Accessibility, utilisation, management and quality of water resources for vegetable production in Ban Ton Phung, Northern Thailand

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Content

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Abstract

An increasing demand for irrigation water in Northern Thailand, has caused problems of water shortages during the dry and hot seasons. A case study on water use and management in Ton Phung village was conducted in order to investigate the effect of water access and availability, on the intensive farming of vegetables in the area. Furthermore, an investigation of water quality in the area was conducted in order to evaluate some ecological consequences of the intensive farming practices. In the study area, we found that 100% of the people were engaged in vegetable farming to some extend. They all practiced intensive farming of their field, but only people with possibilities of connecting to an irrigation system could generate income in all of the 3 seasons (dry, hot and rainy). The ability of the farmers to irrigate their fields also influences whether or not they are accepted in the Royal Project. A possible consequence of the intensive farming activity is a decrease in water quality from upstream to downstream.

I. INTRODUCTION

1.1 Background Information on Upper Mae Pae Watershed

Author: Signe, Contributing Author: Laura

The Upper Mae Pae Watershed is located in the Chomthong district in the province of Chiang Mai, Northern Thailand. The area is inhabited by a variety of ethnic groups; the Thai people generally inhabit the lowlands whereas various hilltribes reside in the upland areas. In this sub-watershed the highland population is mostly Karen and Hmong communities (Mingtipol et al. 2007). During the last few decades, this region has experienced population growth as well as large amounts of deforestation as a consequence of intensive logging activities (Lakanavichian 2001). In 1985, the National Watershed Classification was established in order to conserve the existing highland forest and protect the headwaters of the area. This classification imposed major restrictions on land use for farmers. As a result, there has been a gradual shift from small scale swidden farming of traditional crops, such as upland rice, to intensive farming of cash crops, such as vegetables and fruits (Laungaramsri 2000, Rigg 1993). The combination of deforestation and intensification of agriculture has led to increasing demand for water, causing water shortages during the dry season (Mingtipol et al. 2007, Tomforde 2003, Yamaguchi 2006). As water shortages grew more serious, increased tensions have been observed amongst individuals in the same village, neighbouring villages, and between highland and lowland villages competing for the same water resources (Yamaguchi 2006, Tomforde 2003).

Intensification of agriculture has not only impacted the quantity of water resources available, but also water quality. It has led to increased pollution of surface waters from fertilizer and pesticides residues. This pollution is mainly seen as threat when it is nearby sources of water used for consumption, however the ecological impacts of decreasing water quality are significant and increasingly being recognized as well (Thomas et al. 2002). Where surface water is used for irrigation purposes, the quality of the water can impact soil quality. Poor water quality can lead to salinization of soils and result in decreased field productivity (FAO).

Growing environmental degradation, pollution and scarcity of water, has prompted an increased interest in a more sustainable management of water resources. As water availability is one of the main factors controlling agricultural production capacity (Athipanan & Chainuvati 2006), there is a close relationship between access to water and a farmer's ability to support their household on a crop-based income.

The overall aim of our study was to investigate how farmers' livelihoods are influenced by the availability of water for crop production. Furthermore, to investigate how existing management rules and regulation are implemented in practice in order to gain understanding on how the water is distributed between stakeholders. To narrow down the subject further we chose to focus on water used for vegetable production which is a main form of crop production in the highland areas. Another component of the study was to investigate if any pollution from agricultural practices along the stream had occurred.

1.2 Research Questions and Objectives

With these topics in mind we formulated the following research question:

How do the accessibility, utilisation and management of water resources influence vegetable production and water quality in the Mae Pae sub watershed?

The main research question was investigated based on the following sub questions and objectives:

1) a) How does the community manage the water resources and what are the roles of each stakeholder (government, NGOs, local people)?
   b) What are the conflicts arising from different management strategies?

   Aim: To identify important stakeholders, investigate and evaluate water management rules and regulations in the area.

2) What characterizes vegetable farmers' access to water and cropping systems?

   Aim: To describe the main irrigation systems used in the village and investigate the accessibility and seasonal variation of water resources experienced by the farmer. To describe the agricultural practices in the area, main crops grown and inputs to the system.

3) How does the water use for vegetable production affect the yield and house hold income?

Aim: To understand the importance of vegetable production in the household economy in relation to season and water access.

4) How do changes in water resources at different locations throughout the community (upstream, middle, and downstream) affect the people in the community and in which way is the water quality affected by the water use and agricultural practices (e.g. quality of surface water and water used for irrigation)?

Aim: To identify possible problems arising between farmers from having different levels of accessibility to water resources. To investigate the possible effect that intensive agriculture might have on soil and water quality. To investigate what is being done to address these problems.

II. AREA DESCRIPTION

Authors: Hieu and Margarette

2.1 Physical Geography

The study was conducted in the village of Ban Ton Phung situated in the north west of Thailand. It is located in Khun Pae sub-district, ChomThong district, Chiang Mai province, about 70 km south west of Chiang Mai city. Ban Ton Phung (from now on called Ton Phung) is situated approximately 1200m above sea level in a mountainous region of the Upper Mae Pae Watershed and it encompasses an area of approximately 6000 rai[1]. The village is situated in an area with watershed classification 3 (WSC 3) but bordering a larger area with WSC 2. This means that in the vicinity of the village, planting of fruit trees and intensive cultivation of cash crops is allowed, but moving in to the area of WSC 2 these activities is strictly prohibited (Mingtipol et al. 2007).

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[1] 1 rai= 0.16 hectares

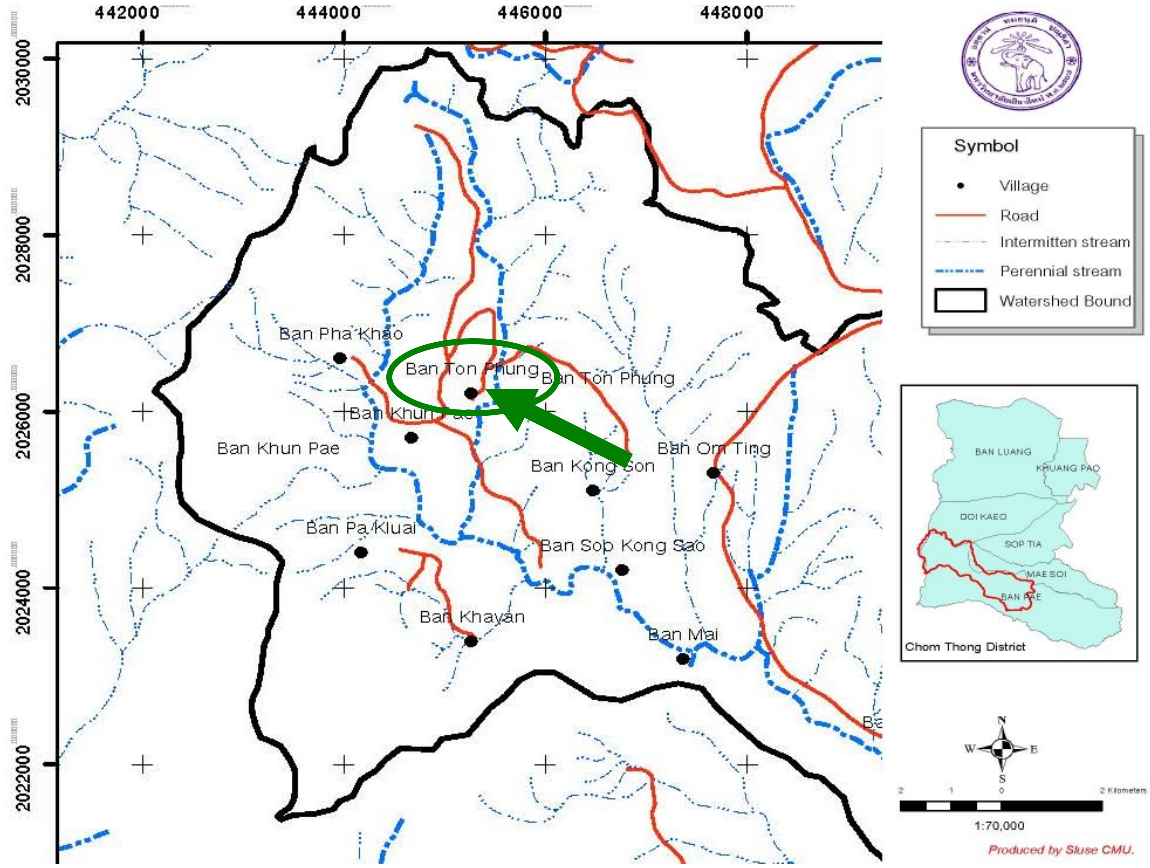

Fig 1. Location map of study area

2.2 Climate

The village is located in the sub-tropical humid zone characterized by three seasons: dry, hot and rainy. Dry season lasts from November to February with months of very low rainfall (<50mm). Hot season begins in March and lasts until May when temperatures are highest and precipitation is generally low. The rainy season has two parts: the first part from May to early June, and the second part from the beginning of July to early November (Mingtipol et al. 2007, Rainfall and temperature patterns- Appendix 1).

2.2.1 Annual Temperature and Rainfall Pattern

Ton Phung has an average annual rain fall of about 1700 mm and average temperature of about 21 ^{o} C (Mingtipol et al. 2007). These climatic conditions of fairly high rainfall distribution and amount favor rapid growth of a large number of crop and plant species. Hence, a variety of agricultural crops are widely cultivated in the area. Red onion, cabbage, and lettuce are cash crops grown in the uphill areas and rice in the lower flood plains. However, during the dry season low precipitation and water scarcity makes it very difficult for farmers to cultivate crops. The soil in the area is characterized by the red yellow podzolic soils and reddish brown lateritic soils. (Community Plan 2006)

2.2.2 Demography

Ban Ton Phung was originally jointly administered with Ban Khun Pae but because of an increase in population the village was separated into two approximately two years ago. Ton Phung is within the district of the Royal Project which seems to be very actively involved in the community’s vegetable farming and natural resource management. The village consists of about 111 household, with a population of approximately 503 people out of which 249 are male and 254 female. (Community Plan 2006)

The village was chosen based on population size and geographic location. Size was important as we were mainly interested in talking with vegetable farmers so we had to ensure a village with enough respondents available, especially because another group was also working in the same village. As our subject was connected to water availability, location also played a role in choice of village. Ton Phung is located between two rivers and land use maps show us that intensive farming of vegetables is of great importance in the area. Furthermore, Ton Phung is located very close to Ban Khun Pae village, so we saw the opportunity of expanding our study into that villages if time would allow it.

The average annual income of the people is approximately 22.725 baht per person. This income is generated mainly from agriculture, livestock and some household savings. Transportation in the village or the sub-district is mainly by pick-up trucks. It is usually very difficult to travel in the rainy season because of bad roads which get very slippery in this season especially as the road is made up of asphalt and lateritic soils. (Community Plan 2006)

III RESEARCH METHODOLOGY

Authors: Margarette, Hieu, Laura, Signe

3.1 Sampling

The target population for our research was the villagers of Ban Ton Phung. For the questionnaire survey, we decided to randomly select 35 out of the total 111 households in the village, 31.5 % of the total population. However, we also did some accidental random sampling if the household we had selected was not at home or if they could not speak Thai (only the local Karen language).

3.2 Literature review

Literature from different sources was searched and used during the preparation period to get a better understanding of the research question and area was used. Also, secondary data was provided to us by the local agencies on water use, management and vegetable production.

3.3 Survey

3.3.1 Direct observation

Direct observation was conducted during the whole research process. During this period, observation was done on the water source, watering and farming practices. Also, observation was done on the current status and functioning of the pipelines and the reservoir systems.

3.3.2 Transect walk upon arrival with village headman

This was a useful participatory appraisal method we did at the beginning of the research period because it allowed us to meet the village headman and became familiar with the landscape. From the transect walk we obtained some information on the basic demographic, and an overview of the water use and management system.

3.3.3 Questionnaire

Questionnaires were applied to the villagers to make generalizations on household, land area, water use and management, income, chemicals used and the various impact of water on vegetable production of the farmers.

3.3.4 Semi-structured and in-depth interview

Semi-structure interviews were used with the different management agencies and vegetable farmers in order to gather some information regarding water use, management, conflicts arising from water use and their perceptions on water use and production as well as suggested solutions.

3.3.5 Field walks and GPS mapping

This method was carried out to know and map out the locations of the stream system as well as artificial irrigation system of the research area. The activity was carried out with the support of the village assistant headman, Mr. Subat. During the field walk, points with the fields and water sources were marked by GPS to obtain the position as well as elevation.

3.3.6 Participatory mapping and Seasonal calendar exercises

During the field stay 2 community meetings were conducted together with group 1 in the village. During these meetings a village map over water resources, a seasonal calendar and a timeline was constructed. Participatory rural appraisal methods were carried out to know the irrigation system, the location of the vegetable fields and farmers' accessibility to the water. During the exercise, the villagers were divided into small groups; males, females and children. At the end of each session a discussion of the issues in concern were facilitated.

A participatory mapping exercise was carried out with a random gathering of villagers from Ton Phung village and was aimed at letting the villagers show the location of their vegetable fields and their accessibility to the water. They came out with maps showing the location of streams, houses, dams, reservoirs and other important points in the village. This was to an extent a successful exercise as the villagers especially the men, came out with a very clear picture of the village and even sharing the fields according to size and names of the various owners. A focus group discussion was later on carried out with a group of the villagers present at that meeting. This was mainly to gather more information on the changes in farming methods especially the history of vegetable cultivation and water management. The villagers were very eager to answer as they consulted with each other before answering the questions they were asked.

A seasonal calendar over cropping pattern, workload, income and water availability was constructed together with a group of 5 farmers.

3.3.7 Water sampling

The water quality was investigated at 4 places along the river system starting above the 1. reservoir at Huai Ton Phung stream close to the headwater of the area, and ending at the outlet of Khun Pae river around 6-8 km further downstream (see Table 1 & map Appendix 2 for approximate sampling location).

Table 1. *Location of water sampling*

Location	GPS coordinates	Elevation	Sample time
1. The Huai ton Phung River	445541-2026688	1102 m	9.2
2. First Reservoir	445312-2026684	1098 m	11.10
3. Ton Phung stream	445203-2025103	1044 m	13.20
4. Khun pae river	448138-2023319	871 m	15.43

At all locations Time and GPS position was noted and the following parameters measured as an average of three separate measurements along a 10 m homogeneous part of the stream: PH, Dissolved oxygen (DO), Total Dissolved Solids (TDS), Salinity (Sal), Conductivity (Con) and Temperature (T). All the parameters were measured using a meter

On each location 2 water samples and 2 sediment samples were collected, stored on ice and within 4 days of collection send to the laboratory where they were analyzed for NO3 and total P concentration as well as pesticide residues. The samples were screened for 3 types of organophosphates (*Mevinphos, Chlorpyrifos, Malathion*) and 3 types of Carpamates (*Cabofuran, Phosalone, Methomyl*).

Furthermore the macro invertebrate fauna of the streams were investigated at each sampling site (except location 2). Three people were collecting animals for 10 minutes using fishing nets and sieves, while 2 persons made the identification of the animals by using an identification booklet provided by the Chiang Mai University.

IV. RESULTS AND FINDINGS

4.1 irrigation system and area of land used for vegetable production

Authors: Hieu, Margarette, Laura

The land used for vegetable production of Ban Ton Phung is situated between 2024000 to 2030000 and 444000 to 448000 (Map position) It can be divided into 3 categories according to accessibility to water. The first category is rain fed land that only relies on rainfall. This type of land is mostly situated in highland areas and the northern part of Ban Ton Phung. The second type is the land that can be irrigated directly from the stream, either by converting the water to the fields by pipes or by digging of irrigation channels. These lands are located along the streams. The third category is the land that uses the irrigation system built by Royal Project and this land is mostly concentrated in a small area in the valley surrounding Ton Phung.

4.2 Water Resources

Authors: Margarette, Hieu Contributing author: Adit

Ton Phung village is divided by two rivers; Khun Pae stream and Ton Phung stream. Khun Pae stream flows from the north and diverts towards the western side of the village area. Ton Phung stream flows north to south and eventually join with Khun Pae Stream further south of Ton Phung. The irrigation system was initiated in 1984 by the King of Thailand, with the objective to have irrigation water for an area of 2000 rai of land surrounding Ban Ton Phung Village. The system includes two main branches of a total pipeline distance of 4.5 km and diameter of 20cm that carry the water from two separate storage reservoirs that are about 770m apart. The water source for this system is mainly Ton Phung stream (Fig 2). The system runs basically by pressure created by the difference in elevation between the higher and lower lands.

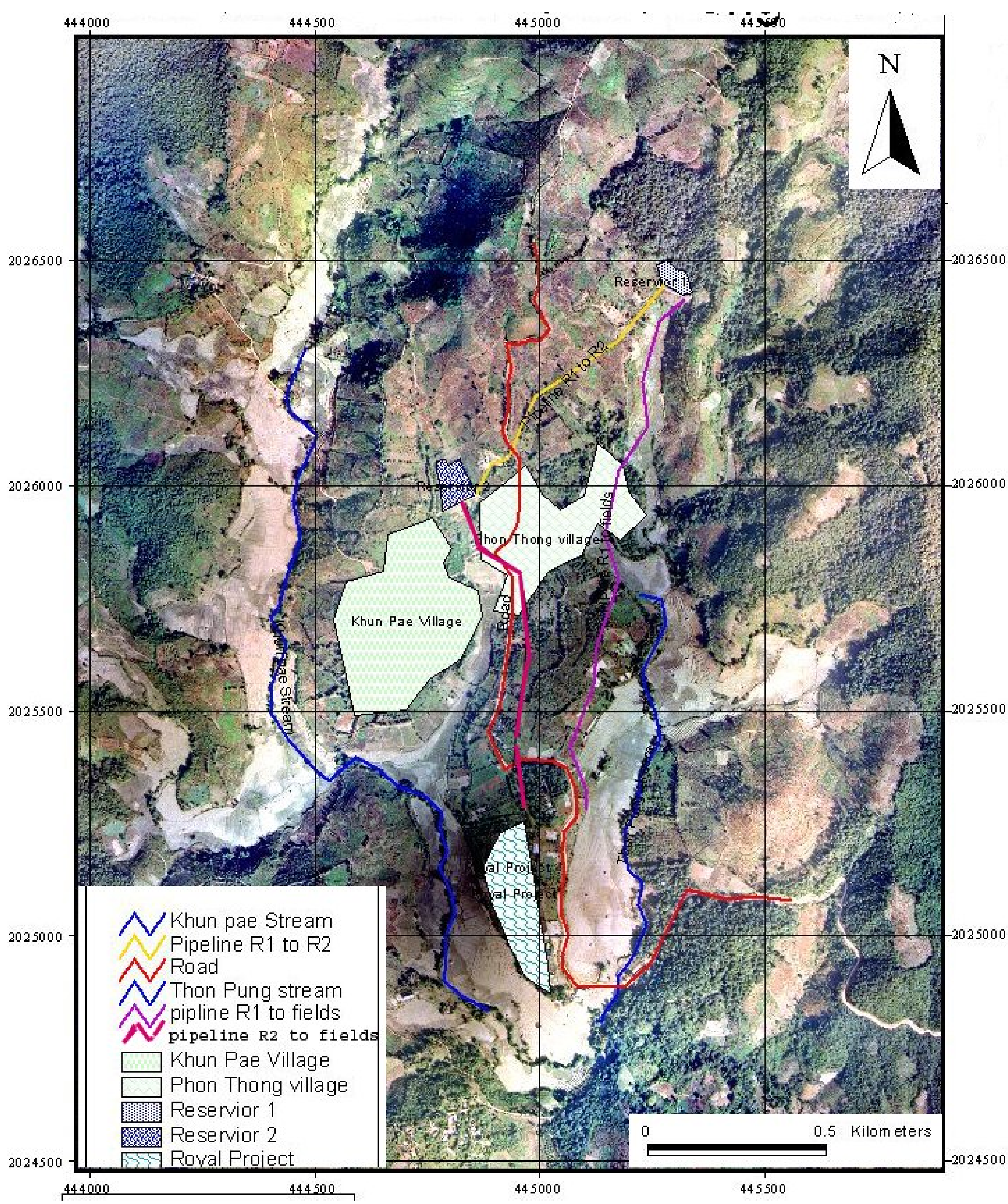

Fig 2. Map of Ban Ton Phung water source system

4.3 How farmers get water to their fields

Authors: Hieu and Margarette

For the fields which are far away from the water source or that cannot access the water from the stream or pipeline system, the farmers have to wait until the rainy season for them to cultivate. With fields situated along the stream, farmers divert the water from the stream by putting their own pipeline directly into the stream or building check dams with walls approximately 0.7 m high across the stream. Small pipes are then installed to bring the water to their fields and watering is done using sprinklers. For fields located in the area of the irrigation system built by Royal Project, farmers can attach their own pipes with smaller diameters to the main pipes running directly from the reservoirs.

4.4 Land use for vegetables

Authors: Signe, Margarette and Hieu

From the questionnaire survey we found that small scale farming was the most abundant farming strategy in the area (Fig. 3A & 3B)

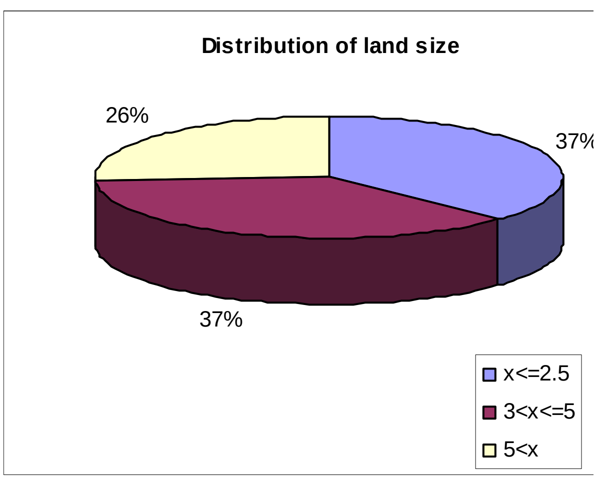

Fig. 3A: *Total agricultural land distribution for selected household.*

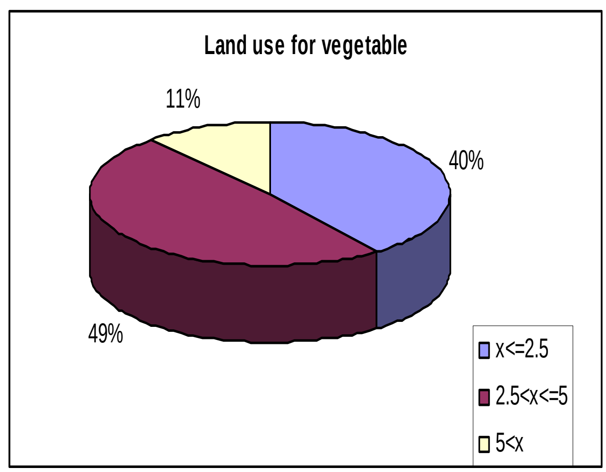

Fig. 3B: *Distribution of agricultural land for vegetable production.*

Based on the above figures, 37% owned less than 2.5 rai, another 37% owned land between 2.5 rai to 5 rai while the remaining 26% owned land greater than 5 rai (Fig 3.A).

When looking at the amount of land used for vegetable planting the pattern is even clearer. Only 11% of the farmers have land bigger then 5 rai, while 49% had a land size between 2.5 and 5 rai and 40% had less than 2.5 rai (Fig. 3.B).

Due to the high percentage of farmers that use such small fields, they need to practice highly intensive farming in order to generate enough income from such small plots of land.

4.5 Vegetable Cultivation

Authors: Signe Contributing author: Margarette

The main agricultural activity in the research area is vegetable cultivation. 100% of the 35 households surveyed are engaged in vegetable production and 82% of their land is used to farm vegetables. They also grow rice but mostly for consumption whereas the vegetables are grown for marketing purposes. Herbs and flowers are also an important income source and are supported by the Royal Project. The main types of vegetables produced in 2006 were cabbage, red onion and lettuce (Fig. 4). More than 80% of the farmers were growing cabbage, 75% grew red onion and 42% grew lettuce. Most farmers were growing two to three different crops per season.

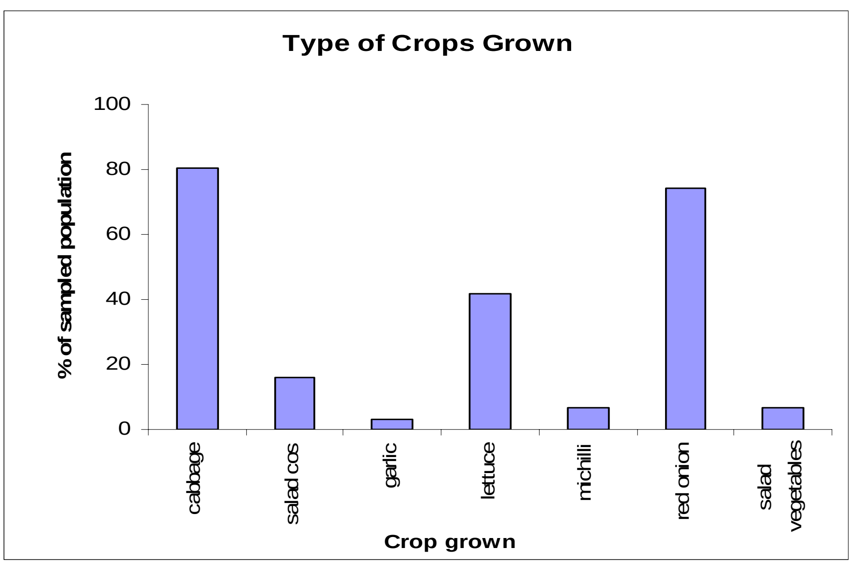

Fig 4. *Crops grown in Ton Phung*

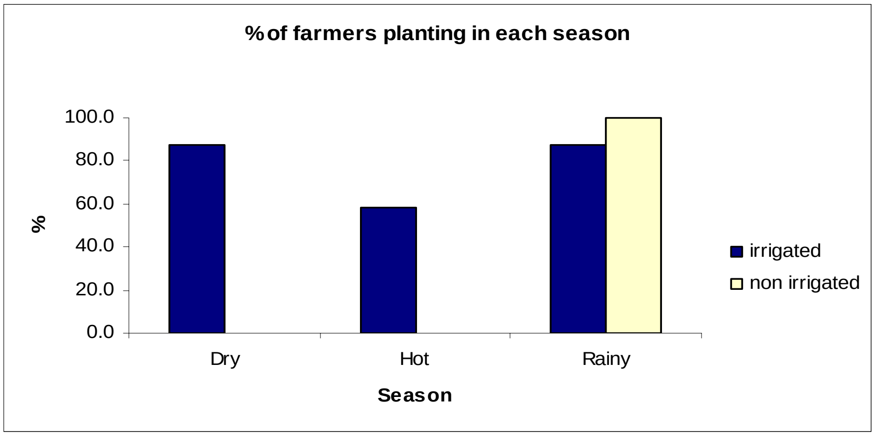

Fig. 5: *Percentage of farmers owing irrigated and non irrigated land farming in each season*

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The ability to farm in the dry and hot seasons was evidently very closely related to the farmers' access to an irrigation system (Fig. 5). None of the farmers having non irrigated land were able to plant in dry season or in the hot season. In the rainy season the percentage of farmers owning irrigated and non irrigated land who could plant was roughly the same, as water was not a problem during this period.

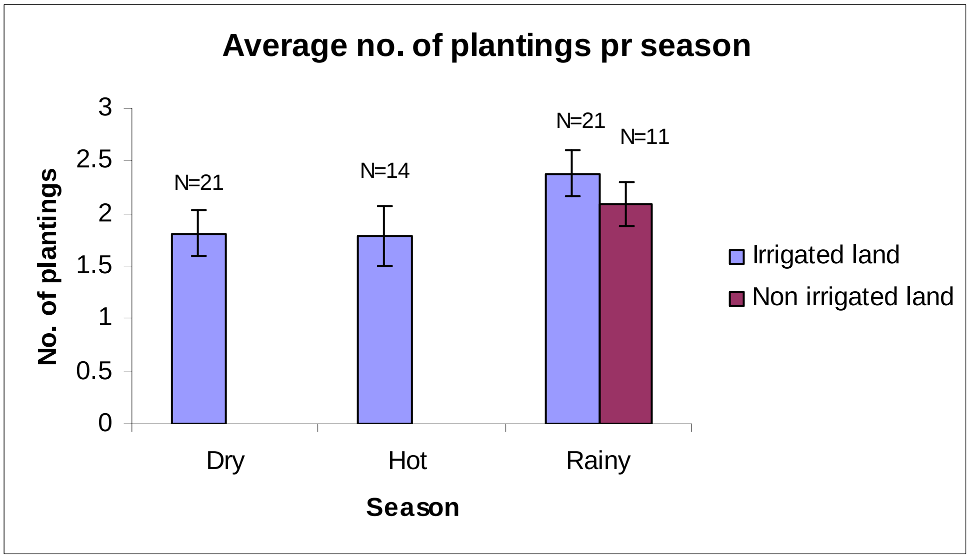

Fig. 5: *Average number of plantings for irrigated and none irrigated farmland.*

One way of analyzing the productivity of the fields is looking at how many plantings the farmers could do per season. Overall there is not much difference between the average number of plantings for each season. However, there is some indication that there is a slightly higher number of plantings during the rainy season, which could also be due to the fact that the rainy season is longer that the other seasons giving farmers a chance to plant again.

4.6 Chemical inputs

Author: Signe

Intensive farming requires a certain amount of inputs in order to avoid nutrient depletion of soils and pest infestation. We found that the most frequently used inputs were chemical fertilisers, pesticides and manure (Table 2).

Table 2. *Percentages of farmers using fertilizers, pesticides, manure and other chemicals on their fields. The group "other" includes different kinds of hormones applied.*

	Fertilizers (%)	Pesticides (%)	Manure (%)	Other (%)
Dry	94.7	73.7	47.4	36.8
Hot	71.4	42.9	28.6	14.3
Rainy	88.5	42.3	15.4	42.3

From the questionnaire survey we found that chemical fertilizers were used by most of the farmers (71 to 95%) throughout all three seasons, whereas the use of pesticides and manure appears to be more dependent upon season. Dry season seems to be the most input intensive period as the percentages of people using chemical inputs were higher than in hot and rainy season (Table 2). The average amount of inputs used in the different seasons is pictured in Fig. 6. The amount of fertilizer used in each season was approximately the same, around 150 kg rai^{-1}. For pesticides and "other" chemicals the amounts were highest in dry and hot season, whereas they were not applied as much in the rainy season. One of our respondents explained that in the hot season they always had problems with pest infestations and therefore had to apply more chemicals in this season.

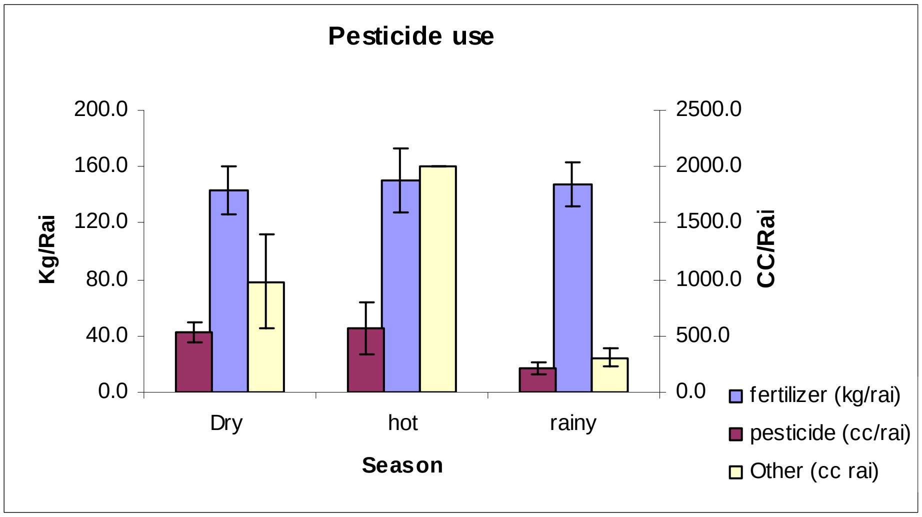

Fig. 6: *Average amount of pesticide use pr rai in dry, hot and rainy season.*

Table 3. *Variation in amount of inputs between the different households.*

	Dry	**Hot**	**Rainy**
Input	Range	Range	Range
fertilizer (kg/rai)	50-300	100-200	100-250
pesticide (cc/rai)	100-1000	200-1000	100-500
Other (cc rai)	200-2000	-	150-550

We observed that ourselves when visiting Ms. Kaelae's field (HH no. 51). Pest infestation had made her cabbage unmarketable. She said the reason for the bad qualities of crops were that she couldn't afford to buy insecticides this season. Her situation illustrated the problem that some farmers were facing as they do not have the capital to buy sufficient amount of inputs. This also explains the big range in Table 3. between the amounts of fertilizer applied by individual households.

4.7 Income from vegetable production

Authors: Adit and Hieu
Contributing author: Margarette

4.7.1 Gross value added and average net income of varying access to water of vegetable farms

Gross value added is the difference between output and *intermediate consumption* for any given sector/industry. That is, the difference between the value of goods and services produced and the cost of raw materials and other inputs which are used up in production. "Gross value added (GVA) is a measure of economic activity at basic prices, excluding taxes plus subsidies" (National statistic UK 2006) The figure below shows the differences in the productivity of irrigated and non irrigated fields from their average incomes earned in the various seasons.

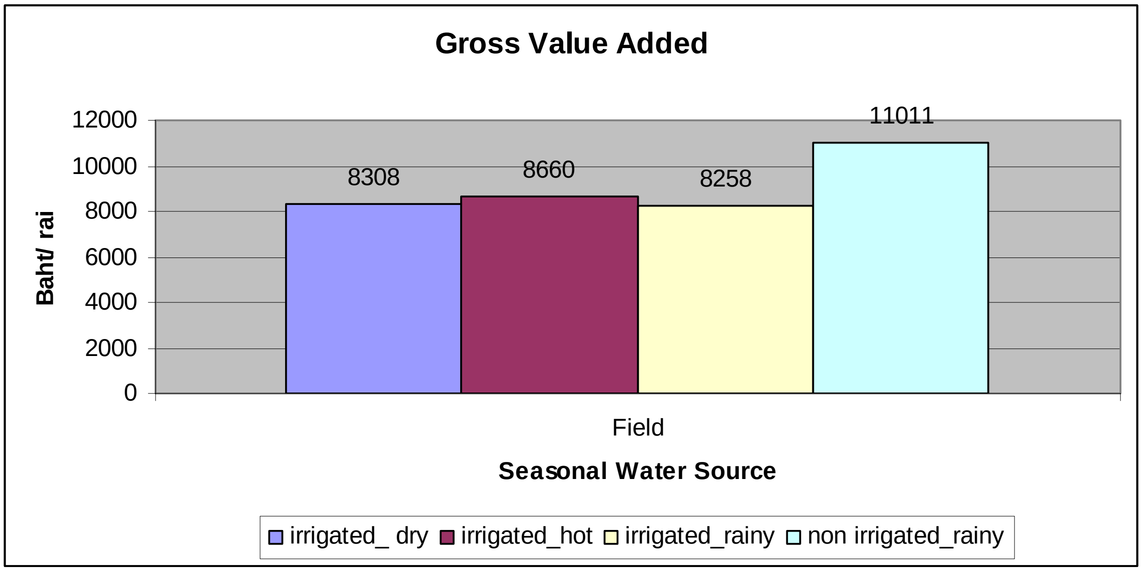

Fig. 7: *Relationship between income, season and access to water.*

Figure 7 show that farmers with irrigated fields earn approximately the same amount per rai for each season. Farmers with non irrigated fields only earn an income during the rainy season from their fields, but this figure shows that it is in fact a greater amount than the income earned by irrigated fields during this season. This might be because the farmers with non irrigated fields do not have to invest money in buying pipes to convey water to their fields. Furthermore, the non irrigated fields are left uncultivated except for during the rainy season, and as such they are more productive since they have been left to regain nutrients, whereas irrigated fields decrease productivity because they are used more frequently during the year.

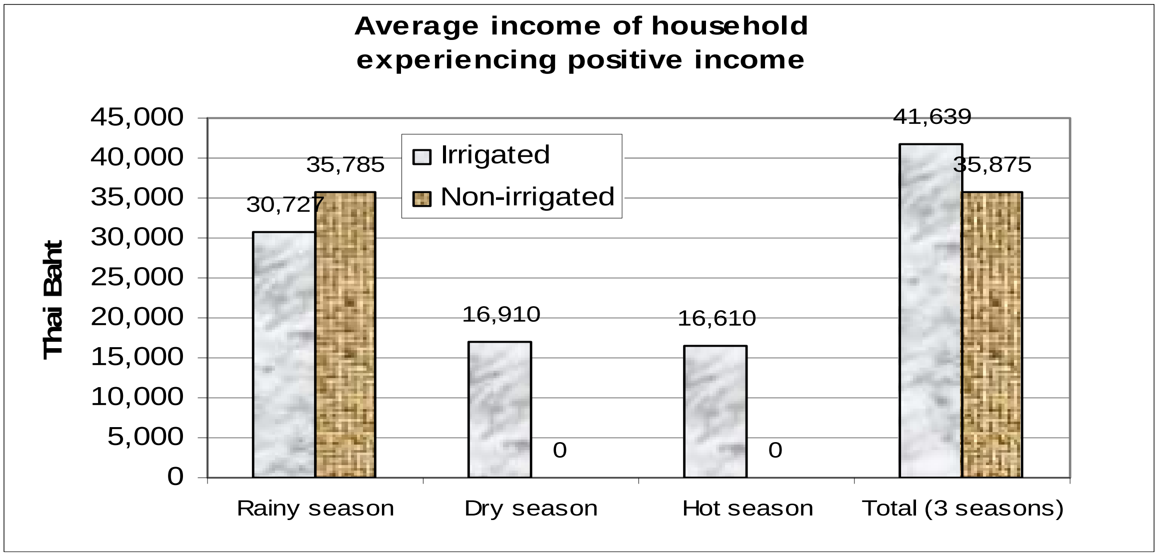

Fig. 8: *Average income of households experiencing positive income*

Here, we tried to analyse the annual average income of households surveyed. 79% of the farmers with irrigated fields generated a positive net income. For those with non irrigated fields, 89% experienced a positive net income. In general, it shows that households with non irrigated fields in the rainy season experienced a higher income than the households with irrigated fields; we observed this is because more land has been cultivated. In the dry season and the hot season, the non irrigated farmers are unable to carry out vegetable farming. But the irrigated fields can still cultivate vegetable with an average net income not as high as in the rainy season. However, the total average annual income of irrigated farmers is significantly higher than those of the non irrigated farmers since the irrigated fields are able to cultivate vegetable throughout the year. The tight link between water availability, season and income was further supported during a participatory exercise where a seasonal calendar was constructed (Appendix 3). However through analysis, we found that some farmers experienced a negative net average income per season. From our sample, approximately four households in the rainy season, four in the dry season and two in the hot season experienced a negative net income. Looking at the total annual income, there are two farmers who experience a negative annual income. But in conclusion the majority of the households investigated experience a positive average net annual income. Thus, we can therefore say that, water plays an important role in vegetable production, as it can help vegetable farmers in Ban Ton Phung to improve their income.

4.7.2 Contribution of off farm income to household.

Off farm income is an important aspect of household income in that it serves as a ‘safety net’. The off farm duties are mostly carried out by farmers who do not grow vegetable in certain seasons especially in the dry season. This is because most of them are unable to access water for the irrigation of their fields while others are unable to buy the pipes which can convey water to their fields. These off farm duties are made up of drivers, traders, middlemen and labourers. These off farm incomes are in most cases re-invested in the vegetable farms: for the purchase of other farming inputs such as fertilizers and herbicides. Income from off farm is considered as additional income. Based on observation and interviews, most of the inhabitants of Ton Phung village own the fields they cultivate but work at times as labourers for other farmers especially in the hot and dry seasons when they have less work in their own farm

4.8 Royal Project vs. Non Royal Project Farmers

Authors Laura, Signe

In this section, we have chosen to examine our findings based on comparing results from Royal Project farmers[2] and non Royal Project farmers. Our reasons for doing this include that our initial observations suggest that Royal Project has great influence on farming systems and water use in the area as well as the stability of farmers’ incomes and livelihoods. Therefore, we will explore this idea further in this section.

4.8.1 Role of Royal Project (RP)

According to RP officials, approximately 30 to 36 farmers in Ton Phung area are farming for the Royal Project (interview of group 3 and our own RP interview 1) From our 35 questionnaire respondents, 17 are Royal Project farmers and 18 are non Royal Project farmers; therefore we interviewed about half of the Royal Project farmers in the area.

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[2] Farmers that have identified themselves as farmers growing vegetables for the Royal Project

The RP supports the farmers by providing them with seedlings, fertilizer and pesticides. These inputs are provided free of charge but the cost is subtracted later when the farmer is ready to sell his yield. The yield is bought by the RP either for the market price or for a fixed price reduced by 25% to cover cost of transportation and other marketing costs. The RP officers also offer technical advice on production to the farmers.

If a farmer wishes to join the RP, the decision is up to RP officer Mr. Kiat on whether to accept them or not. He stated some of the criteria for joining the RP as follows:
"The farmer must accept the price and quality of the products. /../The RP also decides how much of which crops they will buy from the farmer. This depends on the farmers skills ie. an old and skilled farmer will be allowed to grow more products compared to a new farmer. The RP also considers the amount of land the farmer owns and the access to water (reservoir, irrigation)."
When we talked to him he would not say directly that farmers that do not have an irrigation system will be excluded from the project, but he did state that
"*if a farmer does not have a reliable access to water, then they should not join the royal project because they will most likely end up in debt*" (RP interview2). Consequently, it seems like access to water is one of the main factors deciding whether a farmer would join the RP or not.

4.8.2 Access to water

To further explore the differences between RP and non RP farming we have evaluated our questionnaires results.

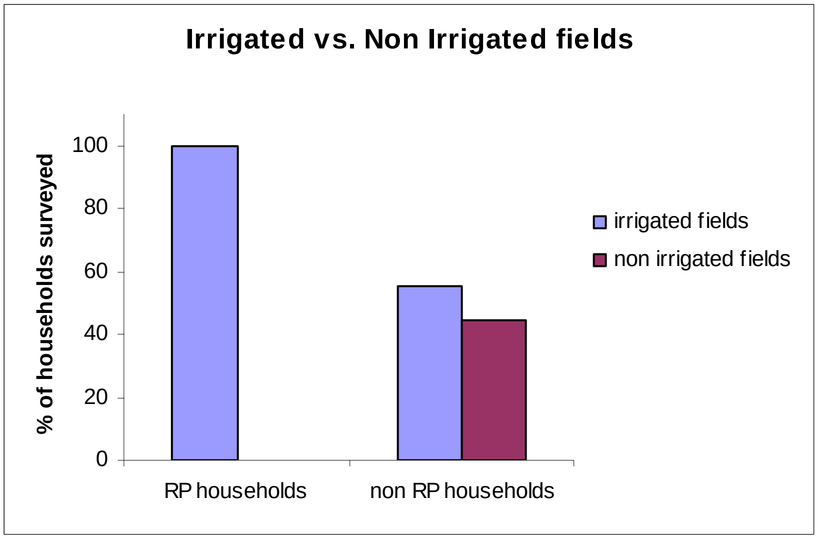

Fig. 9: *Percentage of households with irrigated or non irrigated fields that farms for the Royal project.*

Figure 9 show that 100% of respondents from RP households have irrigated fields, whereas only 56% of the respondents from non RP households have irrigation on their fields. This is not surprising as it confirms that without a good irrigation system a farmer is not likely to be accepted into the RP.

One of the main incentives for joining the RP is the security of prices offered for products. When comparing the prices obtained for lettuce over the three seasons for RP and non RP farmers this advantage became evident (Table 4). This table clearly shows that RP farmers are getting more than double as much for their crops as non RP farmers.

Table 4. *Average price/kg obtained for RP and non RP lettuce*

	Dry	Hot	Rainy
RP	7.5	4.7	23.8
non RP	1.5	N/A	10.3

Because it is Mr. Kiat alone who decides who joins the RP or not in the Ton Phung area, this probably biases the project to include certain people, and perhaps to exclude people as well. We observed that often, members of the same family were either all Royal Project farmers or not. This made us think that working for the Royal Project could be associated with a families' status or position within the community. We also noticed that all of the 'important' people (headman, assistant headmen, water maintenance representatives, most successful farmers, etc.) that we interviewed were associated in some way with the Royal Project, whereas many of the poorer farmers were not. However, when comparing the income per rai for the RP and non RP farmers, we were not able to obtain any conclusive results on a link between of being in the RP and household income. Nevertheless, when speaking with farmers, it seemed that there are many who are not associated with the Royal Project not because they do not want to be, but because they have not been 'chosen'.

4.9 Water quality

Author: Signe

In this section the results on water quality a long the river system (location 1, 3 and 4) is presented firstly, followed by a short note on water quality of the 1. reservoir an ending in an evaluation of irrigation water quality.

4.9.1 Description of sampling sites

Location 1, were at The Huai ton Phung river just above the dam that fill the 1. reservoir of Ton Phung village, and close to the headwaters of the area. The place was chosen as a reference location as it was situated in a protected forest zone area, thus no pollution from human activities were expected. Location 3, were further down the Ton Phung stream opposite the royal project. This location was chosen as intensively farmed fields were found on the slopes bordering the side of the stream. At the sampling site there was a cabbage field on one side and an old rice field with livestock on the other side. Location 4 were furthest downstream at the outlet where the Kong Pae stream from the Kong Pae village join the Khun Pae stream. Location 2, at the first reservoir was chosen as many farmers rely on water from this reservoir for irrigation. The reservoir was surrounded by intensively farmed fields on one side and forest on the other (Map Appendix 2).

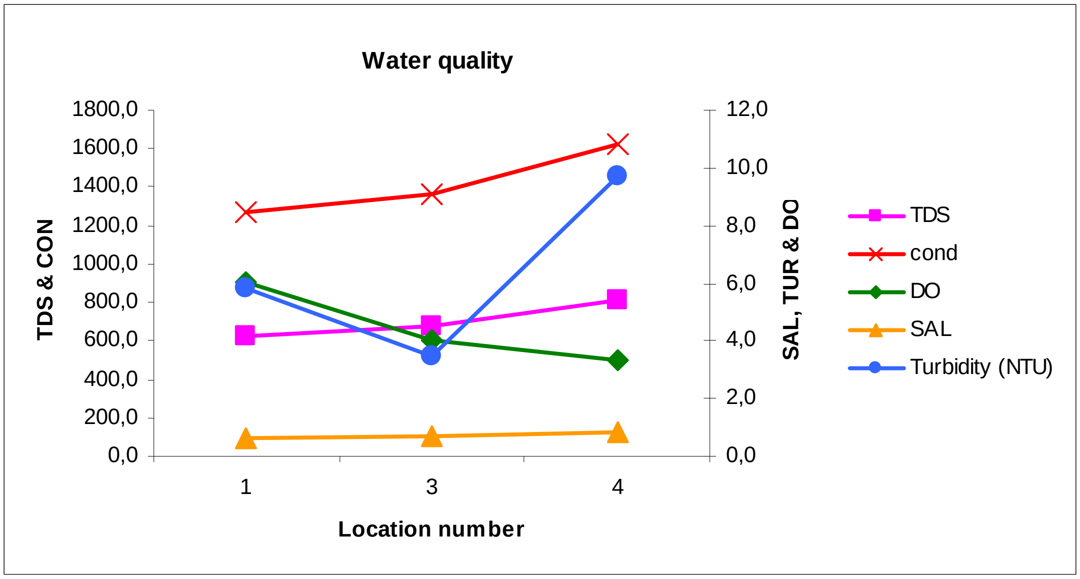

***Fig. 10**: Changes in water quality from upstream to down stream. X-axis shows no. of location. Y1 show total dissolved solids (TDS, mg l^{-1}) and conductivity (Con, µs cm^{-1}). Y2 show salinity (Sal, ppt), Turbidity (Tur, ppm) and dissolved oxygen (DO, mg l^{-1}).*

4.9.2 Changes in water quality.

The results from the water sampling showed a tendency of decreasing water quality from location 1 to location 3 and 4 (Fig 10). While the salinity (Sal), conductivity (Con), turbidity (Tur) and amount of total dissolved solids (TDS) increased from upstream to down stream, the concentration of dissolved oxygen (DO) were decreasing (Fig. 10 & Table 5). PH was found to be rather constant ranging from 7.2-7.8. As standard deviations on all measurements were fairly high a T-test did not reveal any statistical evidence for changes in water quality between the locations (P>0,05, pairvise T-test), nevertheless the tendency of decreasing water quality were clear.

Table 5 : *Results from water sampling at the 4. locations. Results are an average of 3 separate measurements ± standard deviation (stdev).*

Loc	Rainy season		Dry season		pH	DO	TDS	Sal	Con	T	Tur
	With	Depth	With	Depth		mg/l	mg/l	ppt	µs/cm	ºC	ppm
	Cm		cm								
1.	630	150	161.7	25.0	7.5±0,4	6±2.8	623.7±61.3	0.6±0.1	1265.3±143.1	15.2	5.8
2.	-	-	-	120	7.7	0.3	645	0.6	1291	21.7	278.5
3.	450	90	156.7	17.3	7.2	4.1±0.2	679.3±5.0	0.7±0.0	1365.0±4,4	22.2	3.5
4.	144	120	15.3	120	7.8±0.2	3.4±0,2	809.3±108.6	0.8±0.1	1618.3±216.8	21.1	9.7

4.9.3 Nutrient concentration and pesticide residues.

The concentration of P and N were low at all 3 locations but with a small increase in concentration from upstream to down stream (Table 6). No pesticides residues were found at location 1 and only traceable amounts were found at location 3. At location 4, the concentrations of the organophoshates Mevinphos and Chlorpyrifos as well as the carbamate Carbofuran, exceeded the guideline values by up to 3 times, indicating that runoff from fields indeed polluted the water here (Table 6 & 7). All the residues found were neurotoxic compounds of insecticides and highly toxic to aquatic animals and birds (Wikipedia**,** FAO 3). The investigation was conducted in the end of the dry season when only a part of the population were able to farm and run of from fields were low. Therefore it might be expected that pollution with pesticides and nutrients would be a bigger problem in the rainy season where the intensity of farming activities tops.

Table 6 . *Nutrient concentration and pesticide residues. Numbers marked with red are higher than the allowed border values given in Table 7.*

Loc	**NO3 (mg/l)**	**T-PO3-4 (Mg/l)**	**Organoposphate**	**ppm**	**Carpamate**	**ppm**
			Mevinphos		*Cabofuran*	
1.	0,053	0,016	*Chlorpyrifos*	none	*Methomyl*	none
			Malathion		*Phosalone*	
			Mevinphos	**0.040**	*Cabofuran*	**0.035**
2.	0.98	0,77	*Chlorpyrifos*	**0.065**	*Methomyl*	0.015
			Malathion	0.045	*Phosalone*	none
			Mevinphos	0.007	*Cabofuran*	none
3.	0,09	0,031	*Chlorpyrifos*	0.025	*Methomyl*	0.005
			Malathion	Trace	*Phosalone*	none
			Mevinphos	**0.035**	*Cabofuran*	**0.027**
4.	0,087	0,057	*Chlorpyrifos*	**0.055**	*Methomyl*	0.009
			Malathion	0.025	*Phosalone*	0.017

Table 7. *Maximum guideline values for pestide residues, Nutrient concentration, and parameters measured. Source of information: A = Doctor Orotai, Chiang Mai University. B= FAO. *standard values indicating moderate risk of salinisation and clogging of irrigation system*

Factor	Concentration	Source
Mevinphos (PEL-TWA ppm)	0.011	
Chlorpyrifos (PEL-TWA ppm)	0.05	A
Malathion (PEL-TWA ppm)	1	A
Cabofuran (PEL-TWA ppm)	0.011	A
Phosalone (PEL-TWA ppm)	0.05	A
Methomyl (PEL-TWA ppm)	0,375	A
TDS	500*	FAO
Salinity (ppt)	0.5*	FAO
Tur (ppm)	25	A
NO3 (mg l^{-1})	0.25	A
P (mg l^{-1})	0.15	A

4.9.4 Macro invertebrates.

Macro invertebrates were sampled at all 3 location along the river system. Macro invertebrates are normally good indicators for water quality. Many species are highly vulnerable to changes in their environment and especially to changes in DO as they rely on diffusion of oxygen through their skin (*Handbook for stream detectives*). Furthermore does the macro invertebrate fauna also give an idea about the year round water quality and is not just a snapshot of the current conditions, as one single day of measuring water quality is. The results from the investigation are shown in Fig. 11 & 12.

As very few animals were sampled at each place, and sampling procedure appeared somewhat random an unorganized, it could not be scientifically justified to draw many conclusions based on the results. Nevertheless they did indicate that the quality of the water was fairly good at all 3. locations as clean water indicators as *mayfly nymps, stonfly nymps* and *cassidyfly larvea* were found (Fig. 11) We would have expected the diversity of clean water animals to be highest at location 1. but the low number of animals identified could be a question of having to learn the procedure as it was our first location.

In Fig 12 the animals have been divided into indicator classes following *Handbook for stream detectives*. At location 1 only animals indicating good an excellent water quality was found, where as also animals indicating poor and average water quality was found at location 3 and 4.

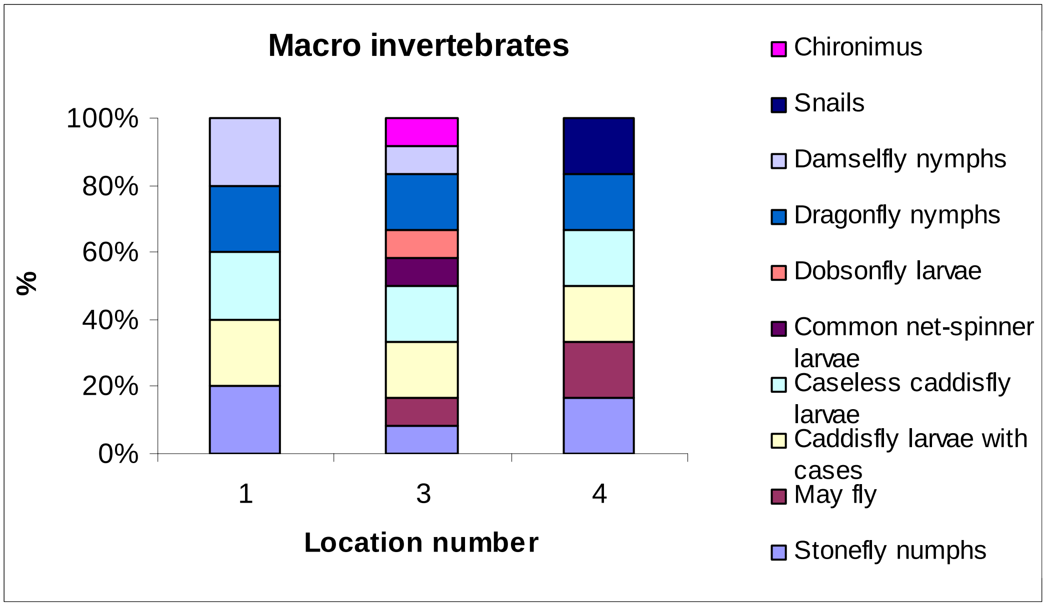

Fig. 11: *The percentage of each species group found at the 3 different locations. X axis show the location number and Y-axis the percentage of each animal group (Location 1. n=5, location 3. n=12, location 4. n=6)*

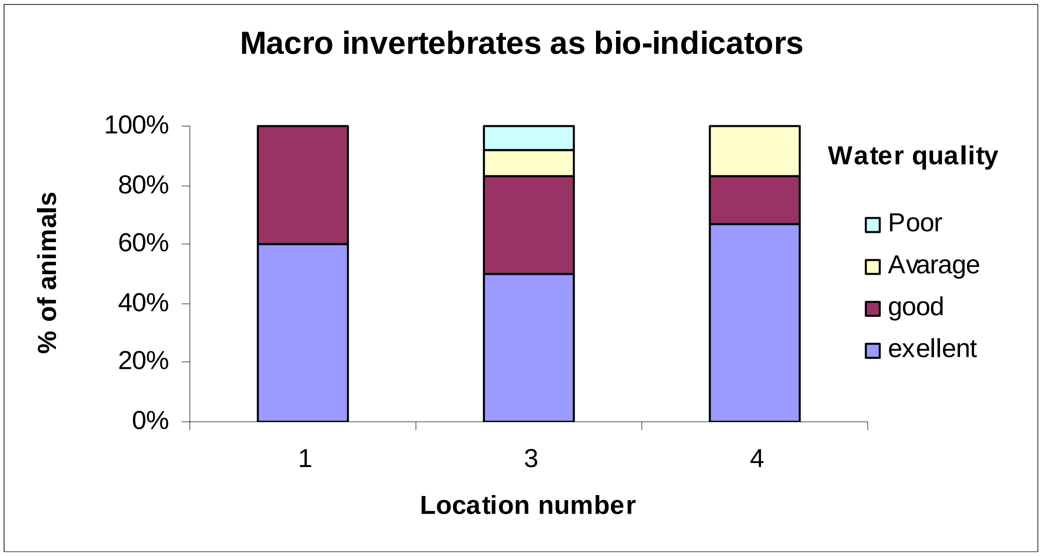

Fig 12: *Percentages of animals on each location indicating poor, average, good or excellent water quality (following Handbook for stream detectives). X axis show location number, Y-axis the percentages of animals.*

4.9.5 Quality of water in the 1. reservoir (Location 2)

The reservoir was shallow and bordered by intensively farmed fields. The water in the reservoir appeared very dirty and high turbidity value and low DO concentrations confirmed that observation. (Tabel 5). N and P concentrations were also exceeding standard values and pesticide residues of Mevinphos and Chlorpyrifos and Carbofuran were traced in a concentration up to 4 times higher than guideline notes recommend.

4.9.6 Quality of irrigation water.

When looking at irrigation water quality some of the important parameters are Salinity, Turbidity, and Total dissolved solids. High irrigation water salinity can cause salinisation of soils where as high values of TDS and turbidity might clock the irrigation system. According to FAO there will be a moderate risk of soil salinisation when using irrigation water with a salinity > 0.5 ppt. The values for all 4 locations exceed this value (Table 5). The risk of salinisation increases the higher the precipitation is, and as irrigation of fields only occur during daytime where temperatures in hot and dry season easily pass 30C, there is reasons to believe that salinisation of soils could be a problem in our area (FAO 2). The TDS values at all locations were higher than recommended, and in the reservoir

Turbidity value exceeded the guideline value at 25 ppm by far. These factors might cause clogging of irrigation system and further more hinder water uptake by plants by changing the osmotic potential in the ground.

4.9.7 Conclusion.

The stream water at the 3 sites investigated appeared fairly clean at time of investigation (dry season), but with a tendency of decreasing quality the more downstream you'd go. There was a pattern of accumulating residues in the sediment from agricultural production and increasing concentration of nutrients. Nevertheless there was no the big difference in macro invertebrate fauna between the 3 locations, all of them being habitats for clean water species as *mayfly nymphs, stonefly nymps* and *caddisfly larvae.*

Looking at the water with irrigation glasses the conclusion is somewhat different. Salinity and TDS concentration of the water was high at all 4. location which could by time give problems like salinization of soil and clogging of irrigation system, and thereby severely affect the productivity of the fields.

We had planned to investigate soil quality of the fields as well, but due to time constraint this part of the plan was given up. It would have been very nice to see if soil salinization was a problem in the area and if differences could be detected between the different water sources used. The treatment for soil salinisation is normally flushing of the soil with lots of water (FAO 1). In this area we might expect that to occur naturally during the rainy season when huge amounts of water pour down. That could prevent the problem of soil salinisation arising from poor irrirgation water quality.

4.10 Water Management

Author: Laura

4.10.1 Water resource management in Ban Ton Phung

Based on information that we have gathered from a village survey, interviews with vegetable farmers and key informants, and secondary data, we have constructed the following analysis of stakeholder involvement in water management. First we will discuss the role that each stakeholder plays in management and use of water resources, and then discuss conflicts or issues that have arisen.

Farmers' perception: self-regulation

What we have found throughout our village survey and interviews with farmers is that water use for vegetable fields is generally conceived as self-regulated with no real governing body. It is viewed by many farmers as completely unregulated and unmonitored; farmers say that they control themselves how much water they use and for how long. Farmers that choose to construct their own pipelines must pay for the cost of their own pipes (according to a couple of farmers, low quality pipes cost 20 to 25 baht each, and high quality pipes cost 80 baht) and if they attach it to the main pipeline owned by the Royal Project then they must pay 100 baht per year.

> "Connection to the Royal Project pipeline is a private business. Farmers must find out about it and pursue it themselves. Often they cooperate together to buy the main pipe; from there they split it up into an individual pipe system. As they have bought the pipes themselves, they can decide if another farmer is allowed to join their pipe system."-vegetable farmer, Ban Ton Phung

There did also appear to be some unwritten rules that the farmers abide by. For instance, some farmers told us they can use water anytime and as much as they want, but due to water scarcity during certain times of year they coordinate with farmers in neighbouring fields to alternate using the water so that there is enough pressure in their pipes. Also, farmers often work together to build a pipeline from the main pipeline to their fields, splitting the cost and working together.

Village Water Resource Management Representatives (WRMR)

There are three men in the village elected to be in charge of the maintenance and operation of the communal irrigation system. In reality, their job is mainly to open and close the valve at the top of the pipeline that runs from Ton Phung Stream into the upper reservoir. They are supposed to open and close the pipeline each morning and night and ensure that it is functioning properly. During the dry and hot seasons the pipeline is open during the day from approximately 6am to 6pm, and during the rainy season it is closed because the reservoir is filled by rainwater. These village representatives receive a payment of approximately 1000 baht per year in total from the farmers that get water from the upper reservoir pipeline. They told us that they were in charge of organizing specific times throughout the day when each farmer is supposed to use the water for their fields, to ensure greater equity of distribution. However, this was not mentioned by the farmers that we talked to and based on the data we obtained from our questionnaire it seems that farmers used water whenever they wanted to.

Royal Project (RP): 'middle man'

The King and the Royal Project came to the village in January 1984. They proposed a water reservoir project for improving access to water for villagers in this area. However, some villagers protested to stop the project because they worried that their fields would be flooded.

Consequently, the Royal Irrigation Department was assigned to carry out a survey to adjust the project. The officers chose appropriate places for two smaller reservoirs and connecting pipelines; this proposal followed the King's initial idea with some adjustments, and was eventually accepted and implemented during the next couple of years by the Royal Irrigation Department. (Royal Project document).

The Royal Project emphasizes that the current role of the Royal Project in local water management is primarily that of a middle man that 'supports' the irrigation system (see text box).

> In the past, the Royal Project has organized meetings for Royal Project farmers to discuss issues of water shortages and decide amongst themselves who uses how much water. The RP has also acted as a middle man to request help for water resource management from the Royal Irrigation Office.
> - Mr. Sinlapawattananun, Chief Royal Project Officer in Ban Ton Phung area on the role of the Royal Project

However, some farmers that we talked to viewed the Royal Project as playing a larger role than this. They viewed the Royal Project as being the main organization directly in charge of maintenance and repair of the system and organization of water use for the villagers. Many of the farmers that we spoke to believed that the Royal Project had in fact built the system, and that they should therefore be responsible for taking care of it. For example, farmers thought that the Royal Project should be fixing the broken reservoir, or build a completely new system.

Royal Irrigation Department (RID)

The role of the Royal Irrigation Department includes regulating, distributing, conserving and allocating water for agricultural use (RID). They were initially brought in by request from the Royal Project to build the irrigation system including the two reservoirs during the mid-1980s. From our observations, it seems that the Royal Irrigation Department does not seem to be involved directly with the farmers but only in correspondence with the local Royal Project office. According to the Royal Irrigation Department, its duties and responsibilities include the "operation and maintenance of irrigation structures" (RID) therefore it seems likely that they should be in charge of repairing the reservoir system. The Royal Project is expecting that the Royal Irrigation Department will repair the irrigation system sometime next year. Although some of the farmers briefly mentioned the responsibility of the Royal Irrigation Department, most of them did not consider it to play a major role in local water management.

Role of NGOS: IMPECT, CARE

CARE (also called RAK THAI) and IMPECT are two NGOs that work together closely in the Mae Pae Watershed. They are organized so that CARE works mostly with lowland people and IMPECT works with highland people. CARE's main objectives are to help manage and resolve conflicts between high and lowland people by acting as middlemen between the two groups. They will arrange and coordinate meetings between farmers from the highland and the Local Irrigation Committee of the lowland. The Local Irrigation Committee is responsible for water management in the lowland areas, where water demands are very high. IMPECT and CARE both work indirectly on water resource management; IMPECT works directly on the land demarcation process together with the Watershed Management Office, and CARE work indirectly by supporting activities of land demarcation and thereby protection of forest in headwater areas.

Watershed Management Office (WMO)

This office's main objectives in water management are from a conservation approach- to improve the protection of headwaters. They are directly involved in water management through the support for the construction of check dams. Every year they get money from the ministry of natural resources to help the farmers in planning, building and paying for the check dams. They informed us that last year they supported 50 dams in this area and this year they hope to build around 150 dams. However, we did not encounter any evidence of this in the village area that we were working in, and found no indication that the villagers were aware of these initiatives.

TAO Office

Seem to be more concerned with water quality, especially down in the lowlands. They are organizing a campaign to increase the awareness on the excessive use of chemical fertilizers and the impact it has on the water supply in the lowlands. Their objectives include to “protect and preserve natural resources and the environment” as well as provide clean water for consuming, using in household and in agriculture” (Mingtipol 2007 p.22). The TAO was not mentioned by farmers as a significant contributor to local water management. When asked about the broken reservoir, TAO officials replied that it is not their business but the responsibility of the irrigation office. Overall, their role in Ban Ton Phung’s water management is unclear, this is probably due to the fact that the Royal Project is already so prominent in the community.

Watershed Management Committee (WMC)

Consists of a network of headmen from both high and lowland villages and is organized under support of TAO.

Sub Watershed Management Committee (SWMC)

Consists of 15 people from each village and is a part of the bigger WMC committee. The members in this committee are volunteers (i.e. are not paid).

Agricultural Extension Office (AEO): Responsibilities are of the RP

In terms of water management this office also does not seem to play a very important role because they believe it is up to the Royal Project.

Table 8 .Stakeholder Analysis for Ban Ton Phung Water Resource Management

Stakeholder	**Description of role in water resource management**	**Functional level**	**Degree of daily involvement in water resource management in Ban Ton Phung***
Vegetable Farmers	Individual or communal use of water, self regulation	Village	High
WRMR	Maintenance and some regulation of main irrigation system	Village	High
RP	Link between village and RID, tries to help with conflict resolution	Ban Ton Phung/ Khun Pae area	Medium
AEO		Regional Office	Low
TAO	Raising Awareness on environmental impacts in water system of chemical agricultural inputs	Regional Office	Low
NGOs CARE, IMPECT	Protection of headwater areas and support for construction of check dams	Mae Pae Watershed	Medium
WMC	Communication Network to discuss issues	Mae Pae Watershed	Low
SWMC	Brings local village concerns to rest of watershed	Village	Low
RID	Operation and maintenance of irrigation structures	Provincial Office and Regional Office	Low

4.10.2 Conclusions

4.10.2.1 Local Community Water Resource Issues

Lack of water

There was a general consensus among key informants and farmers that we talked to that one of the biggest problem faced by local people is lack of water for production, especially during the hot and dry seasons. Although we cannot conclusively state why there are water shortages, our observations, interviews and previous knowledge of history of area would lead us to suggest the following contributing factors:

-seasonal climate change

-decreasing water level of water source

-increased intensive agriculture in area leading to greater demand

-malfunctioning communal irrigation system (broken pipelines to lower reservoir)

Case study: a closer look at the broken reservoir

Based on the villager's testimonies, we learned that before the reservoir and pipeline systems were built, people obtained water directly from natural resources. They often constructed their own small channels from the streams to their fields. Then, after the dams were built, people began to convert water to their fields through pipelines. Now, these old pipelines are beginning to break.

The lower reservoir was built in a good location for collecting and storing water. But, since the pipe connecting the upper and lower reservoirs is broken, the reservoir cannot be maintained and refilled. The old pipes are breaking, factors that could be contributing to their demise are: too much pressure from pipes following the hilly contours of the area, age and soil pressure. Now the lower reservoir only collects rainwater (which people still use) but it is not refilled with water from the headwaters.

Villagers estimate that the reservoir has been non functioning for about three years now. Some people mentioned that it has been broken several times before, and each time they have been fixed, the pipes break again. One farmer even suggested that it was broken on purpose.

We were not able to obtain a response from the Royal Irrigation Department to confirm if they are in fact going to arrange some repairs on the system, but if they are not going to take some action then it seems that no one will repair the broken reservoir and the system will continue to function only partially, leading to continued water shortages during the hot and dry seasons in the Ton Phung and Khun Pae area.

To address these issues, many farmers complain to the Royal Project about the water shortages that they are facing, and these complaints have increased within the last year or so due to the broken reservoir. In response to this, the Royal Project has put in a request to the Royal Irrigation Office and they say they are expecting to get money and resources in the next year or so. Furthermore, some farmers are constructing private pond systems or catch dams if they cannot access the main pipeline system. Since pipelines from second reservoir no longer work, some farmers that used to rely on this pipeline have since built alternative pipelines that connect to the pipes from first reservoir. However, this method does not always work; some farmers find they cannot get enough pressure from this alternative pipeline. Another strategy being used to cope with water shortages is that some farmers are simply growing less crops because they cannot get enough water, renting land from someone else that has better access to water from their field. As well as individual coping strategies, there have also been some increased efforts to cooperate together. An increased number of community meetings are being organized by various local stakeholders to discuss how the community as a whole should deal with water shortages and are also a platform for which individual farmers can resolve water ‘conflicts’.

Rainy Season: too much water

Some farmers claimed they encountered the issue of too much water in their fields during the rainy season, causing their vegetables to rot in the flooded fields and hindering the transportation of yield back to the village or to the market. We were not able to find out what farmers were doing to address these issues.

4.11 Conflict

We found it extremely difficult to obtain information on previous or current conflicts over water resources. There are several reasons why this was the case; the reluctance of people to discuss something that is viewed as a private or personal with foreigners such as ourselves may have played a role, also it may have been that we simply did not speak with the right farmers who would have had something to say about this topic. Also, some farmers mentioned that there have already been people coming from outside to ask them about conflict, and so they may be bored or annoyed with questions on this topic.

4.11.1 Among villagers in Ban Ton Phung

We did not encounter any specific examples of disputes between villagers, but were told that any disputes that came up would be mediated by calling a meeting with the Royal Project, the headman, and the village water representatives. However, with the increasing scarcity of water it seems that the abilities of the Royal Project and village leaders to dispel conflicts are decreasing.

We encountered some farmers that could not afford a pipeline or could not obtain enough water pressure in their pipes. These farmers have to rely on rainfall and so would most likely only be able to grow crops during the rainy season. If they do not receive enough pressure from their pipeline, they usually try and arrange something with their neighbour to alternate the time that they use the water. Or, sometimes they bring their complaints to the Royal Project or a village meeting.

Often farmers dig into the main pipeline themselves to connect their pipes. This concerns some of the farmers who already have pipelines; they are afraid that if more people want to connect to the main pipe the water will not be enough for all of them to share. Ultimately, water shortages seem to be growing more serious, and all of these are factors that could lead to conflicts between villagers as resources become scarcer.

The general attitude of the people regarding these increased water shortages is that it is a natural phenomenon, that is nobody’s fault and it cannot be stopped. This is also the attitude of the Royal Project, who has told the people to just deal with it as best they can. However, some people we talked to did acknowledge that there is increasing fear among the villagers as the problems grow more serious, for example with the event of the broken pipeline rendering the lower reservoir unable to function. Many of them see this as a threat to their own abilities to look after themselves and their families. The overall tension among villagers has increased, and there was even one farmer who claimed that there have been problems of people stealing water from other people’s private sources or pipes at night.

4.11.2 Between neighbouring villages (Ban Ton Phung and Ban Khun Pae)

We can only speculate that there may be some existing conflicts between villagers from the two villages. When the system was first built, the lower reservoir was supplying water to the fields in what is now the Khun Pae area. However, now that it is broken, this has put a greater strain on the pipelines of the first reservoir as an increased population is now competing to use it. One farmer that we talked to said that in order to have pressure enough to convert water into the lower reservoir, the pipeline between the first reservoir and the Ton Phung stream must be closed. This would mean that only one of the villages can use water at a time and he claimed that it occasionally happened that the pipeline leading into the lower reservoir was damaged on purpose, most likely by the users of the upper reservoir from Ton Phung village.

4.11.3 Upstream/downstream tensions and history of conflict

Conflicts between upstream and downstream people over natural resource management in Northern Thailand have a history that extends back at least twenty years or so. Conflict first arose in this area when a reservoir was first proposed in 1984. Some local villagers who believed their land would be flooded or negatively affected by the reservoir protested to the government. However, the main protest was from NGOs and people living in lowlands, because they believed that the construction of this system would result in less water for them to use. A lack of water in the lowland area in dry season is normally being blamed on water use by highland people.

“The lowland farmers accuse the hill tribes of destroying ecologically sensitive watersheds in the uplands and threatening water supply to those living downstream.” (Sakanond 1999) Lowland people have even staged road blocks so that the highland people are prevented from selling their products at the market. This is based in a general mistrust from the lowland people for how the upland people are managing the resources that they all have to share. This has become an increasing concern as local stakeholder involvement and participation in natural resource management is becoming increasingly a part of national policy (Whaley 2004).

V. DISCUSSION

5.1 Sustainability of vegetable production

The sustainability of vegetable production can be assessed from an economic standpoint and also from an ecological standpoint. In the Ban Ton Phung area, vegetable production is an important source of income. As a consequence of land use restrictions, farmers cannot expand the area of their land and are therefore increasing intensity of production.

This requires increasing inputs to the land which has negative ecological consequences. Since 1981 Thailand has experienced a 10-fold increase in amounts of pesticides imported with an increasing pollution of ground and surface water as a consequence (FAO). The TAO is concerned on how chemical run off from agricultural production is affecting people in the lowlands. “Whereas for upstream villages water quality seems to be a minor concern, downstream users are increasingly worried about residues of pesticides and other agrochemicals,” (Eltsner et. al p.15-16) While the people of Ban Ton Phung seem to be more concerned with water scarcity, there is still some concern regarding decreasing quality of water. There were a couple of farmers who commented on water quality issues in Ban Ton Phung: they had noticed that there has been increased turbidity in the water and irrigation system. Therefore, changes in water quality can affect the relationship between the people living in the highland and lowland communities. For instance, decreasing water quality in downstream areas could result in increasing tensions between the two groups of people, because the downstream people feel as if the upstream are mismanaging the resources. The same can be said about the amount of water available; if the amount is also decreasing this could also increase tensions between the lowland and upland people.

Decreasing water quality can also impact soil quality, therefore leading to decreased productivity of agricultural areas. Therefore, agricultural practices that pollute water resources can be very unsustainable from an ecological as well as economic standpoint.

In a place where livelihoods are dependant on vegetable farming, access to water can determine a farmer’s ability to sustain their own livelihood.
Water use and accessibility will continue to be determining factor in income generated and overall ability to sustain livelihood as a vegetable farmer. As we have seen, some farmers are looking to various off farm activities as a supplementary source of income if they cannot generate enough income on their vegetable field, which may be largely due to limited access to water. At the same time, there are increasing demands on water resources to supply irrigation systems.

5.2 Reflection on water resources management

Clearly there is a lack of accountability in this management system. This is demonstrated with the current situation of a broken pipeline resulting in one of the two reservoirs being unable to function. Water management seems to be very confusing and lacking in clear structure and efficient organization. It seems that every new NGO or organization that comes to area works on its own with separate agenda, there is a lack of coordination and cooperation. Even with JoMPA there seems to be very little impact of any organization besides the RP in Ton Phung village.

In 1997, Thailand's government came up with a National Water Vision Statement:
"By the year 2025, Thailand will have sufficient water of good quality for all users through efficient management and an organizational and legal system that will ensure equitable and sustainable use of water resources, with due consideration for the quality of life and the participation of all stakeholders." (Whaley 2004)

However, for many years sustainable water resource management has been neglected by the government as policies focused instead on development. The government has failed to produce clear policies and an overall resource management plan (THAICID). There is also the problem of redundancy among the structure of government agencies working in water management sector, and a lack of legal framework:
*"[the] problem of fragmentation prevails in water sector management. There are more than 30 agencies in 9 ministries work in water resources development and furthermore, 7 national committees involved in this field. This makes things complicated and even confused. Local administrations have no role in management of their own sources of water."(*THAICID p. 3-4).
Overall, improved management of watersheds with the cooperation and participation of all interest groups is vital to ensuring that resources do not continue to be depleted in an unsustainable fashion (THAICID).

VI. CONCLUSION

Our results confirm the assumption that amount and accessibility of water is indeed affecting people's livelihoods. This is an obvious conclusion as most of the farmers stated that farming is their main source of income, even in periods where they are not able to farm because of lack of water. Access to an irrigation system allowed the farmers to farm throughout the year and furthermore gives them a possibility to join the RP who can secure them fair prices for their crops, technical advice on production and provide them with inputs. The intensive farming activity of the area did affect the water quality of nearby streams negatively. Pesticide residues were found at more locations along the stream and turbidity, conductivity and salinity concentrations were increasing from upstream to downstream thereby influencing the suitability of the water for irrigation purposes. This may not have the biggest consequences in the area we were investigating but as the water quality can be expected to continue decreasing the further down stream you go it might affect people in the lowland more severely.

Using the progress triangle framework (Walker) to assess the conflicts in the area, they seem to be mostly about the actual substance, water. However, the relationship between interest groups plays an important role in increasing tensions over water resources; changes in water quality and quantity are impacting the way that groups interact with each other- this is most clearly illustrated looking at the highland and lowland peoples. Although the level of escalation of the conflict currently appears to be very low, it is possible that with increasing water resource issues of quality and scarcity the conflict could quickly escalate as it has in the past with actions such as protests.

VII. METHODOLOGY REFLECTION

Authors: Margarette and Hieu

7.1 Questionnaire survey

Because of lack of experience by group members, we found it quite difficult to go through the entire process of carrying out the questionnaire survey. The language barrier made it quite difficult to get exact responses, and sometimes the language barrier was even greater if the respondent was having trouble communicating in Thai with the translator, and spoke only the Karen language. Lack of organization or clear communication between members of our group resulted in many unclear or incomplete answers on the questionnaires which were very difficult to interpret later on. It was also difficult to collect data on income and inputs as most of the respondents were unable to exactly remember what they got from vegetable cultivation.

7.2 GPS mapping

GPS was a useful tool for us that could help us find vegetable fields and watering system after a field walk. Through GPS, we could map out the pipeline system of the village with position and elevation of the different points. However, since it was the end of the dry season it was impossible to visit so many fields as it was difficult to find villagers to willingly bring us to their fields.

7.3 Semi-structured interview

This method provided us with a lot valuable quantitative and qualitative data. In-depth information was also extracted from this survey method. Due to the presence of other groups in the area who repeatedly came for interview with the respondents, a lot of questions were asked which took long time required made the respondents to become bored and lose their concentration.

7.4 Field Walk

Through out the time we spend in the village for our research, we carried out several field walks to the vegetable fields and water sources. Because of limited time of guides, we were unable to visit the areas which were at times quite far. Thus we could not get enough data as we expected.

7.5 Direct observation

It was useful to observe things happening in reality to give us a better understanding of the information provided by the respondents and to double check the information. For instance, when conflict related questions were asked, the villagers were very reluctant to talk about it. As such, the only thing we could do was direct observation and interviews in the fields.

7.6 PRA methods

PRA exercises were very interesting exercises as they attempted to get the farmers actively involved. Through this exercise, we could learn the distribution of vegetable farms and this helped us to decide on the key informants. A lot of things were learned from the seasonal calendar exercise. A focus group meeting was also conducted in combination with participatory mapping which helped us to understand the trends in the growth of vegetable and water resources and the problems they faced in times of water resource scarcity.

The information that we gathered during these sessions is somewhat biased due to the fact that it was generally the same group of people attending the meetings each time (usually the people who lived close to the village hall). Also, the village assistant headman was very outspoken and dominated the conversations that we had in many instances.

7.7 Group work

The outcome of the research is dependant upon the knowledge and involvement of each and every member of the group. Different backgrounds, cultures, experience, working style created a great challenge for the group work. At times the group experienced some setbacks but were however compromised various ideas and learn from each other. Our Thai counterparts were very kind and understanding though they had very different objects in carrying out the research, so it was possible to integrate the two research objectives. They had a different approach to collecting their data during the field work though we had already come to a compromise at the university.

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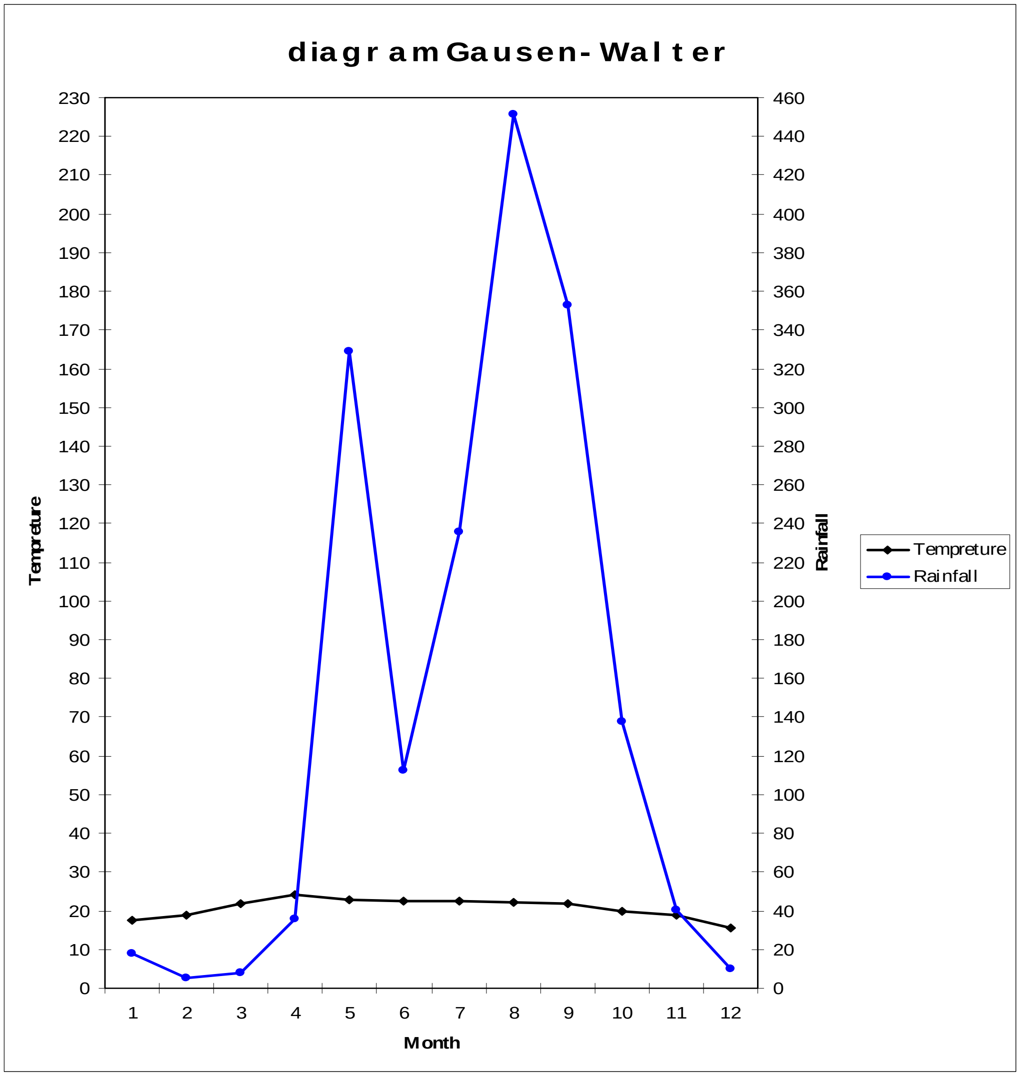
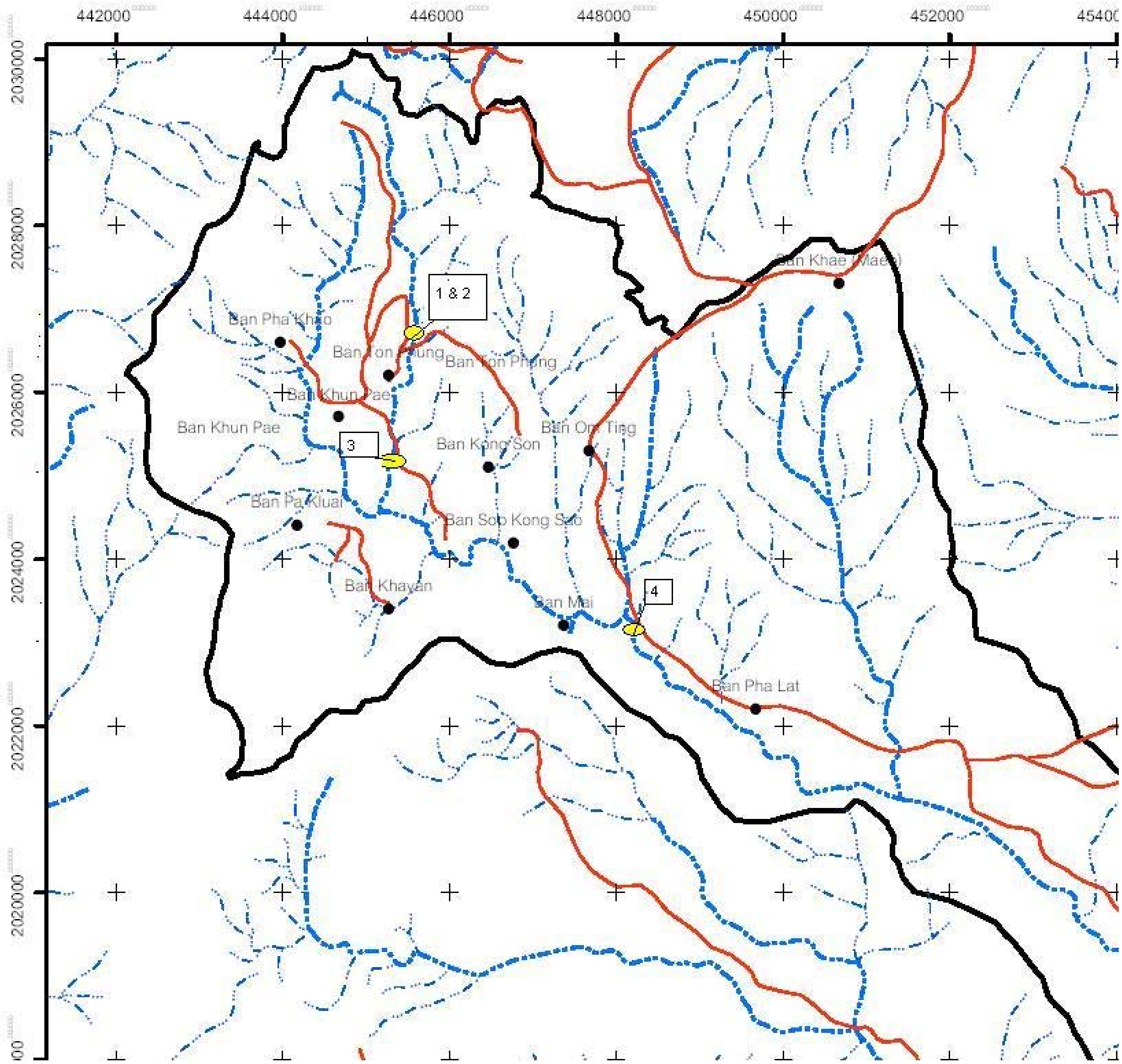
Appendices

Appendix 1.



Appendix 2

Map over approximate water sampling locations: Yellow dots indicate where the samples were taken.



Appendix 3.

Seasonal calendar of water availability and income.

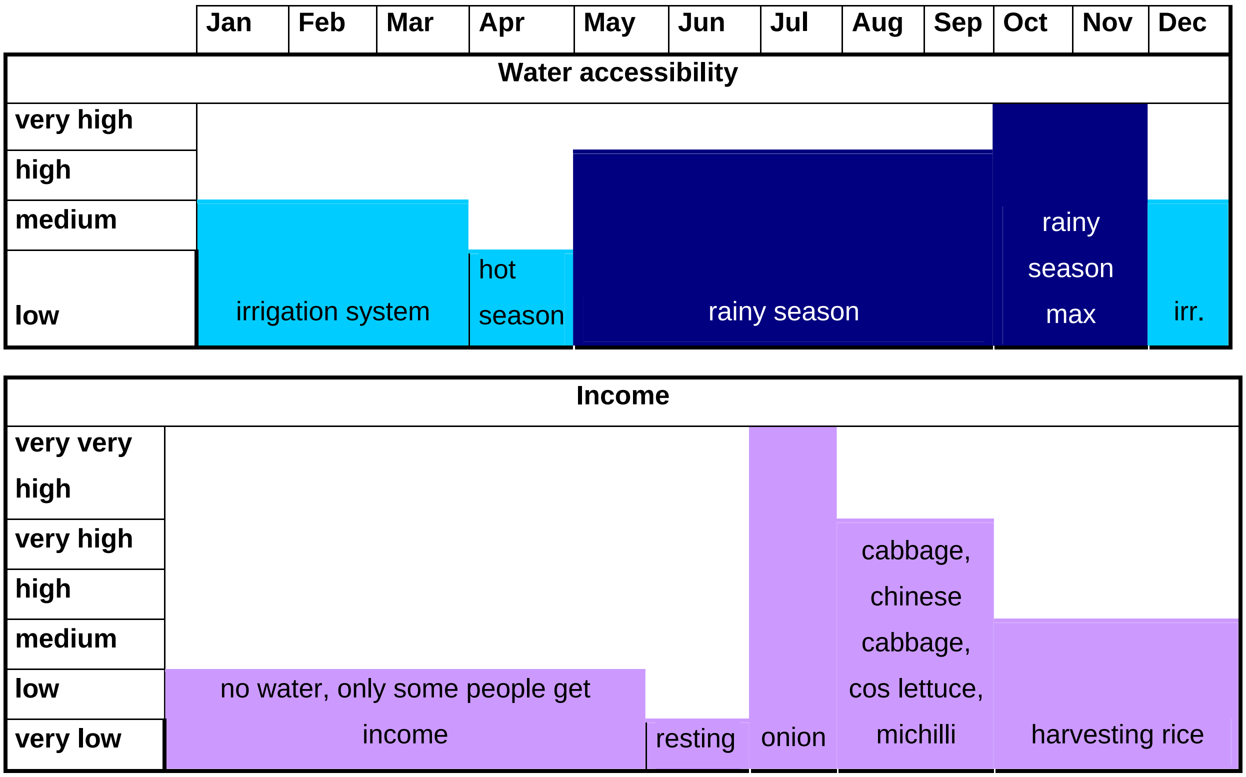


Fig XX. Seasonal calender of water availibility and income.

Appendix 4. Daily activity plans of group members.

Activities sheet (Nguyen Huu Hieu)

Date	Time	Activities
Tuesday 06 March	Morning	Depart to Upper Mae Pae
	Evening	Visit village headman home and have discussion
Wednesday 07 March	Morning	Transect walk with head man
	Afternoon	Continue with group members visiting the village area Discuss with group on questionnaire
Thursday 08 March	Morning	Testing questionnaire survey
	Afternoon	Questionnaire survey
	Evening	Discuss in group on preparation of PRA mapping
Friday 09 March	Morning	Discuss on the result of PRA
	Afternoon	Questionnaire survey
	Evening	PRA mapping in village hall
Saturday 10 March	Morning	Questionnaire survey
	Afternoon	Field walk on stream system (down part)
Sunday 11 March	Morning	Questionnaire survey
	Afternoon	Midterm presentation
	Evening	Interview a selected key informant
Monday 12 March	Morning	Survey upper part of village following stream system
	Afternoon	Home work
Tuesday 13 March	Morning	Field walk on surveying the 1 st pipe line system
	Afternoon	Home work on data base design
Wednesday 14 March	Morning	Survey on 2 nd pipe line system
	Afternoon	Work with a Royal project officer on data related to man-made irrigation system.
Thursday 15 March	Morning	Field visit
	Afternoon	Home work
	Evening	Meet villagers in village hall for saying good bye to them
Friday 16 March	Morning	Depart for Chieangmai

Daily activities during field course: Signe Juul Madsen.

Day 1.
Arrival to the field station and meeting with the village headman.

Day 2.
-Morning: Transect walk with village headman
-Midday : Planning a water sampling strategy and visiting possible sample locations
-Evening : Preparation of questionnaires

Day 3.
-Morning and midday: Water sampling
-Evening: Conducting questionnaires

Day 4.
-Morning and midday: Conducting questionnaires
-Afternoon: preparing for PRA session (participatory mapping and focus group discussion)
-Evening: Conducting PRA session

Day 5.
-Morning : Joint evaluation of PRA session with group 1.
-Midday: Debriefing Thai students about her visit to TAO office and typing up data
-Evening: Conducting questionnaires and later interview with Royal Project officer.

Day 6.
-Morning: Evaluating water data with Thai counterpart, Typing up interviews, preparing midterm evaluation.
-Evening: Conducting questionnaires and setting up meetings with farmer for the next day.

Day 7.
-Morning: Visit to field and in-depth interview with farmer and assisting our Thai counterparts in soil sampling
-Afternoon: Preparing for PRA session in the evening (Seasonal calendar)
-Evening: PRA session cancelled

Day 8
-Morning: PRA session cancelled again because of a drunken doctor. Conducting questionnaire with woman group nearby while waiting for the village meeting to end, and set up appointments for field visit next day.
-Midday: Walk in the area and informal interviews with farmers on their fields
-Afternoon: PRA session. Seasonal calendar

Day 9.
-Whole day :Visit to fields and in depth interview with farmers, setting up meeting with watershed management office and sleeping over in the village

Day 10.
-morning: Interview with Watershed management office
-Day typing in data and interview with CARE
-Evening farewell party with villagers and each other

* upon arrival to Chiang mai university an interview with Dr. Siddidatha was conducted.

Daily activities during field course: Laura Gosset

Day 1
Evening: meeting with village headman

Day 2
Morning: Transect walk with village headman to upper reservoir and surrounding fields
Afternoon: Field walk to lower reservoir, talk to local farmers
Evening: Prepare questionnaire, select random sample from village map, discussion with assistant village headman

Day 3
Morning: test questionnaire
Afternoon: begin random sampling of questionnaire
Evening: Interview with Royal Project Officer

Day 4
Morning: Preparation for PRA session in village
Afternoon: questionnaire sampling in village
Evening: Participatory mapping and focus group discussions at meeting in village

Day 5
Morning: debrief discussion about previous nights' meeting
Afternoon: prepare for future key informant interviews, questionnaire sampling in village
Evening: interview with another RP officer

Day 6
Morning: type up data, prepare for midterm presentation
Afternoon: midterm presentations
Evening: interview with 3 village water resource management representatives

Day 7
Morning: questionnaire and interviews with two farmers, visit their fields and obtained soil samples
Afternoon: prepare for second village meeting, visit to farmer's field in Khun Pae area
Evening: PRA meeting cancelled

Day 8
Morning: PRA session cancelled again because of a drunken doctor. Conducting questionnaire with woman group nearby while waiting for the village meeting to end, and set up appointments for field visit next day.
Afternoon: walking around lowland area, walk to Khun Pae village, visit fields and interview farmers
Evening: PRA seasonal calendar, historical timeline construction

Day 9
Morning/Afternoon: Visit to field, conduct in depth interview and walk to water source, GPS mapping
Evening: sleep in village household

Day 10
Morning: interview with Watershed Management Officer
Afternoon: interview with farmer from Khun Pae, GPS mapping of fields
Evening: community meeting to offer feedback and thank you to villagers

*also interview with IMPECT NGO when back in Chiang Mai

Adit’s day to day activity

Day	**Activity**
March6	-arriving -meeting with the village headmen in the evening (introduction of ourselves and appointment for the next day)
March 16	-Going back to Chiangmai
March7	-meeting with my group -GPS mapping on transect walk
	-adjusting the questionnaire and testing the questionnaire
March8	-GPS mapping and transect Walk -meeting with supervisor for the Questionnaire -group discussion for community mapping
March 9	-group discussion -questionnaire survey -community mapping in the village hall
March 10	-Down stream and upstream Transect walk -collecting data with questionnaire survey -Semi structured interview in the water management representative ’s house
March 11	-Collecting data with questionnaire survey
March 12	-Interview some farmers and GPS mapping -upper Stream survey -Collecting data questionnaire survey
March 13	-GPS mapping and Pipelines of the 1st Reservoir survey -Community mapping in the village hall
March 14	-GPS mapping and Pipelines of the 2nd Reservoir survey -group discussion for questionnaire -Consulting the questionnaire to supervisor
March 15	-Preparing the presentation -Presentation -cleaning the base camp -farewell party with the villagers

Activity sheet: Margarette Enowkpa

Date	Time	Activities
Tuesday 06 March	Afternoon Evening	-Arrival at Base camp -Discussion with village headman
Wednesday 07 March	Morning Afternoon	-Transect walk with village headman -Transect walk with of group members
Thursday 08 March	Morning Afternoon Evening	-Testing of questionnaire -Questionnaire survey -Interview with
Friday 09 March	Morning Afternoon Evening	-Questionnaire survey -Discussion on Participatory mapping -PRA meeting at village hall
Saturday 10 March	Morning Evening	-Questionnaire Survey -Questionnaire Survey
Sunday 11 March	Morning Afternoon	-Data entry Midterm evaluation and presentations
Monday 12 March	Morning Evening	-Visit to two farms; interview with the farmers and some soil sampling. -Preparation for second PRA
Tuesday 13 March	Morning Evening	-Questionnaire survey -Group work
Wednesday 14 March	Morning Evening	-Questionnaire Data entry
Thursday 15 March	Morning Afternoon Evening	-Interview with RIO -Interview with key vegetable farmers and GPS position of farms
Friday 16 March	Morning	-Departure to Chiang Mai

Appendix 5. Synopsis

Impact of access to water on vegetable production and farmer livelihoods in the Mae Pae sub-watershed of Northern Thailand

Synopsis Group 6: Water use

SLUSE ILUNRM Field Course February 2007

Margarette Enowkpa Egbe Tambi (Geography)

Nguyen Huu Hieu (Forestry)

Laura Caroline Gosset (Resources and Development)

Aditiawarman Hasanuddin (Agricultural Economics)

Signe Juul Madsen (Biology)

Supervisors:

Mogens Pedersen

Mille Møllegaard

Santosh Rayamahji

I. Background

The Mae Pae sub-watershed located in the Chom Thong district in the province of Chiang Mai, Northern Thailand. The area is inhabited by a variety of ethnic groups; the ethnic Thai people generally inhabit the lowlands, where as the hill tribes include a mix of ethnicities. In this sub-watershed the highland population is mostly Karen and Hmong communities (Mingtipol et al. 2007). During the last few decades, this region has experienced population growth as well as large amounts of deforestation as a consequence of intensive logging activities (Lakanavichian 2001). In 1985, the National Watershed Classification was declared in order to conserve the existing highland forest and protect the “head waters” of the area. This resulted in major restrictions on land use for farmers. Farming procedures have therefore gradually been shifting from small scale swidden farming of traditional crops (such as upland rice) to intensive farming of cash crops (such as vegetables and fruits) (Laungaramsri 2000, Rigg 1993). The combination of deforestation and intensification of agriculture has led to increasing demand for production water and water shortages during the dry season (Mingtipol et al. 2007, Tomforde 2003, Yamaguchi 2006). As water shortages continue to increase, growing tensions have been observed in all aspects of society: between individual stakeholders in the same village, between neighbouring villages, and between highland and lowland villages competing for the same water resource (Yamaguchi 2006, Tomforde 2003). Therefore, there has been increasing interest in a more sustainable management of the water supply and a number of rules and regulation have been implemented. As water availability is one of the main factors controlling agricultural production capacity (Athipanan & Chainuvati 2006), there is a close relationship between access to water and the farmers’ ability to support their family on crop-based income.

Therefore, the aim of this study is to investigate how farmers’ livelihoods are influenced by the availability of water for crop production. Furthermore, to investigate how existing management rules and regulation are implemented in practice in order to gain understanding on how the water is distributed between stakeholders. To narrow down the subject further we have chosen to focus on water used for vegetable production which is a main type of crop production in the highland areas. With this topic in mind we have formulated the following research question:

<u>How does access to water affect the vegetable production and livelihoods of vegetable farmers in the Mae Pae sub-watershed?</u>

In this question, we choose to focus only on the socio-economic aspects of livelihoods, such as how income generated from vegetable production influences a farmer's ability to support himself. We are aware that our research question is very specific and we anticipate that we may have to broaden it to incorporate the interest of our Thai counterparts.

II. Sub Questions and Objectives

1) *What characterises vegetable farmers' access to water?*

Aim: To investigate farmers' proximity to water sources and the seasonal variation in water availability.

2*) How do the water distribution and irrigation systems of this sub-watershed function?*

Aim: To investigate irrigation systems used in the village for vegetable production and how the systems work. To investigate quantity of water used for irrigation.

3) *What are the existing government policies as well as social norms that influence agricultural water use?*

Aim: To investigate the distribution of water among villagers, existing customary rules for water use as well as the regulations put forth by government institutions, NGOs, local officials, and key community leaders. To explore how these rules and regulations are being implemented. To determine who benefits the most and least, and how this contributes to ongoing tensions between key stakeholders. We will try to put the water management issues into a broader context by investigating downstream farmers' perceptions of upstream water use and how it is affecting their livelihoods.

4) *How do water use and management practices influence farmers' crop productivity?*

Aim: To understand the cropping systems in the area and investigate vegetable yield variations in relation to water supply, soil fertility and proximity of water source as well as inputs such as fertilizer and pesticides. To investigate farmers perception on how restricted water use influences the productivity of their fields.

5) How does vegetable production influence farmers' livelihoods?

Aim: To understand the importance of vegetable production in the household economy. To explore the relationship between crop productivity and financial capital of farmers. To investigate some of the basic market factors influencing the pricing of crops, thereby evaluating the costs and benefit of vegetable production.

III. Methodology

In our field work we plan to use various tools from both Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) approaches. These include many strategies for researching in an interdisciplinary team, and allow us to effectively collect information on livelihoods (ICRA). PRA methods in particular will be useful; through facilitation of discussions we will gain a better understanding of the social context in which we are working.

Transect walk upon arrival with community leaders

This is a useful participatory appraisal method to do at the beginning of the research period because it will allow us to meet the village community leaders and become familiar with the landscape. In this method we hope to observe significant aspects of the landscape, and identify which village or villages would be most beneficial for us to work in (we have decided to focus on one or two villages to make the most of our time). Also, by meeting the community leaders we can perhaps start to collect general background information on the people of the community and the area.

Community Meeting and participatory mapping

Through this method we hope to create a community map in which we identify the location of various vegetable farms in relation to the water sources they depend on. This will help us to identify potential farmers who may become our respondents, and also to begin to stratify the farming population based on water use and field area. Limitations to this method may include a potential bias from the sample population of people that come to the meeting (there may be different opinions from people who are not present) or there may also be dominant voices that control the meeting (ICRA).

Focus group discussions

If possible, after making a community map at the community meeting, we would like to use the opportunity to split into smaller groups and facilitate more in-depth discussions based on the information we have received from the participatory mapping. The focus groups will consist of 4-6 people, divided by gender and possibly also by age. This would allow us to gain more information on the general history of the area in relation to water use. In this process we hope to continue to identify who will be our key informants in the villages.

Sampling Strategy

Since we are covering a large geographical area and investigating several villages it will be of great importance to us to find an effective way of stratifying our sampling when conducting interviews and handing out questionnaires. Our stratification criteria will be: farmers' main cropping activity (which should be vegetables), vegetable field proximity to water source, and size of the farmed area (as an indication of economic status), type of irrigation system and water source. This method will make sure that we cover as wide a spectrum of the population as possible, and reduce our sampling error (StatPac 2007). Hopefully we will be able to identify one or two villages of interest (with help from our Thai counterparts and maps and aerial photos showing the villages' proximity to water sources). Selection of respondent households will be based on information and observations gathered during transect walks and informal talks with the village leaders as well as community mapping.

Questionnaire (open, semi-structured or structured)

This could be an effective way to collect both qualitative and quantitative general background data from the sample population. However, there are limitations in the ability to do an accurate statistical analysis of the data, and an appropriate sample population must be chosen to reduce biases (ICRA).

In depth semi-structured and unstructured interviews

This would include on site farm research talking to vegetable farmers as well as talking with local authority figures. Through these interviews we would hope to learn about water distribution systems and also information on vegetable crop productivity.

GIS analysis

GPS will be a useful tool to collect some concrete data on the geographical location that we are working in. In particular we can explore the location of various water sources and map their flow. Also, it will allow us to triangulate the data we have collected through a participatory mapping exercise with community members.

Estimating water quantity used for irrigation

Collection of such data will rely on information available on irrigation systems, volume of water pumped per minute, and how long the crops are irrigated each day. If this information is not available we will try to collect the data qualitative from farmer interviews. We are also aware that since we will be arriving at the end of the dry season, irrigation might be minimal.

Measurement of productivity indicators.

When dealing with production capacity of a field, soil fertility can not be disregarded. To be able to compare differences in yield between farms, both in terms of quality and quantity, it is important to be aware of differences in soil fertility that may bias the data. Therefore we aim to investigate different measures of soil quality that might have an impact on the productivity of the system. The factors to be investigated are pH and nutrient content (Nitrogen, Phosphorous and Potassium-NPK). The amount of nutrients in the soil is directly linked to crop productivity, and pH tells something about the availability of these nutrients (Hodges). We could have included various other indicators of soil fertility, but as soil fertility is not the topic for our project we choose to focus on just these two indicators. Soil samples from various fields will be collected and analysed using a tool kit (see Appendix A). In combination with the quantitative measure of soil quality we will look at some approximate indicators of soil fertility and plant quality. This method is based on visual observation; for example crop growth and leaf colour. This is based on the concept that different nutrient deficiencies result in different visible affects on the crop that is produced (Lefroy et al. 2000). An actual test of nutrient levels in plant material would be preferred, but we believe it would be too time consuming. This approximate indicator method will be an easier way to get an overview of the nutrient situation on the fields. Some of the symptoms of nutrient deficiency resemble symptoms of water scarcity and pest infections; therefore, it could be hard to distinguish between them (Larsen 1998). It will be decided upon arrival to the field area if meaningful conclusions can be drawn using this method.

Data from institutions

As part of our research, we plan to visit several local authority offices and gain as much information as possible from interviews with authority figures and statistical data that may be available at these offices. For instance, we hope to find some background information on the population demographics, rainfall patterns, history of local water use (quantity), crop productivity yields, irrigation systems, and water use rules and regulations. While we recognize that this data may have significant discrepancies with what is actually the reality in the communities, we still believe that it will be useful for us to compare with what we see in the field.

Offices that we would like to visit include:

-*Local authority (TAO) office*

-*The District Royal Irrigation Department*

-*Forest Department*

-*Agriculture Extension Office*

Table 1: An overview of data needed for answering sub-question 1-5 as well as the methods used to collect the data. The letter (a,b,c….) in front of the "data required" correspond to a letter in front of "methods to be used" indicating which data will be collected by which method.

Sub question	Data Required	Methods to be used
1.*What characterises vegetable farmers' access to water?*	a)Watershed topography b) Source of water for irrigation purpose c) Location of vegetable farm in relation to water source d) Direction of flow. e) Rainfall quantity and seasonal changes in water availability.	a) GIS analysis b,c) Participatory mapping b,c,d) Transect walk and landscape observation, visits to individual farms and the various water sources e) Statistical data from institutions and Seasonal calendar.
2. *How do the water distribution and irrigation systems of this sub-watershed function?*	a) Information on irrigation systems on different farms. b) Quantitative or qualitative estimates of water use for irrigation	a,b) Visits to individual farms -Farmer interview -Questionnaire -Secondary data
3. *What are the existing government policies as well as social norms that influence agricultural water use?*	a) General history of area in terms of water use and management b) Current management practices c) Water politics: sources of tension key actors/institutions d) The role of NGO's operating in the area e) Ongoing water projects in the area	a-e) Interview with key persons from district offices, TAO's, NGO´s and village Headmen -Focus group discussions -Secondary data
4.*How do water use and management practices influence farmers' crop productivity?*	a) Main crops grown at different times of the year b) Vegetable yield in different seasons c) Vegetable and soil quality of various vegetable farms d) Inputs of fertilizer and pesticides e) Vegetable farmers perception of water regulations	a,b) Seasonal calendar a,b,e) Interviews a,b,d) Questionaires c) Soil analysis and approximate indicators.
5.*How does vegetable production influence farmers' livelihoods?*	a) Farmer household income and income sources b) Seasonal changes in income from crop production c) Seasonal expenditures including money for fertilizer, pesticides, transport of vegetables, water and land access. d) Accessibility to market and market chain e)driving forces and resistance to vegetable production	a) Questionnaire a,b,c,d,e) Interviews b) Seasonal calendar d) Secondary data

IV. Timeline of Events

Activity	1	2	3	4	5	6	7	8	9	10 (½ day)	Subjects
Meeting community leaders											Key informants
Transect walk											Key informants
Focus group discussion											Vegetable farmers
Participatory Mapping											Vegetable farmers
Interview and walk to field											Vegetable farmers
Interview to official staff											Staff at local institutions (may involve daytrip)
Interview of farmers in downstream villages											Downstream Farmers (day trip necessary)
Questionnaire survey											Households
Seasonal calendar											Vegetable farmers
Feedback to farmers											Vegetable farmers
GPS mapping of field and water sources											Vegetable fields and water sources
Soil analysis, productivity indicators											Vegetable fields

	Group 1
	Group 2
	Both groups

Day 1 and 2: Trying to get an overview of the area, to locate the villages and identify villagers of interest in order to stratify our sampling.

Day 3-10: Going in the field, observing, interviewing, giving feedback

V. Explanation of Utilisation of Disciplines

We will be investigating a research question that leans more towards the collection of qualitative data; however we will be also attempting to collect quantitative data wherever possible. For our field work we will be collaborating with approximately five students from Chiang Mai University in Thailand so we will hope to adjust our research focus to incorporate their areas of study as well.

Our group members who specialize in forestry and agricultural sciences will be in charge of investigating cropping and irrigations systems as well as household economic structure on vegetable farms. The group member specializing in development studies will be in charge of investigating water policies and practices in the area and livelihood issues. Our group members specializing in biological and geographical science will be in charge of identifying water sources, GPS mapping water sources, analysing seasonal changes in rainfall patterns, soil sampling, as well as take part in evaluating existing management rules of water resources.

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