Partner Report Series No 7

Mainstreaming adaptation into local development planning: A case study in Chainat, Thailand

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The *Partner Report* Series highlights the insights and outcomes of studies, assessments and other field activities that the Adaptation Knowledge Platform (AKP) national implementing partners have undertaken in their countries to mainstream adaptation into plans, policies and programmes. The intention of the series is to disseminate their findings to partners and relevant professionals in Asia.

We welcome suggestions or comments.

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Preface

During the last three years, the Regional Climate Change Adaptation Knowledge Platform (AKP) has worked towards building bridges between existing knowledge on adaptation to climate change and the governments, agencies and communities that need this knowledge to inform their adaptation to the impacts of climate change, while working for poverty reduction and environmental sustainability. AKP's work has been carried out following three key objectives:

1. Promoting dialogue and improving the exchange of knowledge, information and methods within and between countries on climate change adaptation, and linking existing and emerging networks and initiatives.

2. Generating new climate change adaptation knowledge, promoting understanding and providing guidance relevant to the development and implementation of national and regional climate change adaptation policy, plans and processes focused on reducing vulnerability and strengthening the resilience of the poor and women: the most vulnerable segments of society in most Asian countries.

3. Synthesizing existing and new climate change adaptation knowledge and facilitating its application in sustainable development and poverty reduction practices at the local, national and regional levels.

This publication is a result of these objectives. AKP supported thirteen countries in the Asian region to strengthen their capabilities to mainstream adaptation, introduce effective adaptation measures and assess their needs and priorities for adaptation. Thailand is one of the thirteen countries.

AKP is implemented by the Stockholm Environment Institute (SEI), AIT's Regional Resource Centre for Asia and the Pacific (AIT RRCAP), and the United Nations Environment Program Regional Office for Asia and the Pacific (UNEP ROAP) with funding provided by the Swedish Government through the Royal Swedish Embassy in Bangkok and the Swedish International Development Agency (Sida). The former Swedish Environmental Secretariat for Asia (SENSA) was also instrumental in setting up and supporting AKP.

AKP's publications provide insights on adaptation in the region. A consolidated initiative, known as the Asia Pacific Adaptation Network (APAN), has been established and will be fully implemented starting 2013. Its ultimate objective is to assist the region to build the climate resilience of human systems, ecosystems and economies through the mobilization of knowledge and best practices, enhanced institutional capacity, informed decision making processes, and facilitated access to finance and technologies.

The outcomes of AKP have been made possible by the active participation of partners and various stakeholders. SEI acknowledges the editorial assistance provided by Marion Davis and Skye Turner-Walker. SEI also expresses heartfelt thanks to John Soussan, Lailai Li, Kai Kim Chiang, Lisa Schipper, Sabita Thapa, Tatirose Vijitpan, Muanpong Juntopas, Nantiya Tangwisutijit, Chanthy Sam, and Dusita Krawanchid for their contributions to AKP.

Abstract

This pilot study aimed to understand climate risks and uncertainty within local communities and demonstrate the integration of climate change adaptation into local development plans. The study began with an assessment of climate risks, uncertainty and vulnerability in an agricultural community within the Sapanhin sub-district, Nong Mamong district, Chainat province in Thailand. From this, adaptation options were identified. In addition to the vulnerability assessment, the study employed a mixture of approaches, including Participatory Rural Appraisal, a review of local development plans and related documents, in-depth interviews, household surveys, and focus group discussions.

Raising awareness of climate risks and variability, communicating climate information, and fostering public engagement are central to the integration of climate change adaptation into community development plans. If government officials can work with the local agriculture office, community leaders, farmer groups and other stakeholders to plan and implement the adaptation actions, the community's vulnerability to climate change could be significantly reduced.

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1. Introduction

This pilot study aimed to understand climate risks and uncertainty within local communities and demonstrate the integration of adaptation into local development plans. It began with an assessment of climate risks, vulnerability and uncertainty in a community within the Sapanhin sub-district, Nong Mamong district, Chainat province, Thailand. From this, climate change adaptation options to support planning decisions were developed.

The study employed a mixture of approaches, including a vulnerability assessment, Participatory Rural Appraisal, a review of local development plans and related documents, in-depth interviews, household surveys and focus group discussions.

Vulnerability assessment

The goal of the vulnerability assessment was to understand the climate change risks the community faces, along with key socioeconomic drivers, to identify adaptation needs and appropriate responses. Four important terms are crucial here:

Exposure is the extent to which a community or sector is in contact with climate change impacts; for example, if someone lives in an area affected by drought, or in a flood zone.

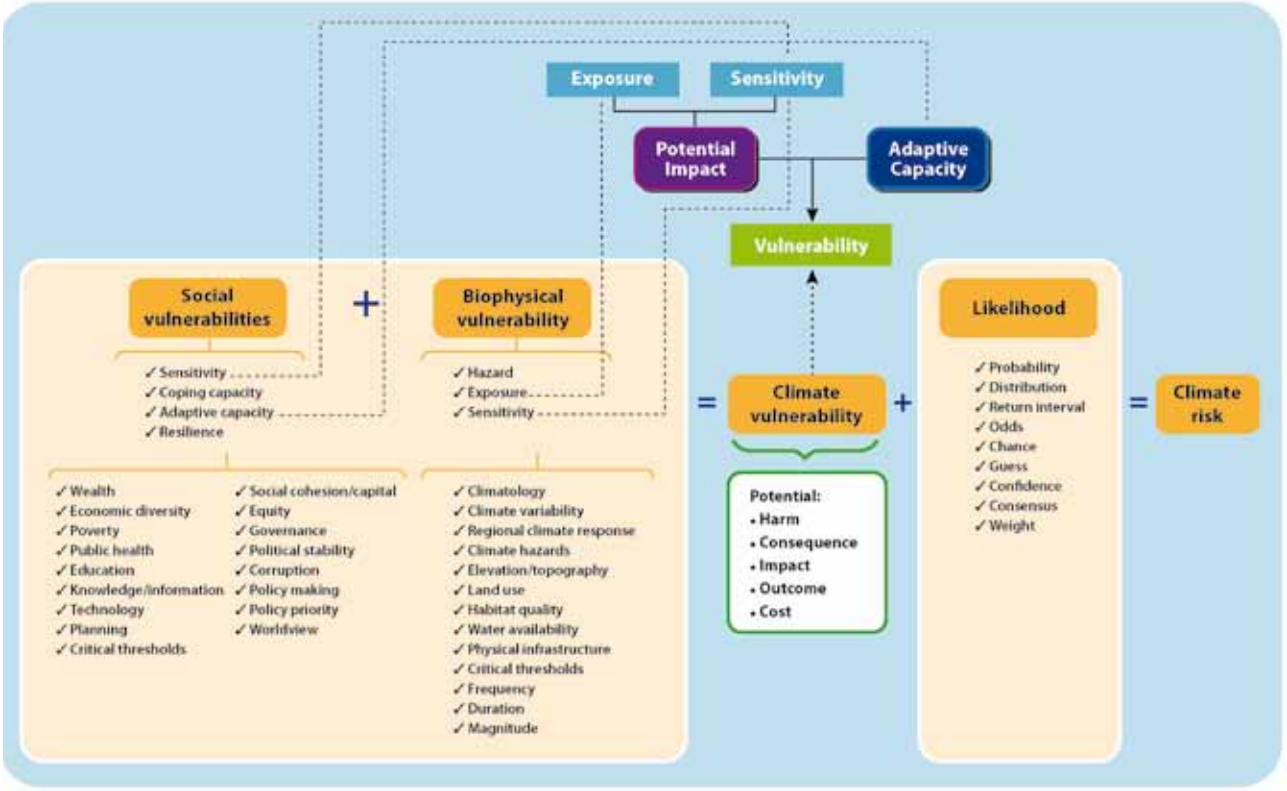
Sensitivity is the degree to which a community or system can potentially be affected by climate change; for example, droughts will have a much-greater impact on agriculture than on transportation.

Vulnerability is the degree to which a community or system is actually susceptible to climate change impacts; it increases with exposure and sensitivity, and declines with adaptive capacity.

Adaptive capacity is the ability to adjust to new climate conditions; for a farmer facing drought, for example, this might mean being able to switch to drought-resistant crops, install irrigation systems, or find a different way to make a living.

Climate sensitivity does not necessarily imply negative impacts; for example, a reduction in rainfall might benefit tourism in a region, even as it harms agriculture. Similarly, adaptive capacity can mean being able to minimize negative effects, or seize new opportunities. Thus, in vulnerability assessments, it is important to look not only at climate change impacts, but also at climate sensitivity and adaptive capacity. While physical exposure is an important aspect of the vulnerability for both human populations and natural systems, a lack of adaptive capacity is often the most important factor that creates a hotspot of human vulnerability (IPCC, 2007). Figure 1, taken from Preston and Stafford-Smith (2009), illustrates the relationships among different concepts associated with climate change vulnerability.

Figure 1: Relationships among different concepts associated with vulnerability and risk



Source: Preston and Stafford-Smith (2009), Figure 3.

Participatory Rural Appraisal

This part of the study examined local social capital, land use, water resources, natural resources, and disaster issues in a community context.

Participatory Rural Appraisal is a set of tools used to facilitate the collection and analysis of information by, and for, community members. It emphasizes local knowledge and involves communities in inventorying, monitoring, and planning of local forest management. As a collaborative process, it actively empowers marginalized communities, de-emphasizes hierarchies, and helps to identify resource needs and sustainable use systems (Asia Forest Network, 2002).

With support from the study team, Sapanhin community members participated in discussions on climate risks and vulnerability within the context of local livelihoods and development pressures. Together, they mapped their community history and risks, rice farming seasonal calendar and sugar cane farming calendar, as well as a community risk profile. All of these enabled them to better understand their climate risks and uncertainties.

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Review of local development plan and related documents

In order to understand whether local officials had considered climate risks and uncertainty in their development plans, and if so, how, the study team reviewed the three-year (2008-2010) strategic development plan of the Sapanhin Sub-district Administration Organization and the Nong Mamong District Agricultural Plan.

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In-depth interviews

In-depth interviews with key informants were conducted to explore the community's capacity with respect to climate risk management, including local strategies and practices. The following people were interviewed:

1. Mr. Suthat Wongwanit, chief of the Sapanhin Sub-District Administration Organization
2. Mr. Supat Chansri, head of the sub-district
3. Ms. Prateep Chansri, women's group representative
4. Mr. Wisut Romyen, rice farmer group representative
5. Mr. Tanya Taotong, sugar cane farmer group representative
6. Mr. Phuwanai Inthawong, permanent secretary of the Sapanhin Sub-District Administration Organization

Household surveys

Household surveys were also conducted in order to understand household vulnerability to climate risks and uncertainty, and the socioeconomic factors influencing vulnerability. A total of 325 questionnaires were distributed and collated by field researchers and local research assistants.

Focus group discussions

A series of focus group discussions on mainstreaming climate change adaptation was conducted with stakeholders in the Sapanhin sub-district development plan. Stakeholders included the Department of Environmental Quality Promotion (DEQP), Regional Environmental Office 5 (REO 5), the Tha Chin River Basin Tha Chin Committee, four 'We Love Tha Chin River' Clubs from four provinces (Chainat, Supanburi, Nakorn Pathom and Samut Sakorn), the Sapanhin Sub-District Administration Organization, community leaders, farmers, and occupation groups. Key activities with stakeholders under the pilot study are listed below:

1. Launching the AKP pilot study and inception workshop with partners and the community (9-10 October, 2010):
   - Climate change adaptation and implications for local communities
   - Involvement of government bodies and local community in adaptation planning
2. Community risks and variability and adaptation workshop (27-28 November, 2010):
   - Community mapping, community risks profile and seasonal calendar
   - Water resource management
   - Alternative agricultural practices
   - Examples of adaptation practices in other communities
3. Networking with the Tha Chin River Basin and Bangpakong River Basin networks (22-23 January, 2011):
   - Sharing experiences from networks
   - Connecting with other communities, organizations and networks to collaborate on environmental and climate change adaptation issues

During these discussions, the stakeholders had the opportunity to discuss their concerns. Experts from Kasetsart University and government officials joined the workshops, and provided recommendations on how the community could manage its climate risks.

2. Study site background

Administration

The Sapanhin sub-district is an administrative unit under Nong Mamong district, Chainat province. To understand its climate risks better, the geographical settings of both the province and the district are described below.

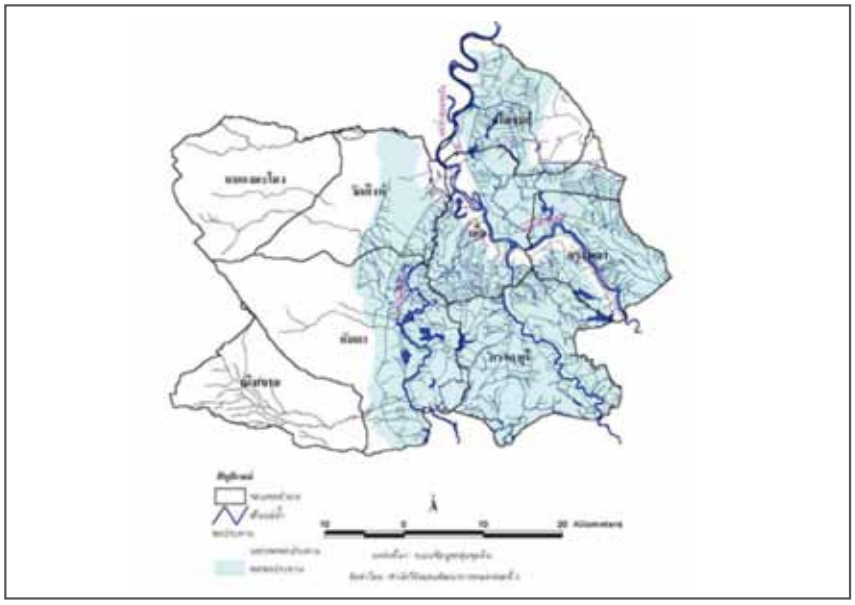
Chainat province is bordered by Nakorn Sawan province to the north, Uthai Thani province to the north and west, Singburi in the southeast and Suphanburi in the south. The province is subdivided into eight districts. These districts are further subdivided into 53 sub-districts which include 474 villages (Chainat Provincial Office, 2006).

The Nong Mamong district is situated in the northwest of Chainat province, bordering with Uthai Thani province in the north and the west. It incorporates four sub-districts and 41 villages (Chainat Provincial Office, 2006).

Geographical information

Chainat province is located in the upper part of the central region of Thailand in the Chao Praya River valley. The Chao Praya River runs through the province and has two tributaries, the Tha Chin and Noi Rivers. The Chao Phraya dam is also located within the province and is used for flood control and diverting water for the irrigation of rice paddies in the lower Chao Phraya River basin. Eighty percent of Chainat residents are farmers. Most of the population has access to irrigation systems, except in two districts, Nen Kham and Nong Mamong (Agricultural Research and Development Region 5, 2006).

Figure 2: Irrigated areas and rivers in Chainat province



Source: Agricultural Research and Development Region 5.

Nong Mamong district includes low land, forested and hill areas. In 1964, 34,386.75 rai (54.99 km^2) of Khaolak-Khaochonglom forest area was officially declared a National Reserved Forest. To improve management of the forest area, 20,933 rai (33.50 km^2) of forest was recently transferred to the Agricultural Land Reform Office to allocate degraded forest land to landless farmers (Agricultural Research and Development Region 5, 2006). However, some areas still remain under the management of the Royal Forestry Department.

Sapanhin sub-district

The Sapanhin sub-district covers an area of 86.92 km^2 (54,326.56 rai), and incorporates 1,722 households. Rice farming and the production of other field crops are the main livelihoods. However, a land use survey revealed that 8.8% of the sub-district is covered by forests that are managed by local communities, who rely upon forest products for their livelihoods. Also, although Sapanhin is in the central plain where irrigation systems are generally well equipped, the sub-district sits outside of the irrigated area and is therefore unable to access irrigation. As a result, farmers depend on seasonal rain and natural water resources, making water resource management one of the major challenges for farmers within the district. In addition, the conversion of forests into agricultural land causes changes to the environment and to the supply of natural resources, which in turn affects the people whose livelihoods depend on these resources. In 2006, the Office of Agricultural Research and Development Region 5, located in Chainat, declared Nong Mamong as one of the districts most vulnerable to natural disasters (Agricultural Research and Development Region 5, 2006). The sub-district is divided into 10 administrative villages; information concerning land use for each village is provided in Table 1.

Table 1: Sapanhin sub-district area

Village	Total area (rai)	Agricultural area (rai)	Housing area	Public area	Other areas
Sapanhin	5,708.80	4,953	553.64	154.84	47.00
Nong Kham	6,620.46	6,205	497.80	87.66	10.00
Nong Si Fan	2,890.40	2,663	140.43	86.97	-
Phothong	4,954.17	3,470	375.98	1,048.94	59.25
Pu Noi	3,450.99	2,722	120.97	591.02	17.00
Nampu	7,431.40	6,032	230.54	1,042.86	126.00
Nong Maikaen	6,894.61	6,058	249.81	556.80	30.00
Nong Kata	6,887.36	6,015	128.98	734.38	9.00
Dong Kwankong	5,863.29	5,619	158.29	86.00	-
Khaolak	3,625.40	3,106	129.02	390.38	-
Total	54,326.88	46,663	2,585.46	4,779.85	298.25
Percentage	100%	86.0%	4.7%	8.8%	0.5%

From Table 1, it can be seen that Sapanhin is composed of agricultural communities that use their land mainly for agricultural purposes. Figure 3 is a map of the sub-district.

Figure 3: Sapanhin sub-district

Source: Study team.

Table 2 below breaks down the agricultural areas by crop type.

Table 2: Agricultural area in Sapanhin sub-district (2008-2009)

Agriculture type	Area (rai)	Percentage
Agricultural area	**46,663**	**100**
Rice	16,913	36.2
Other field crops	27,012	57.9
Fruit/flower/garden tree	181	0.4
Vegetable	100	0.2
Livestock	1,999	4.3
Fast growing plants	413	0.9
Other	45	0.1

Source: Sapanhin Sub-district Administration Organization

Table 2 shows that rice and other field crops are the main crops in Sapanhin. During the focus group discussions, farmers reported that rice is grown mostly for household consumption. Other main field crops include sugar cane, cassava and maize. Sugar cane is the largest field crop in Sapanhin sub-district. Fruits are also cultivated – especially pomelo, which is regarded as the signature fruit of the province. However, market prices could influence the decisions of farmers to switch from one crop to another.

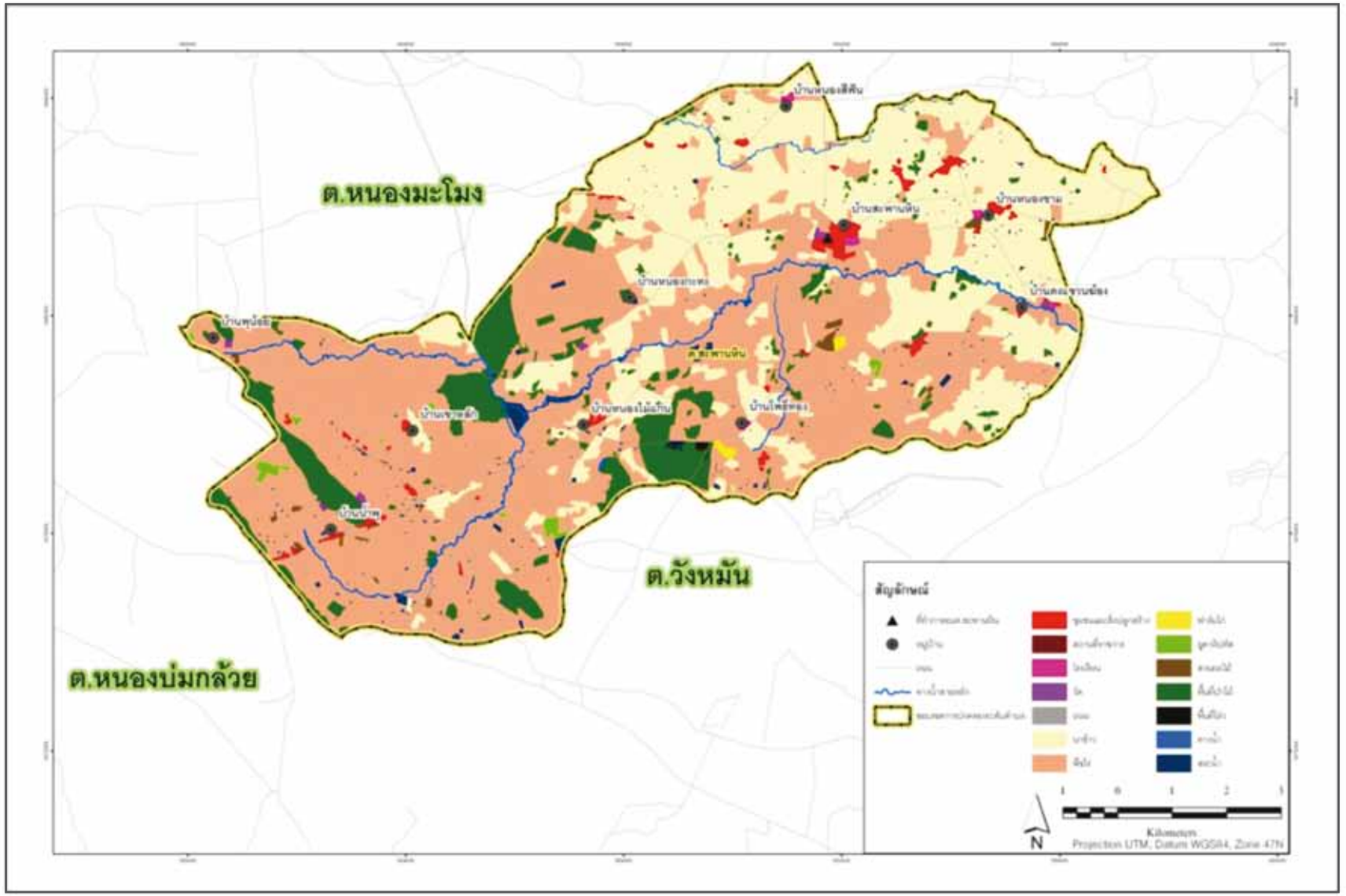
Figure 4: Rice field

Figure 5: Sugar cane field

The study team also conducted a land use survey of the sub-district using a visual classification technique that employed high-resolution satellite imagery from IKONOS (from Google Earth), LANDSAT5 TM Landsat bands 453 (RGB) and field surveys. It was found that most of the sub-district (around 53%) was covered by field crops including sugar cane, cassava and maize. Second to field crops, rice farming accounted for around one-third of the total area, while forests covered around 9%. Figure 6 shows the mapping results.

Photo Credit: creativecommons | Don Rul

Figure 6: Land use in Sapanhin sub-district



Source: Kasetsart University, Faculty of Forestry Study Team. Colour and symbol key: red = settlements and infrastructure; dark red = government offices; pink = schools; purple = temples; orange = field crops; yellow = rice paddies; dark yellow = chicken farms; green = eucalyptus plantations; dark blue = ponds; brown = fruit orchards; black = empty spaces; triangle = Sapanhin Sub-district Administration; circle = villages; gray lines = roads; wavy blue lines = waterways; thick highlighted line = sub-district boundaries.

3. Community livelihoods and resources

Livelihoods

The Sapanhin sub-district incorporates 1,722 households with 5,191 people. The household surveys showed that 84.3% of households are involved in agriculture. Farming households include rice farmers (31.7%), sugar cane, cassava, maize and other crop farmers (25.5%) and agricultural labourers (24.9%). Some households grow fruit or rear livestock (7%). The 15.7% of households that are not engaged in agriculture own their own businesses, are employed by a private company, or are government officials. The main community livelihoods are outlined in Table 3.

Table 3: The main livelihoods in Sapanhin sub-district (from household surveys)

Main Household Livelihoods	Number	Percentage
Rice farming	103	31.7
Sugar cane, cassava, maize and other crop farming	83	25.5
Agricultural labour	81	24.9
Other agricultural livelihoods e.g. fruit orchard and livestock	7	2.2
Others (owning business, employed by private company, and government officials)	51	15.7
Total	**325**	**100**

Households have developed strategies to diversify their livelihoods. For instance, with support from the Sapanhin sub-district government, people have formed occupation groups in order to develop their skills and commercialize their products. There are currently 22 of these occupation groups in Sapanhin sub-district, including eight homestead livestock farmer groups, five food processing groups, two sugar cane farmer groups, two handicraft groups, two organic fertilizer groups, one rice farmer group, one maize farmer group and one self-sufficient agriculture group. Each of these has around 10-80 members, with a total of 449 people belonging to at least one of these groups. Although the groups are not large, their members have tried to support their peers and either generate additional income for their households or decrease household expenses.

Rice farming

About 16,913 rai (27 km^2) or 36.2% of land in the sub-district is devoted to rice farming. On average, each farmer has 20 rai (0.032 km^2) of land for rice cultivation. Depending on rainfall, rice farmers grow the crop once a year, mostly for household consumption. 'Chainat I' is the dominant variety in the sub-district. It takes 119 to 130 days to cultivate. Cultivation typically used to start in April or May, when the seedlings were transplanted or broadcast. However, because of a decrease in rainfall, farmers now have to wait until June or July due to the delay in the onset of the rainy season. Table 4 shows the rice farming calendar in the Sapanhin community.

Table 4: Seasonal rice calendar

Activity	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Soil preparation	↔											
First application of herbicide		↔										
Broadcasting or transplanting seedling		↔										
First application of insecticide		↔										
First application of fertilizer			↔									
Second application of insecticide			↔									
Second application of fertilizer				↔								
Application of rice growth hormone				↔								
Harvesting rice crop production		←	—	—	→							
Manage water in the farm												
Season												

= *dry season* = *wet season* = *dry spell*

Growing rice involves several costs: land lease (except for farmers who own land), seed, labour (soil preparation, seeding, transplanting, harvesting), fertilizer, insecticide, herbicide and growth hormones. These costs amount to about 3,200 baht (approximately US$100) per rai. Under a rice insurance scheme (for the period October 2010 - July 2011), the Thai government set different guaranteed prices for different rice varieties, up to a maximum production of one tonne per household and product per rai. The Chainat I variety costs around 10,000 baht per tonne (US$330). Rice production per rai is around (not more than) 519 kg; this means farmers could sell their rice at 5,190 baht (around US$170) per rai, or earn at least 1,990 baht net per rai (around US$60) per harvest. If they can produce more than 519 baht (around US$17) per rai, they can get a higher return, but are then ineligible to receive government insurance. Farmers typically earned a profit of about 3,300 baht per rai (around US$110) when they achieved the highest rice yields.

Table 5: The government's rice insurance scheme as issued on 14 September, 2011

Type of Rice	Insurance price (baht per tonne)	Limit of tonne per household	Limited rice production per rai in unirrigated area (kg)	Estimated rice production per rai in irrigated area (kg)
Jasmine rice	15,300	14	378	418
Jasmine rice (grown outside Northeast region)	14,300	16	495	518
Pathum Thani 1	11,000	25	643	768
Other rice	10,000	25	519	634
Sticky rice	9,500	16	397	482

Source: Office of Agricultural Economics (2011)

Sugar cane farming

Field crops cover 27,012 rai (43.22 km^2) or 57.9% of the sub-district's agricultural area. This includes sugar cane, cassava, maize as well as other crops. Focus group discussions with farmers indicated that sugar cane accounts for around 60% of the total area of field crops (16,207 rai or 25.93 km^2). Farmers switch to other crops, such as cassava and maize, when prices increase the profitability of these crops. In 2011, the initial prices of sugar cane in the 2010/11 season were estimated (by the government) to be 945 baht per tonne (around US$30).[1] Most of the sugar cane farmers are assigned quotas for the maximum amount of sugar cane they can produce. In turn, this means that farmers are assured that their products will be purchased by sugar mills. Under the quota system, sugar cane products must be sent to a sugar mill for processing. However, there are no sugar mills in Chainat province. Therefore, quota leaders send their products to sugar mills in nearby provinces (Chainat Province Agricultural Extension Office, 2010).

It takes 11 to 12 months to cultivate sugar cane. Farmers plant their fields in November and harvest in November or December of the following year. As sugar cane is a ratoon crop – new shoots can grow from the cut-down plants – farmers usually replant their fields after every five crops. Table 6 outlines the sugar cane crop calendar for the Sapanhin sub-district.

Table 6: Sugar cane seasonal calendar

Activity	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Soil preparation (in the first year)	◄►											
First application of herbicide	◄►											
First application of fertilizer			◄►									
Second application of herbicide								◄►				
Second application of fertilizer								◄►				
Harvesting Previous crop product		◄►										
Season												

= *dry season* = *wet season* = *dry spell*

[1] See Wongsamuth, N. (2011) 'Producers say sugar costs may lift prices'. The Bangkok Post, 1 July. http://m.bangkokpost.com/business/214851.

On average, farmers invest around 5,300 baht (around US$170) into their crops and can harvest 15 tonnes per rai. For a sugar cane price of 945 baht (around US$30) per tonne, farmers can sell the products for 14,175 baht per rai (around US$470) and gain 8,875 baht per rai (around US$300) in return. As with rice farming, climate risks such as flash floods and prolonged dry spells could reduce sugar cane yield and quality. Most of the sugar cane farmers reserve some areas for growing rice for their own household consumption.

Photo Credit: creativecommons | CIAT International Center for Tropical Agriculture

Other crops and household income sources

In addition to rice and sugar cane, people in Sapanhin sub-district also grow cassava, maize, fruit, flowers, vegetables and ornamental trees. Farmers choose their crops based on their knowledge, experience, and the investments required. Households generate income by producing handicrafts, including hand-woven cotton and silk, coconut brooms and dried water hyacinth baskets – all done mostly by women. In addition, household surveys showed 75.8% of Sapanhin households harvest forest products – food, fuelwood, medicinal plants and other items – throughout the year from the three small community forests in the sub-district. Key forest products are bamboo, bamboo shoots and termite mushrooms. Most of this harvesting is for household consumption, though some items are also sold to generate extra income.

Key natural resources for livelihoods

Sapanhin residents have diverse livelihoods, but almost all depend on two key natural resources: water and forests. Farmers depend predominantly on seasonal rain and on water from some small rivers, lakes and ponds for agriculture. Forests also provide additional incomes for households and enhance livelihoods.

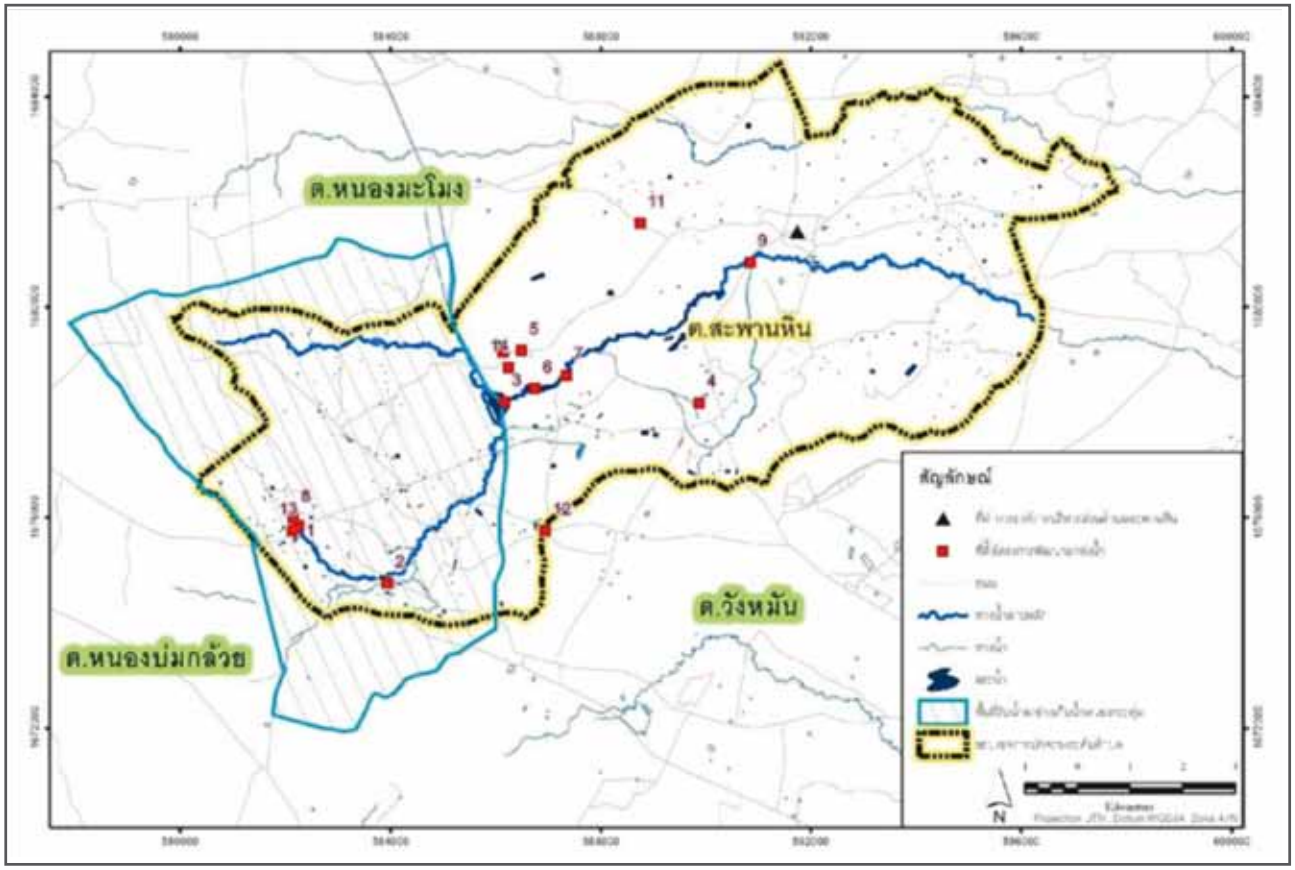
Water resources

The Sapanhin community has two natural water sources. The Sub-district Administration Organization has developed 12 water resources, including four reservoirs, three check dams, four pipelines and one pond. In addition, farmers have excavated 394 wells on their farms to store water throughout the dry season.

In focus group discussions, however, community members said most people could not rely on these water sources, as they run dry during, or even before, the dry season. Around half do not function well enough to divert water to farms or retain it for them, especially during the dry season. Most farmers agreed that they were at risk of drought. Although most farmers have small wells, water levels drop significantly in the dry season and cannot meet demand. This was especially true for sugar cane farmers, who need to irrigate their fields in order to help them get through the dry season and produce high-quality cane. Only well-off sugar cane farmers can excavate wells big enough to irrigate their fields. At the same time, floods can be a problem; Sapanhin is a mountainous/hilly area, and during periods of heavy rain, water from the highlands sometimes pours down abruptly, causing flash floods in the lower areas.

Photo Credit: creativecommons | Scott Hadfield

Figure 7: Sapanhin's watershed areas



Source: Kasetsart University, Faculty of Forestry Study Team. Colour and symbol key: triangle = Sapanhin Sub-district Administration Organization office; red square = water resources development project office; gray lines = roads; wavy thick blue lines = main waterways; wavy thin blue lines = smaller waterways; blue shapes = water sources; striped area framed in light blue = reservoir catchment area; black highlighted line = sub-district boundaries.

Forest resources

Nong Mamong district includes about 34,386 rai (55 km^2) of forest within the Khaolak-Khaochonglom forest area, of which 20,933 rai (33.50 km^2) is now managed by the Agricultural Land Reform Office in order to allocate degraded forest land to landless farmers. Another 13,376 rai (21.40 km^2) is classified as National Reserved Forest, spread across four sub-districts including Sapanhin sub-district (Agricultural Research and Development Region 5, 2006). The small bits of forest that have not been allocated or reserved are managed by the Royal Forestry Department.

Sapanhin has 8.26 km^2 of mixed deciduous forests, mostly on the western half of the sub-district, covering about 8.8% of the total territory. The two main community forests within the sub-district are the Khao Lak and Nong Kata forests. In addition, farmers also keep small forests around their fields.

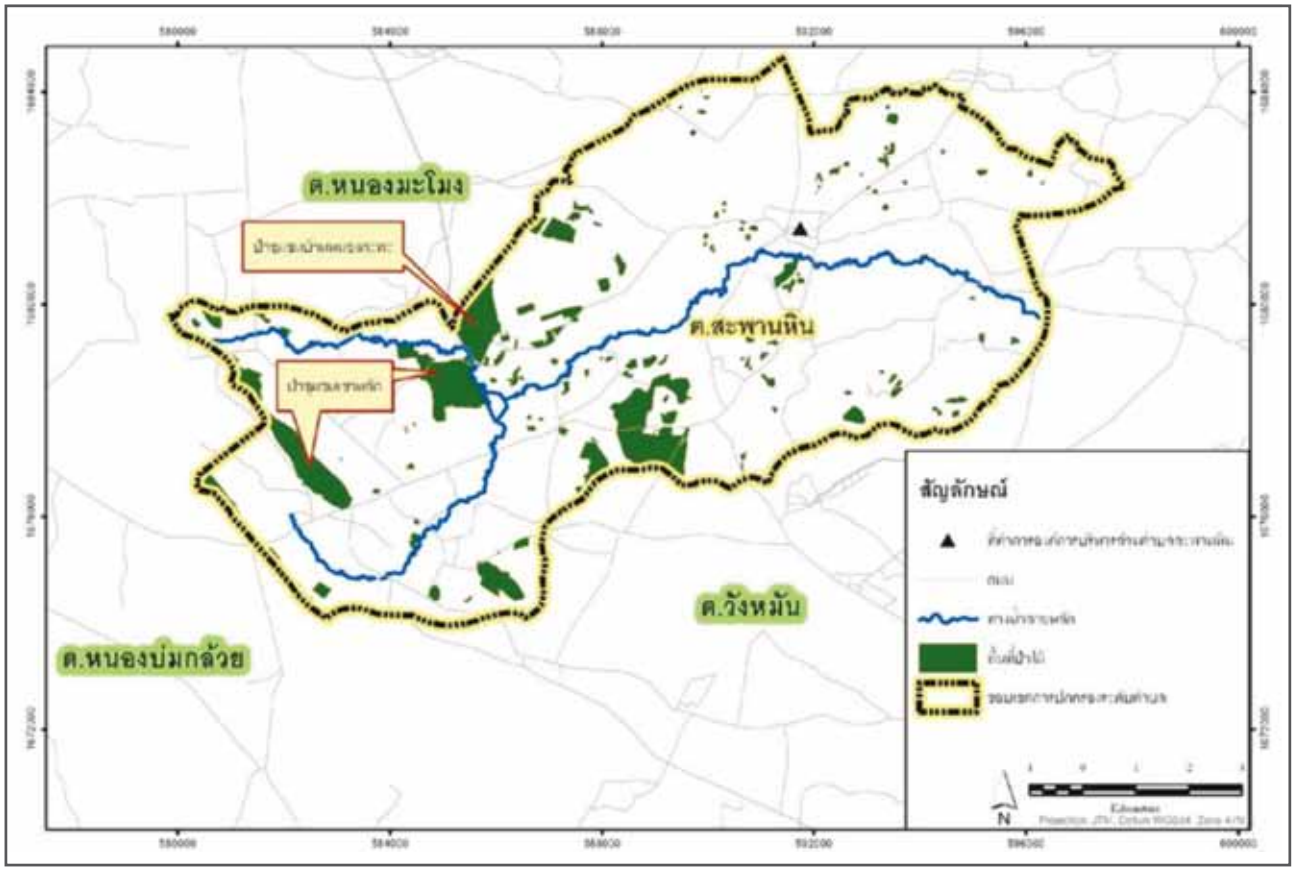
Photo Credit: creativecommons | Tony Roddture

There is no official body responsible for managing the forests sustainably. However, from time to time the Sapanhin Sub-district Organization Administration organizes educational and other activities on topics such as forest fires. In addition, community members have established ground rules for sustainable use of the forests, which allow people to harvest only non-timber products and do not allow anyone to encroach upon the forests for farming. Despite this, however, in focus group interviews, community members said the forest area has decreased due to encroachment from sugar cane farmers, who want to expand their farming areas without investing in purchasing or renting land. In addition, intensive harvesting of forest areas has also degraded the community forests and affected livelihoods.

Figure 8: Khao Lak forest

Figure 9: Small forest around farmers' agricultural area

Figure 10: Sapanhin's forested areas



Source: Kasetsart University, Faculty of Forestry Study Team. Colour and symbol key: triangle = Sapanhin Sub-district Administration Organization office; gray lines = roads; thick wavy blue lines = man waterways; green = forests; thick highlighted line = sub-district boundaries.

4. Climate trends in the central plain and Chao Phraya River basin

Photo Credit: creativecommons | International Maize and Wheat Improvement Center

Sapanhin is in Thailand's central plain and Chao Phraya River basin, where scenarios developed by the Southeast Asia START Regional Centre (SEA START RC, 2010) suggest that there will be significant climate change impacts by 2045-2065. Specifically, the scenarios predict increases in average maximum and minimum temperatures, changes in precipitation, longer summers, shorter winters, and a wetter rainy season.

The scenarios, which are based on the results of eight general circulation models (GCMs), show the annual average maximum temperature in the central plain and Chao Phraya River basin rising from the current 33.49ºC to 36.90ºC (this is the median value; the range is 36.14ºC to 38.22ºC). Temperatures are expected to be higher year-round, including during the summer, when the region already has some of Thailand's highest average temperatures; several models project average highs above 40ºC in March, April and/or May (the median projections show April as the hottest month, with an average high of 39.55ºC).

The scenarios project the average minimum temperature in the central plain and Chao Phraya River basin to increase from 23.74ºC to 27.76ºC (there is less variation in these projections, with a range of 26.74ºC to 28.46ºC). Again, the changes are seen year-round, with the largest projected increases in December, now the coolest month (from 20.06ºC to 24.67ºC), and in March (from 24.18ºC to 28.59ºC).

Precipitation projections, meanwhile, vary more significantly. The median values show higher precipitation during the rainy season, and a roughly 10% increase in annual precipitation from 1,095 mm to 1,210 mm. However, although more GCMs predict increases than decreases in rain, the projections vary widely, for both monthly and annual precipitation. For September, the rainiest month, the projections range from 187 to 252 mm (the median is 245 mm); for December, now the driest month, the range is 5 mm to 25 mm (median: 14 mm). For total annual precipitation, the projections range from 839 mm to 1,627 mm.

The SEA START scenarios also project that the central plain and Chao Phraya River basin will have longer, warmer summers (defined by the number of days that the maximum temperature is over 35ºC) and shorter, warmer winters. By the end of the century, the analysis shows, summer in the region could become as long as seven to eight months.

Finally, SEA START notes that several studies and projections have indicated that across Thailand, erratic weather patterns and extreme events – such as floods and droughts – could become more common and more severe, exacerbating what are already significant climate risks for farmers in some areas.

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5. Community exposure to climate change, variation and extremes

As noted above, the Sapanhin sub-district has long experienced flash floods caused by runoff from Banchang District, Uthai Thani onto lower areas during heavy rains. However, community members report that flash floods have become more severe and more frequent in recent years, costing most farmers their crops. The eastern part of Sapanhin is at a higher elevation than the west, so floodwaters tend to flow downhill to the villages on the west side of the sub-district, with Nampu, Pu Noi, and Khao Lak villages hardest-hit. Those same villages are also the ones most exposed to wildfires, because they are closest to the sub-district's forests – though everyone who harvests forest products is affected when the forests burn.

In terms of water for agriculture, however, it is the east side of Sapanhin that is worst-off. Most of the sub-district's water resources are in the central area and channel water to the lower-lying regions, which are on the west side. This means the east side is likelier to be left without water during droughts.

Recent climate extremes

Sapanhin has already experienced the impact of climate variability and extreme weather, with two droughts and three floods in the last five years; in 2010, a severe drought in August was followed by a flood in October, as shown in Table 7. Short- and long-term measures are needed to protect the community from the impacts of future extreme events.

Table 7: Records of disasters

Year	Disaster	Onset time
2007	Drought	November
2008	Flood	September
2009	Flood	May
2010	Drought	August
2010	Flood	October

From November 2007 to March 2008, seven provinces in Thailand, including Chainat and its Sapanhin sub-district, experienced droughts and were declared disaster areas (Secretariat of the Cabinet, 2008b). Local farmers said in interviews that the drought had affected them in November 2007. In September 2008, many provinces, including Chainat, had flash floods due to heavy rainfall and forest runoff; Sapanhin was one of the affected areas (Secretariat of the Cabinet, 2008a; 2009).

In May 2009, northern and central Thailand experienced rain and isolated heavy rainfall. People in the foothills, near waterways and in lowland areas were warned of the danger of flash floods. Chainat was one of the provinces for which a severe weather alert was issued (Thai Meteorology Department, 2009).

From February until early May in 2010, most areas of Thailand were dry and experienced abnormally low levels of rainfall. Agricultural areas, mainly in upper Thailand, were affected by drought (Thai Meteorology Department, 2010); Sapanhin, in the central area, was one of the affected areas, and many government authorities, including the Chainat Provincial Administration Office, Chainat Irrigation Office and Chainat Disaster Prevention and Mitigation Office, provided water, water pumps and support for the dredging and deepening of ponds.

In 2010, a strong monsoon caused by a low pressure area in the South China Sea moved over the lower central, upper south and the eastern regions of Thailand. In October, the southeast monsoon moved over the Andaman Sea, the south and the Gulf of Thailand, causing heavy rains in many areas, including Sapanhin (Bangkok Biz News, 2010).

Financial support for crop failure and support during and after the disaster consisted of both short-term and partial recovery measures, but did not promote a longer-term plan. Farmers did receive financial support from the government to recover from their crop failures due to natural disasters such as floods, droughts and pest outbreaks. In late 2010, after a large flood impacted agricultural areas throughout the country, the government reconsidered financial support to farmers affected by natural disasters to 2,098-4,908 baht (US$65-165) per rai (Secretariat of the Cabinet, 2010).

Table 8: Government financial support to farmers affected by natural disasters

Type of plantation	Compensation (in baht per rai)
Rice farm	2,098
Other field crops	2,921
Orchard and others	4,908

Source: Secretariat of the Cabinet (2010).

6. Farmers and vulnerability

As most of the agricultural households in the Sapanhin sub-district are rice and sugar cane farmers, this report focuses predominately on these two groups who will be most affected by climate risks and variability.[2]

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During focus group discussions, rice farmers observed that there had been a delay in the onset of the rainy season. Rice farming requires a lot of water, especially at the beginning of the growing season and during the flowering stage. Too little water at the beginning of the season damages seedlings. Rice farmers also worry about prolonged dry spells, which could either destroy their crops or reduce production.

Sugar cane farmers start their growing season in November or December, and do not need as much water as rice farmers. However, prolonged dry spells could also affect the quality and yield of their crop. Infestations of sugar cane borers could also worsen the situation during dry spells.

Table 9: Farm damages and government financial support in the Sapanhin sub-district

Year	Event	Onset	Crops	Area (rai)	Number of affected farmers	Compensation (baht)
2007	Drought	November	Rice	1,940	143	803,160
			Other field crops	1,491	99	863,289
2008	Flood	September	Rice	1,236	178	1,034,532
			Orchard	493	58	298,758
2009	Flood	May	Rice	85	7	51,510
			Other field crops	65	6	54,405
2010	Drought	August	Rice	722	81	1,514,756
	Flood	October	Rice	5,767	504	4,826,979
			Other field crops	234	24	683,514

Source: Nong Mamong District Agricultural Office (2010).

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Both rice and sugar cane farmers have experienced climate risks and variability over the few past years in different ways; for a detailed outline, see Tables A1 and A2 in the Annex. Due to limited resources, only some households have been able to take proper adaptive measures. Most farmers have yet to respond to those risks and still practice the same methods of cultivation. However, the Sapanhin Sub-district Administration Organization has started discussions with community members to try to help farmers adjust to future risks and variability.

[2] It is important to note that rice farmers often face multiple threats at once; in 2010, for example, a planthopper infestation damaged most of the rice farming areas within Chainat including Sapanhin (Office of Agricultural Economics, 2010).

7. Adaptation and development in Sapanhin Sub-district

The Sapanhin Sub-district Administration Organization is particularly well-positioned to support the community in adapting to climate change and reducing vulnerability. As the local government entity, it is in close contact with the people and understands their needs and concerns. It has its own budget, sets priorities for development, and can also connect with other government departments and higher-level officials (such as at the district and provincial levels) to bring in additional resources and knowledge.

The Sapanhin Sub-district Strategic Development Plan

In 2007, the Sapanhin Sub-district Administration Organization formulated a three-year strategic plan (2008-2010) as a local development framework. Though the plan did not directly address climate risks, it touched upon the related issues of natural resources and environmental management. Table 10 summarizes the plan's key points.

Table 10: Three-year strategic plan and development guidelines

Strategy	Development guidelines
Value added agriculture	• Manage water resources for household consumption and agriculture • Develop roads and other public infrastructure and utilities • Add value to agricultural products • Promote and support occupational groups and local economies
Improving the quality of life	• Promote and support education • Promote health care and prevent contagious diseases and drug use • Promote and support exercise • Promote and support religious practices, traditions and customs • Support social groups of children, women, elderly, disabled and the disadvantaged • Promote and support peace in the community • Provide relief after disasters
Good governance	• Provide high-efficiency governmental services • Promote and support personal capacity-building • Promote democratic systems and community participation
Economic empowerment of the community	• Support the dissemination of traditional wisdom and practices that support self-sufficiency • Alleviate community poverty • Develop local products and seek market opportunities
Development of tourism and natural resources and environmental management	• Protect and restore natural resources and the environment • Improve community environment • Formulate local city plans • Promote and support local participation in tourism development

Source: Sapanhin Sub-district Administration Organization (2007).

Sapanhin Sub-district Adaptation Action Plan

Through questionnaire surveys, interviews and focus group discussions, this project identified local people's top concerns – water resources and forests – and ways in which better water management and forest conditions could benefit the community, especially rice and sugar cane farmers. Representatives of the Sapanhin Sub-district Organization, the Sapanhin Sub-district Agricultural Office, village heads, farmer groups, occupation groups, forest ranger volunteer groups and youth groups all provided input. These priorities and insights were then distilled into a draft Community Adaptation Plan that was presented to the Sapanhin Sub-district Organization's council, with the recommendation that it be integrated into the Strategic Development Plan. Table 11 outlines the key points of the proposal.

Table 11: Community Adaptation Action Plan

Strategy/Action Plan	Purposes	Activities	Indicators	Duration (3 yrs)			Key actor	Supporting actors
				2011	2012	2013		
Strategy 1: Water resources provision and development for sustainable utilization								
1.1 Develop small water reservoirs in rice and crop fields	To provide and develop water resources for agriculture	1. Survey geographic area and water resources in the community 2. Have community analyze water usage 3. Dredge and develop water resources in rice and crop fields 4. Promote the use of canopy plants and ground cover plants 5. Regulate measures for water usage via community participation	Effective management of water usage through community participation.	√	√	√		
1.2 Provide and improve reservoirs	To manage water effectively and sustainably by the community	1. Survey community water resources 2. Gather information on water quality in the community, adequacy of water, drought periods, and flooding, which impact the livelihoods and way of life of farmers 3. Designate guidelines for community participation in the effective management and restoration of water resources 4. Develop management, restoration and monitoring mechanisms for monitoring water resources	Database of water resources in the community; Water resources management, restoration and monitoring mechanisms; Guidelines to restoring water resources in the community.	√	√	√	Sapanhin Sub-district Administration Organization/ Farmers network /PHV	Agricultural office/ Irrigation office/ Natural resources and environment office
1.3 Promote efficient water use	To provide adequate water	1. Set up learning processes for the efficient and sustainable use of water 2. Introduce activities to promote efficiency of water use at household and community levels 3. Set up a knowledge exchange forum to share lessons learned 4. Develop community practices for the efficient use of water	An action plan for the efficient use of water; Guidelines for efficient water usage at the household and community levels; Community practice in the area of efficient water use.	√	√	√	Sapanhin Sub-district Administration Organization / Community network/NEPV	Agricultural office/ Irrigation office

Strategy/Action Plan	Purposes	Activities	Indicators	Duration (3 yrs)			Key actor	Supporting actors
				2011	2012	2013		
Strategy 2: Conservation and restoration of natural resources and local biodiversity								
2.1 Prevent encroachment on forest/public areas	To protect public and forest areas	1. Survey borders and check the current status of public areas 2. Analyze problems and produce guidelines via community participation process 3. Communicate prevention methods to the community 4. Monitor encroachment	Produce a public area encroachment prevention plan and monitoring mechanism.	√	√	√	Sapanhin Sub-district Administration Organization	Nong Mamong District/Chainat province/Department of lands/Forestry/ Agricultural land reform office
2.2 Protection from forest fires and open burning	To reduce the problem of forest fires and open burning	1. Survey areas at risk from forest fires and open burning activities 2. Analyze problems and produce guidelines for prevention via a process of community participation 3. Communicate preventative methods to the community 4. Monitor forest fires and open burning 5. Designate fire blockage and regulate no-open burning measures.	Community regulation and preventative measures; Introduce monitoring mechanisms.	√	√	√	Sapanhin Sub-district Administration Organization	Nong Mamong District/Chainat province/Agricultural office
2.3 Land use	To use land more effectively	1. Analyze problems of land use and produce guidelines to solve any problems via community participation processes 2. Communicate guidelines for land use to the community 3. Formulate clear zoning plans 4. Promote the integrated use of land	Land use planning; Land use zoning; Identify the percentage of farmers that practice integrated use in the area.	√	√	√	Sapanhin Sub-district Administration Organization	Sapanhin district/ Office of lands/ Agricultural provincial office
2.4 Conservation of local biodiversity	To promote knowledge exchange and increase biodiversity	1.Conduct a biological database survey 2. Evaluate impact of community activities on local biodiversity and identify potential solutions 3. Formulate plans to increase biodiversity 4. Promote conservation of plant breeds / conservation of local rice varieties 5. Consolidate and communicate the findings of the operation	Introduce action plan to increase biodiversity; Identify the number of local plant/rice breeds that can be conserved; Share knowledge on local plant conservation.	√	√	√	Sapanhin sub-district Administration Organization / Sapanhin school/ Farmers network	Sapanhin district/ district agricultural office/natural resources and environment office/ Forestry

Strategy/Action Plan	Purposes	Activities	Indicators	Duration (3 yrs)			Key actor	Supporting actors
				2011	2012	2013		
Strategy 3: Promote environment-friendly way of life and consumption								
3.1 Integrate organic agriculture into current practices	To develop the quality of agricultural products, promote safe agriculture and improve well-being	1. Survey current chemical use in agriculture 2. Create a process to collect and manage knowledge concerning safe and environmentally friendly agricultural practices (organic agriculture) 3. Support farmer activities 4. Establish knowledge exchange forums to share lessons learned 5. Develop community practices in the area of effective organic agriculture	Create a database of chemical use in agriculture; Increase the area of organic agriculture; Share knowledge in establishing organic agriculture; Establish a knowledge learning area for organic agriculture.	√	√	√	Sapanhin Sub-district Administration Organization /Farmer network/Sub-district agricultural office	Provincial agricultural office/Land development office/ Non-formal education office/ Provincial public health office
3.2 Reduce waste and promote recycling	To improve well-being	1. Survey the recycling of waste in the community 2. Analyze amount of recycled waste in the community 3. Collect and manage knowledge on waste management and reuse 4. Create management mechanisms for community waste 5. Share lessons learned via a community participation process	Decrease the amount of community waste; Introduce waste management mechanisms; Share knowledge concerning waste management and reuse.	√	√	√	Sapanhin Sub-district Administration Organization	Natural resources and environment office/ Provincial public health office
3.3 Wastewater management and water monitoring via community participation	To develop methods for community wastewater problem-solving	1. Survey water resources/community wastewater quality 2. Analyze sources of community wastewater 3. Create community wastewater management processes, including water quality monitoring 4. Support water quality monitoring mechanisms 5. Establish a knowledge exchange forum for sharing lessons learned.	Create a community wastewater database; Improve water quality in the community; Establish monitoring mechanisms.	√	√	√	Sapanhin Sub-district Administration Organization/ Community network/ Natural resource and environment protection volunteers	Natural resources and environment office/ Natural resource and environment protection volunteers
3.4 Develop local educational courses in climate risk preparedness	To share knowledge and prepare to deal with climate risks	1. Formulate courses on climate risk analysis and disaster preparedness 2. Establish processes for communicating knowledge 3. Communicate the current situation and ways to deal with possible natural disasters 4. Share lessons learned via community participation processes	Local courses in the area of climate risk preparedness; Share knowledge; Increase community awareness of risks; Measure outcomes by number of people trained.	√	√	√	Sapanhin Sub-district Administration Organization/ Community network/ Natural resource and environment protection volunteers	Natural resources and environment office/ Natural resource and environment protection volunteers

Strategy/Action Plan	Purposes	Activities	Indicators	Duration (3 yrs)			Key actor	Supporting actors
				2011	2012	2013		
Strategy 4: Efficient local administrative management								
4.1 Monitoring ecosystem changes via a community database	To lesson impact of community activities on ecosystems	1. Create a database of community biodiversity 2. Monitor community operation 3. Evaluate changes in biodiversity in the community, before and after the operation 4. Analyze factors that lead to biodiversity change 5. Share lessons learned via community participation processes	Produce a community ecosystem change report	√	√	√	Sapanhin Sub-district Administration Organization/ Sapanhin school/ Community network	Natural resources and environment office/ Provincial public health office/Office of the basic education commission
4.2 Develop an information system for decision-making	To improve and develop the use of information systems within the community	1. Develop an up-to-date data collection system 2. Provide knowledge/guidelines on data use 3. Promote the use of information for decision-making and situation analysis 4. Share lessons learned by the community	High quality information system; Guidelines to use information system	√	√	√	Sapanhin Sub-district Administration Organization/ Community network	Natural resources and environment office/ Provincial public health office
4.3 Community capacity for dealing with climate risks and natural disasters	To develop the community's capability to deal with climate risks and natural disasters	1. Analyze community data 2. Designate both at-risk and safe areas for natural disasters 3. Establish drills to prepare for natural disasters 4. Devise guidelines to assist or solve problems arising from natural disasters	Devise natural disaster victim relief plans within the community; Create safe areas	√	√	√	Sapanhin Sub-district Administration Organization/ Community network	Natural resources and environment office/ Provincial public health office
4.4 Develop networks to deal with natural resources and the environment	To cooperate with all parties to integrate natural resources and environment management	1. Community analysis and community participation 2. Develop community capacity 3. Develop guidelines to integrate operations within the community 4. Support and promote integrated operation processes 5. Share lessons learned	Number of networks in the community	√	√	√	Sapanhin Sub-district Administration Organization/ Community network	Natural resources and environment office/ Provincial public health office

8. Mainstreaming adaptation into local development planning

As noted in the introduction to this report, adaptation to climate change entails making adjustments to minimize negative impacts – or, take advantage of new opportunities that may arise. Füssel (2007) explains that this is a continuous process; a community may adopt modest measures to address a modest threat (e.g. a small temperature increase), but act more aggressively if the threat keeps increasing. Füssel also notes that in many ways, adaptation is not new: societies have long grappled with variable climate, and adaptation often uses well-established tools from disaster risk management, coastal management, resource management, spatial planning, urban planning, public health and agricultural outreach. However, for conditions in some areas, the rate of change and resulting challenges are 'unprecedented', Füssel argues; as a result, many actors, such as resource and spatial planners, who have not explicitly considered climate in past decisions must now do so.

Mainstreaming adaptation means acknowledging these insights and, accordingly, addressing climate threats in their broader social, economic and environmental context, not separately. From the perspective of government, the UNDP-UNEP Poverty-Environment Initiative (2011) defines mainstreaming as 'integrating considerations of climate change adaptation into policy-making, budgeting, implementation and monitoring processes at national, sector and subnational levels'. The process is seen as ongoing, involving multiple stakeholders, and aimed at contributing to human well-being.

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Decentralization has created opportunities for local government agencies to become more accountable to their constituencies. However, as the OECD (2009) has noted, the most appropriate entry points for mainstreaming climate change adaptation in local government depend upon the details of the individual administrative systems, and these vary widely from country to country. The need for balancing bottom-up and top-down processes to improve adaptation is particularly critical at the local level. Inputs from subnational actors are likely to be critical to successful adaptation actions (OECD, 2009). Planning processes should provide channels through which lessons and experiences at the local level can influence decision-making at higher levels, and ensure that higher-level decisions and programmes incorporate local strategies and actions (Lebel et al., 2012).

Guidelines to implement an action plan for community adaptation for climate risk and natural disaster risks in Sapanhin sub-district could be as follows:

- Engage with related organizations, including local administrative organizations, to formulate an action plan. The formulation of an action plan should also consider people/local community/risk group participation.
- Identify financial resources and coordinate with budget authorities to integrate adaptation activities into budget plans. Resources may be obtained from government agencies at different levels (from local to national), NGOs, research institutions and other entities.
- Form a working group to implement the adaptation action plan, with representatives from:
  - Local government
  - Community leaders (sub-district leader/head of the village/community committee)
  - Occupation groups
  - Local experts
  - Women's groups
  - Natural resources conservation groups
  - Water utilization groups
  - Soil doctor volunteer networks
  - Natural disaster prevention volunteer networks
  - Representatives from related organizations, including sub-district/district agricultural officers, sub-district health officers, agricultural promotion officers and NGOs.

- Establish a working group to monitor and evaluate the implementation of the plan:
  - Develop a monitoring and evaluation plan
  - Develop specify key performance indicators
- Monitor and evaluate the operation and share the findings, providing lessons learned and identifying successes, constraints and areas that require improvement; this will enable the implementation working group, as well as other stakeholders, to adjust the adaptation action plan as needed, and also implement it more effectively. It will also provide accountability to funders, and it may provide valuable lessons for others wishing to emulate the process.

9. Conclusion and discussion

Rice farming and sugar cane farming are the most important livelihoods in Sapanhin community, and medium-term climate projections suggest they need to prepare for more severe climate risks and variability. Effective, sustainable water management at the sub-district and household levels, with active community engagement, will be crucial, especially during dry periods.

Livelihood diversification such as off-farm incomes can also give communities more options and reduce their vulnerability. Forests play an important role in this regard; people significantly benefit from harvesting forest products for food, fodder, fuel, medicine and to sell for cash. Strong community involvement in forest management would help sustain the forest and protect livelihoods. Forests can also absorb and slow down runoff, which could help reduce community exposure to flash floods during heavy rains.

Raising awareness of climate risks and variability, communicating climate information and encouraging public engagement are essential if adaptation is to be integrated into community development plans. If local government officials – in this case, the Sapanhin Sub-district Administration Organization – can work closely with other government entities, local organizations and community members, they will better understand the challenges that climate change may bring, and find effective solutions together.

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Annex: Supplemental materials

Table A1: Rice farmers' vulnerability to climate risks

	Risks	Exposure	Sensitivity	Future impacts	Individual Coping strategy	Collective coping strategy
Climate risk	Drought	Delay in the onset of the rainy season	Rice farming required some water during the early wet season for the broadcast or transplant of seedlings; but, delay in the onset of the rainy season causes damage to the seedlings.	Rice farm will be damaged from the delay in rainy season onset.	• Farmers excavate their own ponds to reserve water for individual farm use. • Change to other crops which need less water: mung beans, soya beans and sunflowers. • Farmers migrate seasonally to find jobs in urban areas to diversify household incomes.	Sub-district Administration Organization and Sub-district Agricultural Office support drought-tolerant short-term crops including mung beans, soy beans and sunflowers.
		Prolonged dry spells	Shortage of water immediately before the seed heading stage could damage all or part of rice crop yield. Vulnerability to pest outbreaks during prolonged dry spells.	Prolonged dry spells will continue to cause damage to rice crop yields.	Farmers excavate their own ponds to reserve water for individual farm use.	Tambon Administration Organization (TAO) supports farmers in excavating their own ponds to harvest rain water for their farm use.
	Flood	Flash floods from forest runoff	Flash floods from forest runoff could abruptly destroy paddy fields.	Flash flood will be more unpredictable and can destroy paddy field more severely.	• Farmers grow perennial trees, which could slow down the flood, near their paddy fields to lessen the damage from floods. • Farmers build earth dikes for flood protection around their paddy fields.	• TAO and community forest committee grow more trees in community forest areas to help mitigate the flood. • TOA diverts flood to water resources. • TAO and its community security volunteer groups communicate flood risks with farmers.
Non-Climate risk	Water management	Inefficient man-made water resources	Rice farmers do not have adequate water during prolonged dry spells. This damages the rice crop.	Individual rice farmers will have to invest more in reserving water for their farm use.	Support TAO in improving or repairing water resources.	TAO and Royal Irrigation Department improve and repair the water resources including reservoirs, check dams and ponds.
	Labour cost	High cost of labour for farming	Inevitably, farmers need to invest in labour, which cost at least 3,200 baht per Rai (around US$100), for rice farming along with other investment costs. As a result, they spend too much household money on these costs.	Farmers need to spend money on agricultural labour despite the risk of reduced harvests. However, they still need to engage in rice farming to assure their household food security.	Diversify their household incomes in order to secure money for the cost of labour.	TAO supports community One Tambon On Product (OTOP) groups to increase household incomes.

Table A2: Sugar cane farmers' vulnerability to climate risks

	Risks	Exposure	Sensitivity	Future impacts	Individual Coping strategy	Collective coping strategy
Climate risk	Drought	Delay in rainy season onset.	Farmers delay their new crop planting period which will cause premature harvesting.	Farmers delay their new crop planting period.	Change to drought-tolerant varieties of sugar cane, cassava and maize	Sub-district agricultural office and sugar cane farmer association in the area support drought-tolerant varieties of sugar cane.
		Prolonged dry spells	• Young sugar cane needs a lot of moisture to ensure a quality crop yield; prolonged dry spells could cause the outbreak of fire or insects and lead in turn to reduced production of sugar cane. • Forest fires	• Prolonged dry spell will continue to cause damage to sugar cane crop yield. • Forest fire	Farmers excavate their own pond to reserve water for individual farm use.	TAO supports farmers in excavating their own ponds to reserve rain water for their farm use. Drought tolerance of sugar cane.
	Flood	Flash floods from forest runoff	To reduce damage from flood, farmers have to harvest premature field crops.	To reduce damage from floods, farmers had to harvest premature field crops	Farmers grow perennial trees, which could slow down floods, nearby their paddy field to lessen damage from flood.	• TAO and community forest committee grow more trees in community forests to help slow the floods. • TAO diverts floods to water resources. • TAO and its community security volunteer group communicate flood risks with farmers.
Non-Climate risk	Water management	• A low capacity of man-made water resources • High labour costs for farming	Farmers could not rely on community water resources during prolonged dry spells which damage crops.	Individual rice farmers will have to invest more in reserving water for their own farming.	Support TAO in improving or repairing water resources	TAO and the Royal Irrigation Department improve and repair the water resources including reservoirs, check dams and ponds.

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