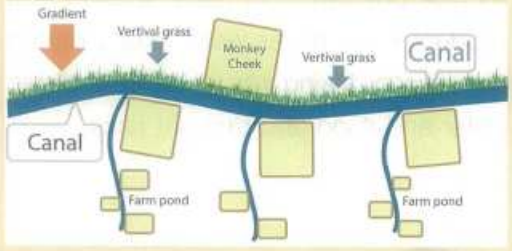


Figure 11: Overflow-trapped canal and pond network

Canal Street

The Canal street structure was introduced to the villagers as waterways to divert floodwater to the retention ponds. This helped reduce flooding both in household and agricultural areas.

2 Integrate water resource management, disaster risk reduction and sustainable agriculture for resilient livelihoods

H.M. the King's New Theory under the Sufficient Economy Philosophy encourages self-reliance of farmers through integrated practices and farmers' cooperation. This approach encourages division of farmland for different purposes (to store rainwater, for agriculture, etc), management of water and other natural resources and sustainable agriculture.

Limthong community villagers were facilitated to improve crop planning such as rice plantation in rainy season and production of fewer water crops during dry season, taking into account available water and flood and drought risks.

As a result, household expenditures are decreased whereas incomes are increased. Water is available throughout the year. Cooperation among farmers was promoted by setting up groups with common interests or a cooperative to facilitate collaboration in planting, distributing and selling the products. Knowledge is shared and best practices are promoted for replication.

3 Promote community leadership and innovations to expand the CWRM network and enhance cooperation for natural resource management

Community ownership and leadership, supported by local governments and other stakeholders, was the key. Villagers were willing to contribute their own land for the pond network. Other villagers compensated the formers with the same size of agricultural land to help them maintain production and income.

A CWRM Committee comprising local members has been set up under local government body to implement and maintain the network in Limthong community.

The project coordinator was trained in project management and voluntarily took

on responsibility for coordinating with HAII, the community, and related public and private sectors, monitoring the water level situation and reporting the progress.

The involvement consisted of youth networks such as "Look-Ling" (baby monkey) and "Thin Thong" (golden land), local governments and other stakeholders. In addition, the HAII connected the community with the private sector such as the 'Coca Cola Foundation' that continues to provide financial supports to the community.

Seeing the benefits, other communities expanded the network significantly (see Figure 12). Starting with an area of 5.9 km^2 in Limthong community, involving only 15 households, it has become an integrated network at community, sub-district and district level with nearly 300 km^2 and benefiting more than 2,000 households over several years.

In five years, the CWRM network has protected more than 16 km^2 from flood and drought saving a total THB 63 million (see Figure 13). It reduced the risk of these disasters in another 20 km^2. The sharing of farmers' own experience, networks (such as youth), local champions as well as NGOs have played a critical role in this self-expansion of the CWRM network. The network has also strengthened cooperation between community members and improved water resource management.

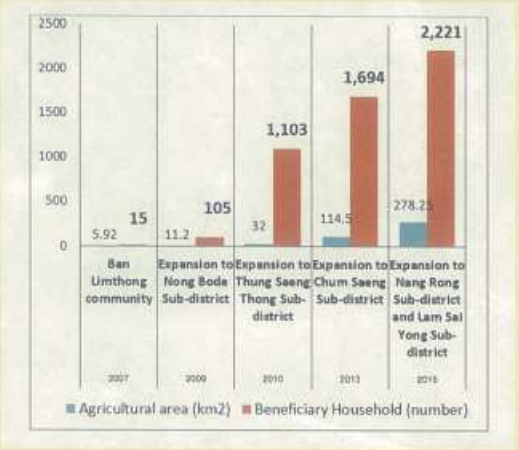


Figure 12: *Expansion of CWRM Networks of Limthong*

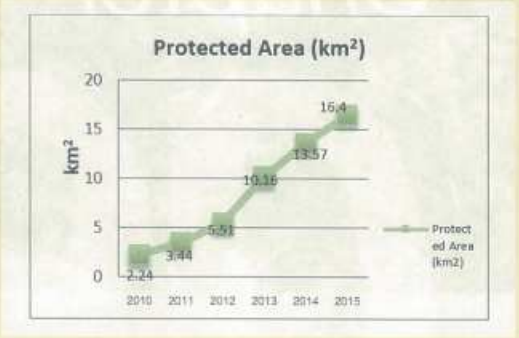
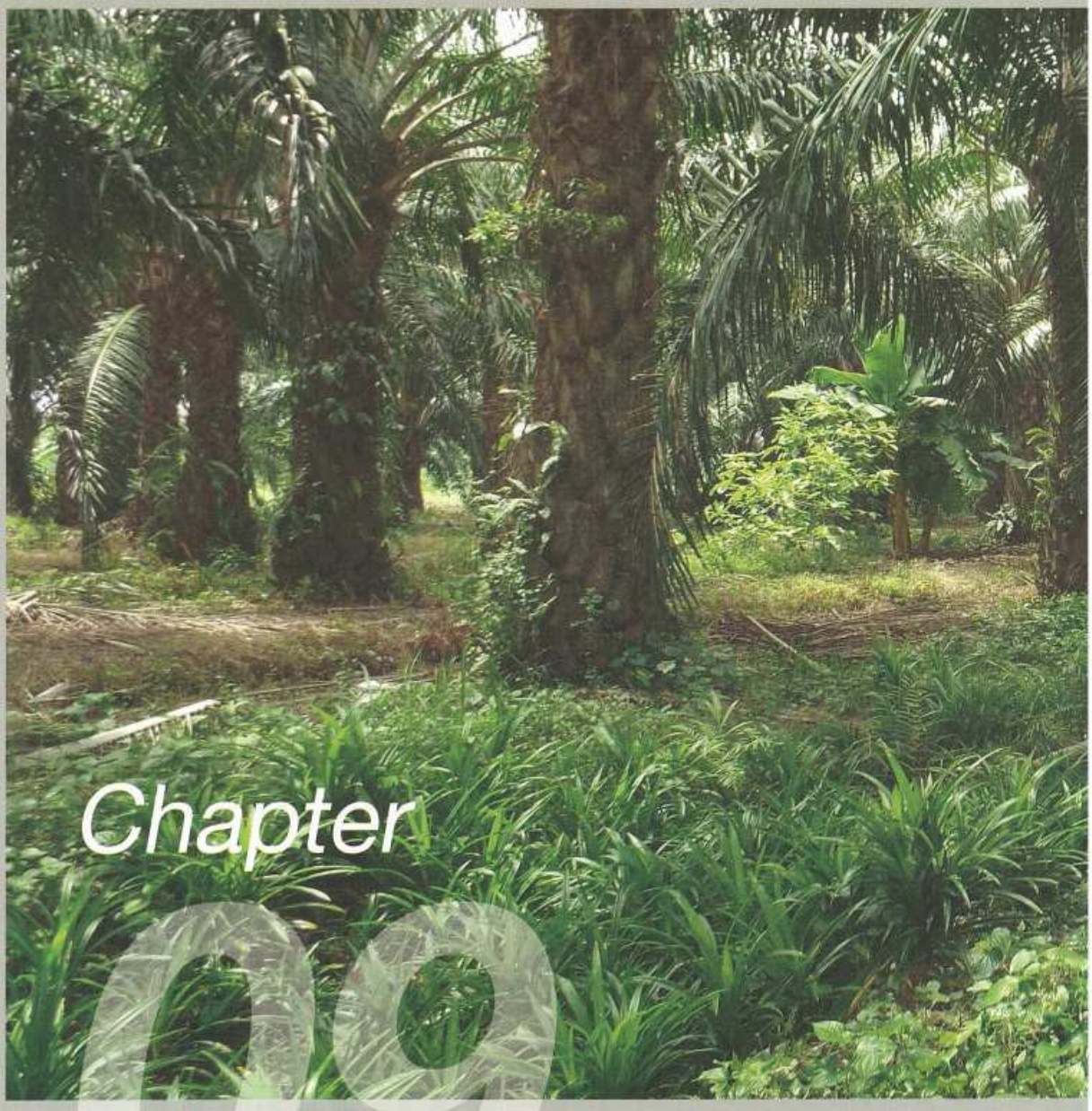


Figure 13: *Increase of protected area in 2010-2015*

Replication

In less than 10 years, the network has expanded significantly from one community with an area of 5.9 km^2 and 15 participating households to 5 sub-districts of Buri Ram province, benefitting 2,221 households in the area of 278.25 km^2.



Chapter 09

Retention by Thriving Furrow and Canal System

Diminish Disaster Risk and Boost Economy

Rangsit Canal Community

Nong Suea District, Pathum Thani Province

Good Practices

- Integrated water management, drought and flood risk reduction and agriculture for resilient livelihood and environmental management
- Build partnership between community, local government and the private sector to scale up good practices

The Challenge

Rangsit canal community is located in Bueng Cham O sub-district, Nong Sua district, Pathum Thani province by the Chao Phraya river basin with total area of 54.48 km^2. While, 44.16 km^2 have been used for agricultural productions. The population of 8,926 people use 19.63 km^2 (44.5%) of agricultural land for fruit crops - perennial plants, 18.30 km^2 (41.44%) for rice fields, 5.20 km^2 (11.8%) for vegetable crops and only 1.03 km^2 (2.33%) for farm crops.

For decades, community living along Rangsit canal searched for ways to improve their livelihoods. In 1984, they changed farmland back into orange orchards. However, an outbreak of citrus diseases in 1991 put many farmers in serious debt. In 2004, the community replaced orange orchards with palm oil cultivation, they started to generate better income. Three years later, selling palm oil helped the farmers reduce their long-term debts. However, a lack of water due to the poorly maintained and shallow canal challenged palm oil cultivation. In addition, the severe flood of 2011 also revealed other challenges including canal bank erosion.

The Approach

In 2011, Her Royal Highness Princess Bajarakitiyabha's graciously supported the introduction of CWRM at Rangsit canal. H.R.H. Princess's donation from the College of Justice to the Hydro and Agro Informatics Institute (HAII) to solve drought problems and develop Rangsit canal to be an "income-booster monkey cheeks area" where the water retention in the furrow would promote palm oil and other cultivation as well as boosting the community income.

The HAII encouraged Rangsit canal community to establish a CWRM Committee. This led the analysis of water balance and implementation of a new water resource management system to provide water for oil palm cultivation areas. The main canals and sub canals were dredged and linked with improved clarifiers and floodgates to maximize water reservoir and drainage system. The water reservoir area was improved by vegetable and oil palm furrows. A mire suction boat is an important innovation for deeper dredging the canal and furrows including opens new waterways to agricultural areas in dry season. Oil palm trees were planted along the canal banks to prevent erosion and illegal construction. Increased palm oil yields together with integrated community-based agricultural production following the New Theory provide a higher and more sustainable income for the community.

The Impacts

A total of 129 kilometers of the main and sub-canals have been dredged. Linked with improved clarifiers and floodgates in 70 locations, this has improved significantly water reservoir and drainage capacity. The mire suction boat dredge furrows and canals to increase water storage in oil palm groves and opens new waterways to agricultural areas in dry season. During the tropical cyclone GAEMI in 2012, Rangsit canal stored more than 17 MCM which helped prevent flooding in Bangkok and central of Thailand. In the dry year of 2013, the mire suction boat helped to open new waterways for 9.6 km^2 agricultural land.

In three years of operation (2012-2015), water storage at monkey cheeks increased to 14.82 MCM providing irrigation for 36.21 km^2 of oil palm furrows and 83.2 km^2 of agriculture areas. A total of 21,734 people from 6,473 households benefitted.

The 72.8 kilometers of the canal bank was improved with the plantation of 13,000 oil palm trees to prevent erosion and illegal construction. Integrated agriculture along the canal banks over an area of 0.00012 km^2 increased income to THB 12,000 per year while reducing household expenditures THB 6,000 per year.

The local farmers can yield oil palms 24 times/tree/year with production of more than 6-8 tons per 0.0016 km^2. The average income is THB 23,800 per 0.0016 km^2 per year (at the price of THB 4 per 1 kg of oil).

Past

Present

Success factors

Building capacity for community self-management

The community was guided in the concept of CWRM and learnt from the success of other villages. At the start in 2011, four pilot sub-districts were grouped to implement a water development plan: survey, collect and analyze data, and improve water structures in the area. Later on, the concrete outcomes of CWRM were evident to people and nearby communities. Within 5 years, the networks had expanded to 9 areas in 1 municipal district and 8 sub-districts in Rangsit canal. The CWRM networks of 9 areas formed themselves to lead the process of cooperative water resource management. Moreover, the community established Community Palm Oil Funds to manage their own budget and revenue from community enterprise.

Promoting the role of community leaders

The HAII and Utokapat Foundation built the understanding in CWRM among the community leaders by showing the mutual benefits of such an approach for each area. The collaboration of community leaders from 9 areas is important for the joint working of CWRM in the Rangsit canal community.

"Water is vital to life like a human vein, especially in agriculture which relies so heavily on it. Sooner or later, the population will increase and impact directly on water demand while the water supply remains the same. Previously, we had no water management; water weeds spread along the canals and blocked the waterways. It made a lot of trouble to the community. We can stand today with a good guidance from HAII and Utokapat Foundation. They not only gave us the water management approach but also provided us with information and technology that helped us solve the problems systematically, and brought benefits to the farmers." said Mr. Aksorn Noisawang, Chief Executive of the Bueng Cham O Sub-district Administrative Organization and Chairman of Rangsit Canal CWRM committee.

Good Practices

1 Integrate water management, drought risk reduction and agriculture for resilient livelihood and environmental improvement

A new water management system based on thorough analysis of water resources and technological innovations has been instrumental for Rangsit canal community to tackle drought risk and improve agricultural production.

Water balance analysis

Using various technologies, the Rangsit canal community was trained to undertake water balance analysis as the fundamental step in designing the new water management system.

The analysis shows a serious lack of water throughout the year. Increasing water storage is the only solution for Rangsit canal community.

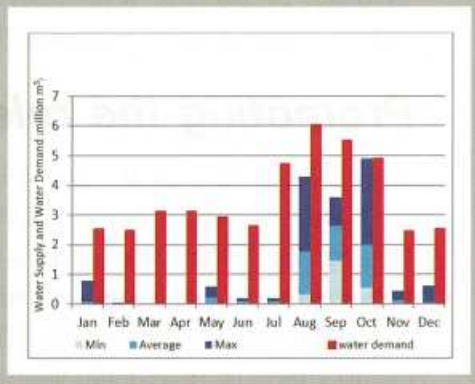


Figure 14: *Water balance analysis in Rangsit canal community area*

The Mire Suction Boat

The community dredged the canals and sub-canals, combined with improved clarifiers and floodgates, to maximize the inflow and outflow. They also dug monkey cheeks in oil palm furrows and link these with the canals and sub-canals to improve the drainage of flood water for storage in the retention ponds.

The use of a mire suction boat increased drainage capacity during flood season while opening new waterways during dry season to provide water to remote areas.

Farmers were also guided to dredge their oil palm furrows to allow better absorption of water into the soil.

Sediment derived from the dredging process helped to increase soil moisture and use as fertilizer to trees.

As a result, there was a reduction in consumption of irrigation water from Pa Sak Jolasid dam.

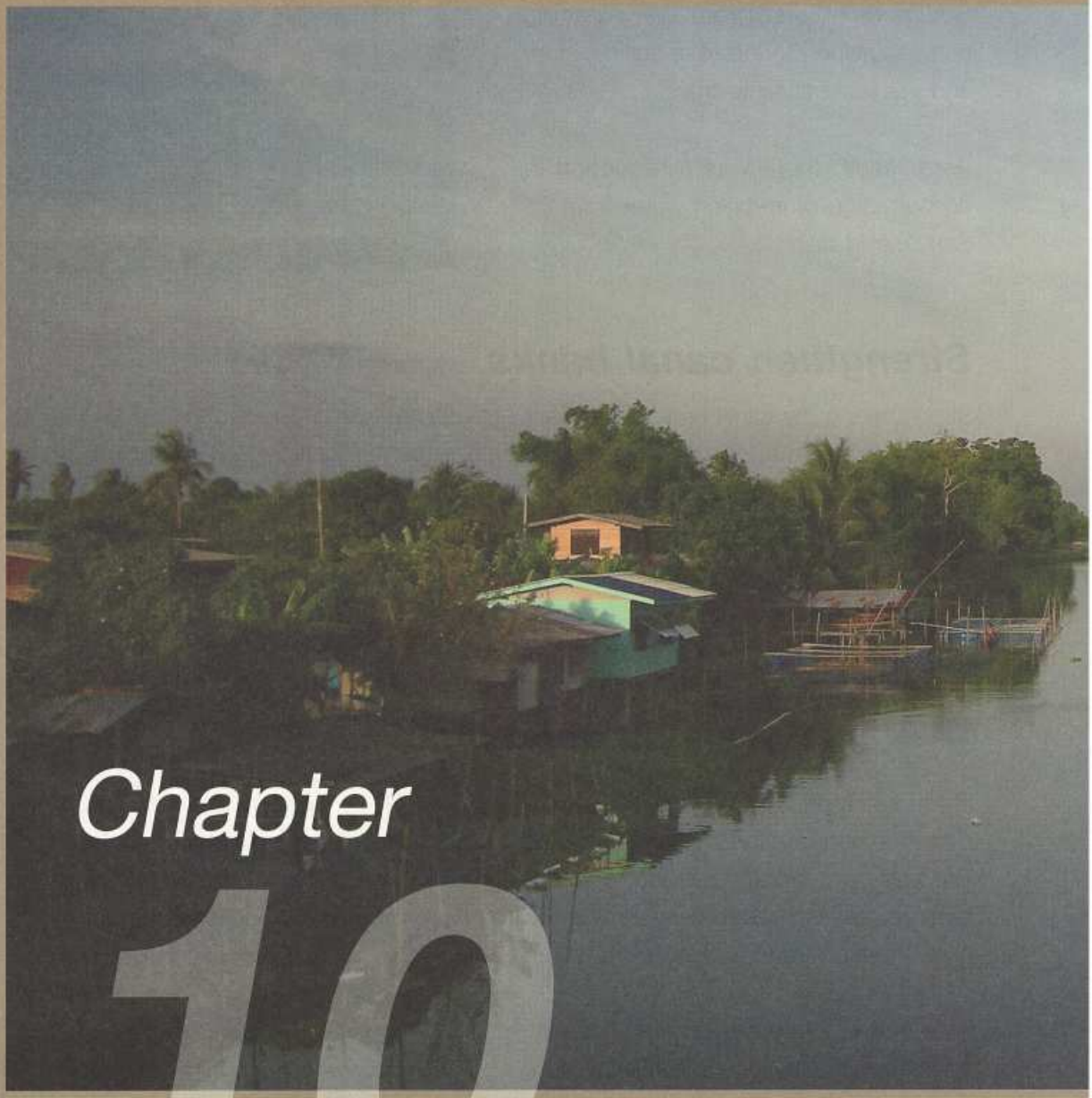
Strengthen canal banks

Strengthening the canal banks to prevent erosion was an important part of the system. In addition, palm tree plantation and integrated agricultural production along the 72.8 km of canal banks provides significant additional income for the community.

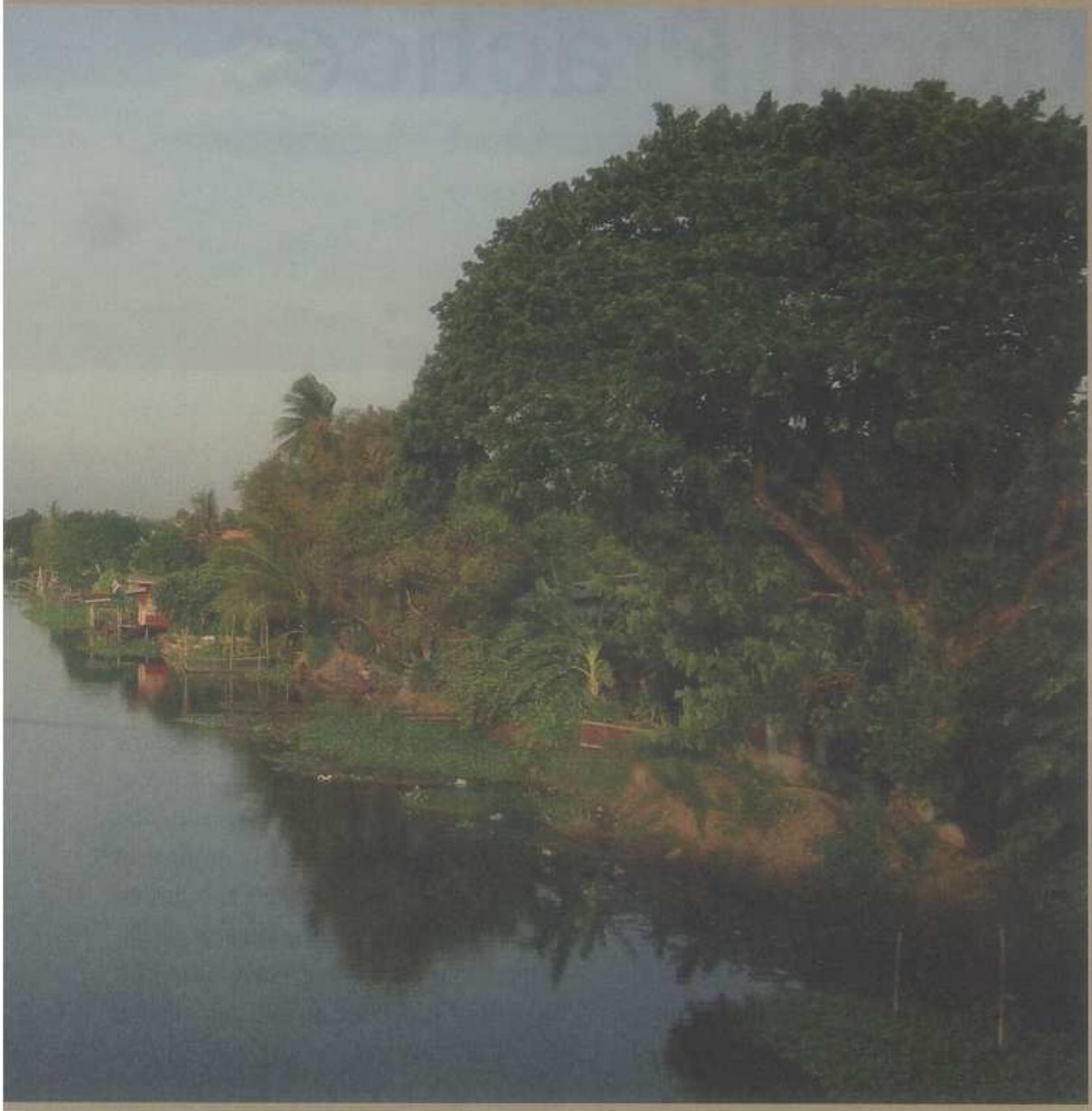
2 *Build partnership between community, local government and the private sector to scale up good practices*

The great flood in 2011 was the starting point for cooperation between villagers and sub-district administrations in water resource management to overcome the crisis. HAII provided data support.

With the strong-willed of the community leaders and sub-district administration, the villagers and related parties began water resource management, dredging the canal, reverting farmland back to oil palm furrows, and managing the whole water system. The community was open-minded to adopt and apply new science and technology, with the support of HAII, to prevent disasters and better manage water resources. The collaboration among community, local authorities and sub-district authorities was a significant reason for the success in getting over water challenges in the area. CWRM was at the core of this and it is why CWRM networks have been expanded from 4 to 9 sub-districts in 4 years. Recognizing the outcomes, Coca-Cola Thailand, whose factory is located nearby, has since 2013 continued to support the community under Utokapat Foundation's management.



Chapter 10



Reduce 4 Water-Related Problems:

Flood, Drought, Brackish, and Waste; by S&T

Saladin Community

Phutthamonthon District, Nakhon Pathom Province

Good Practices

- Build capacity of community to develop appropriate technologies for water resource management
- Mobilize contributions from community to complement Government activities
- Increase value of agriculture products and diversify income

The Challenge

The Saladin community is located in Mahasawat sub-district, Phutthamonthon district, Nakhon Pathom province by the Tha Chin river. Here 8,926 people live in an area of 12.97 km^2. From total agricultural area of 9.98 km^2, rice fields account for 6.85 km^2 (68.6%), fruit crops-perennial plants for 2.28 km^2 (22.8%) and vegetable crops 0.84 km^2 (8.5%).

Farmers in Saladin community used to follow monoculture of rice production. They were faced with four water problems: flood, drought, wastewater and brackish water. Flood and drought were partly due to lacks of care and respect of the water resource. These local disasters contributed to poverty in the area. The 27 kilometers of Mahasawat Canal that goes through the community, as well as its sub-canals, were clogged with household rubbish. A layer of grease also formed on water surface as a result of the disposal of cooking waste directly into the canals. This prevented sunlight from penetrating below the surface and further affected the quality of the canal water. In addition, the canals became clogged from an inundation of water hyacinth. In 1995, local road construction replaced the canals as a means of transportation. This resulted in a further deterioration of the maintenance of canals. In the same year, water gates were built to control the flood level, but making the water stagnant.

Several attempts by Mahasawat Sub-district Administration and villagers to collect water hyacinth and clean the canals since 1997 were not successful. The weeds kept growing fast and community leadership to sustain the efforts was lacking. The severe flood in 2011 also revealed serious water issues to the Saladin community.

The Approach

After the 2011 floods, HAII and Utokapat Foundation worked with the villagers to build the community's ownership in managing local water resources. Local leaders were identified, appropriate technologies, combined with local wisdom, were introduced. Slowly but surely the village's relationship with the natural resource on its doorstep began to change.

The farmers applied the New Theory to the 1.61 km^2 land, graciously donated by H.M. the King in 1975 for agricultural purpose which allocated 0.032 km^2 for each household. Community enterprises of water users were established for stronger collaboration among farmers for water resource management.

> ***"We were affected by the 2011 flood because of the shallow canals and the fact there was no drainage system. The HAII and Utokapat Foundation taught us how to solve problems in simple ways and to gain economic benefits from water management".***

Mr.Wanchai Sawaddaeng, Chairman of the Community Enterprise of Water Users for Agriculture

The Impacts

Drainage was improved through dredging of 15 kilometers canals and pipelines. Less waste was disposed into the canals. Villagers also invented a simple and cheap technology to trap grease that reduce the impacts on the canals. They also installed solar-powered turbines to increase the oxygen in the water. The community began to view the canals as part of bigger system and understood the need to manage their water resources on a catchment area basis.

As the health of the canals improved, the area of water habitat was increased. So were the economic spin-offs. Water hyacinths were harvested and used as fertilized soil. Watercraft transportation returned. Agricultural tourism was encouraged. Lotus farming began, paying a higher return than the previous paddy; and crops such as basil leaf, banana and fish began to provide livelihoods for local families. Villagers learnt how to dredge the sub-canals so that water storage areas could be created. While many parts of Thailand suffered from the 2015-2016 El-Nino and drought, Saladin community had sufficient water for agricultural production.

Past

Present

Success factors

Build community ownership and leadership

A major part of the challenge faced by the Saladin community was lacks of care and respect of local villagers to their water resource. Helping villagers understand their problems, identifying local leaders who facilitated the community work together to find out the prompted solutions was the key factor for success and sustaining the development.

Promote adaptation of technologies

Because the Saladin community faced multiple water challenges, technologies had to be comprehensive to solve all the problems at a reasonable cost. The community applied new technologies such as solar energy. It has also adapted and invented low-cost technologies such as simple way to trap grease and use solar-powered turbines.

Strengthen collaboration between community, local government and other stakeholders

The water management challenges were beyond the capacity of the local community. Technical support from academic institutions such as HAII, support and cooperation from the sub-district administration as well as financial support from the Utokapat Foundation and Royal Thai Army were crucial for achievements in Saladin community.

Good Practices

1 Build capacity of community to develop appropriate technologies for water resource management

Villagers in Saladin community came together with clear determination to restore the canals within Mahasawat sub-district. They were trained on collecting data and analyzing root causes of the problems, using technologies such as satellite image map and Global Positioning System (GPS). In promoting self-reliance of the community, attention was paid to encouraging solutions that are appropriate to the local context. As a result, simple, cheap but efficient technologies have been developed and used for:

- Checking water quality;
- Installing household grease trap containers to trap the cooking oil before release to the canal;
- Producing Micro-organism liquid and EM ball for water treatment;
- Installing a solar powered turbine in the canals to add oxygen into the water;
- Using dried water hyacinth to make ready-mixed soil

A

B

C

A: Grease trap in household
B: EM Ball production
C: Solar powered water turbine

These technologies not only help improve water quality and environment but also provide income opportunities for villagers. The water hyacinth which was perceived as waste provided income for people and the community self-managed fund.

2 Mobilize contributions from community to complement Government activities

The Mahasawat Sub-district Administration Organization helped with dredging and removal of hyacinths for watercraft transportation in the main canal. With support from the Mahasawat Sub-district Administration Organization and HAII, the community carried out a survey of sub-canals and applied water maps for analysis to increase drainage in the whole canal system. They then decided to dredge the sub-canals to improve water circulation, drainage capacity and transport capacity. In 2013, the Railway Canal, Patiroop 1 Canal, Patiroop 2 Canal and Rong-Jay Canal were dredged by the community.

In 2014, the community dredged canals to connect with the Mom Chao Chalermsri canal and installed block conversion under the roads to connect them to increase the water flow. This is a natural method for water quality treatment, using clean water to push away the waste water.

The community also removed constructions that obstructed waterways in order to increase the efficiency of water drainage and strengthened the maintenance of the canals.

In 2015, the agreement was reached to plant local trees along the canals throughout the whole sub-district for future agro-tourism in the community.

To cope with flood, the community and local stakeholders developed their food preparedness and response plan that identified assembly points for evacuation, established a center for providing assistance, prepared an evacuation kit and disaster relief package and equipment, as well as the donation registration system. A plan to grow floating plants which can be used for cooking during floods has also been discussed.

3 Increase value of agricultural products and diversify income

In 1975, together with the gracious donation of 1.61 km^2 of land for the farmers of Saladin community, H.M. the King also introduced the integrated agriculture approach to Saladin community, and continues the practice until present day.

With improved water resource management, the community learnt how to allocate land for different agricultural production. Lotus farming and other crops such as basil leaf, banana and fish have begun in addition to rice production, providing people with more incomes and resilient livelihood.

Community enterprises of water users for agriculture have been established to help farmers collaborate on water use and agricultural production, and to expand CWRM approach.

Example of improved income - Mrs. Suree Swadjun's farm: *Rice production THB 240,000 per year / Vegetables THB 55,000 per year / Fishery in the ditches around the rice field THB 2,300 per year* ***The income increased by 24% per year***

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