

Dynamics of household water management systems in mountainous regions of northern Thailand ¹

Peter Elstner ^{*}, Anne Bollen ^{*}, Chapika Sangkapitux ^{**}

^{*} The Uplands Program (SFB 564) – University of Hohenheim, Thailand Office
c/o Faculty of Agriculture, Chiang Mai University, Chiang Mai 50200 Thailand
E-mail: peter.elstner@gmx.net

^{**} Department of Agricultural Economics, Faculty of Agriculture, Chiang Mai University,
Chiang Mai 50200, Thailand

Abstract

Sufficient and clean water supply is a basic human right, but there are still thousands of communities in Thailand, especially in remote areas, that lack permanent and reliable supply of household water. This study aims to present the complexity of management systems for household water, to analyze regulations and problem solving strategies and to determine the factors which have influenced the evolution of the different systems in recent years.

The study is based on intensive surveys in ten villages (four with northern Thai population and six inhabited by different ethnic minority groups, namely Hmong, Lahu and Shan) in two northern Thai provinces conducted in 2004 and 2005. The two provinces differed markedly with regard to ethnic composition and degree of commercialization of agricultural production. In semi-structured interviews with key persons (village headmen, water committee members, water company owner) and in group discussions management regulations, inter- and intra-village conflicts and resolution mechanisms were elicited. In addition, field surveys of the water sources, as well as storage and conveyance systems were carried out, and the data integrated into a GIS system.

Results suggest that household water supply is of high priority in all communities, which in some cases is reflected in particular regulations that constrain the use of water sources for irrigation. Most household water sources are protected by religious rites, and its control and use are characterized by considerable variations. Three major systems can be distinguished:

a) *Communal systems without water fee* where all users are responsible for the maintenance, which requires a strong social cohesion and collective action to prevent free-riding behavior. These systems could mainly be found in the province with predominantly subsistence-oriented agricultural production and ethnic minority population.

b) *Communal systems with water fee* where the users pay a monthly lump-sum fee or a fee according to water use, and selected persons are responsible for the operation and maintenance of the system. These systems are prevailing in upstream villages in the market-oriented province.

c) *Individual supply systems* where farmers use water for both agricultural purposes and the household from the same, mainly private source or purchase drinking water from a local company. These systems exist mainly in downstream villages with a high degree of commercialization.

Communal household water supply systems were often established with assistance from governmental organizations, while the management is under the control of the villagers. The use and allocation of water is based on explicit rules and regulations, which ascertain the

¹ Paper to be presented at the Eleventh Biennial Global Conference of the International Association for the Study of Common Property (IASCP) “Survival of the Commons: Mounting Challenges & New Realities”, June 19 – June 23, 2006, Bali, Indonesia.

exclusive use of the source for household water and control the use in times of scarcity. However, these management systems are highly dynamic, and villagers adapt the system if it turns out to be unable to provide a secure water supply. The exchange of household water sources between two villages in the predominantly subsistence-oriented province reflects the flexibility and pragmatism of local communities and their potential for collective action beyond the village level. Inter-village cooperation with regard to household water is less prominent in the market-oriented province.

Keywords: household water management, collective action, Thailand

1 Introduction

Access to sufficient and clean water has been declared “a fundamental human need and, therefore, a basic human right” (Kofi Annan, quoted in WHO 2003). The global effort to tackle water problems is reflected in the re-affirmation of the Millennium Development Goals at the UN World Summit on Sustainable Development in Johannesburg in September 2002, particularly in the target “halve by 2015 the proportion of people without sustainable access to safe drinking water.” Water security in Asia is particularly threatened by population growth, widespread overuse and pollution. Fresh water supplies in Asia are among the scarcest in the world and extremely unevenly distributed within and between countries, which heightens the risk of conflict over control and access to water. According to a recent estimate of the Asian Development Bank, availability of drinkable water in Southeast Asia has declined by 55% in the past 50 years. In Thailand, 16,000 villages of a total number of about 72,000 have no permanent access to safe drinking water, most of them located in the northern and northeastern parts of the country. In rural areas about 70 percent of the households have access to improved water from piped systems and tube wells for drinking water, but for household consumption villagers still have to rely on other water sources (Sethaputra, et al. 2000). Especially in the highlands where connections to more centralized systems of water supply are hard to establish due to the difficult topography and remoteness of villages, the majority of the piped water system for rural households are operated and managed at the community level.

In the past, research on household water for rural communities focused mainly on quality aspects and health issues (e.g., UNESO/WHO/UNEP 1992, WHO and UNICEF 2000). Studies that analyze and compare the internal regulations of different household water management systems and investigate how these systems have evolved remain scant. This void is remarkable given the fact that the management system, the associated regulations for water use and the coping strategies in times of scarcity crucially influence the household water supply.

In an attempt to fill this gap and to improve the understanding of household water management systems in marginal highland areas, the objectives of this study are (1) to present the complexity of management systems for household water in two areas in northern Thailand, (2) to analyze regulations for water use and strategies to cope with water scarcity and decreasing water quality, and (3) to determine the factors which have influenced the evolution of the different systems in recent years.

2 Study Area and Methods

2.1 Study Area

This study is based on research in ten villages in two provinces in northern Thailand. In Pang Ma Pha district in Mae Hong Son province three villages (Mae Lana, Ja Bo, Bor Krai) located close to the Thai-Myanmar border were purposefully selected (Figure 1). This district was one of the main intervention zones of the Thai-German Highland Development Program (TG-HDP) which phased out in September 1998. As infrastructure is poorly developed and market access difficult, the village economies are mostly dominated by subsistence agriculture based on fallow systems (Table 1). Irrigated agriculture is confined to a few areas in the valley bottoms where paddy cultivation predominates. The dominance of the karst (limestone) has implications for the water resources, with floods during the rainy season and severe water shortages during the dry season. Bor Krai and Ja Bo are located in the Pai wildlife sanctuary, while Mae Lana is located in a protected watershed area.

Table 1. Selected characteristics of the study villages in Pang Ma Pha district, Mae Hong Son Province

Characteristics	Bor Krai	Ja Bo	Mae Lana
Location	Upstream	Upstream	Downstream
Altitude (m asl)	740-900	900-1050	800-880
Ethnic group	Black Lahu	Black Lahu	Shan
No. of households	52	44	149
Agriculture	upland rice, maize, vegetable	upland rice, maize, beans	paddy rice, beans

In the upper part of the **Mae Sa watershed** in Chiang Mai province seven villages were selected. The Mae Sa watershed is located around 30 km northwest of Chiang Mai, the largest city in northern Thailand (Figure 1). The Mae Sa river feeds into the Ping river, one of the major tributaries of the Chao Praya river. In this watershed market-oriented agriculture, mainly fruit, flower and vegetable production under irrigation is dominant (Table 2). The upstream villages (Pha Nok Kok, Buak Chan, Buak Toey, Pang Lung and Pong Krai) are located in the Doi Suthep-Pui National Park or in protected watershed zones. The lowland villages Muang Kham and Pong Yang Nai are located outside the protected areas.

Table 2. Selected characteristics of the study villages in Mae Sa Watershed, Chiang Mai Province

Characteristics	Pha Nok Kok	Buak Chan	Buak Toey	Pong Krai	Pang Lung	Muang Kham	Pong Yang Nai
Location	Upstream	Upstream	Upstream	Upstream	Upstream	Downstream	Downstream
Altitude (m asl)	1060-1380	1140-1380	1200-1360	1020-1420	1100-1240	780-920	760-940
Ethnic group	Hmong	Hmong	Hmong	Thai	Thai	Thai	Thai
No. of households	62	103	52	79	25	192	237
Agriculture	litchi, flowers, vegetables	flowers, vegetables, fruits	flowers, fruits, vegetables	flowers, vegetables	flowers, vegetables	sweet pepper, vegetables, flowers	flowers, vegetables

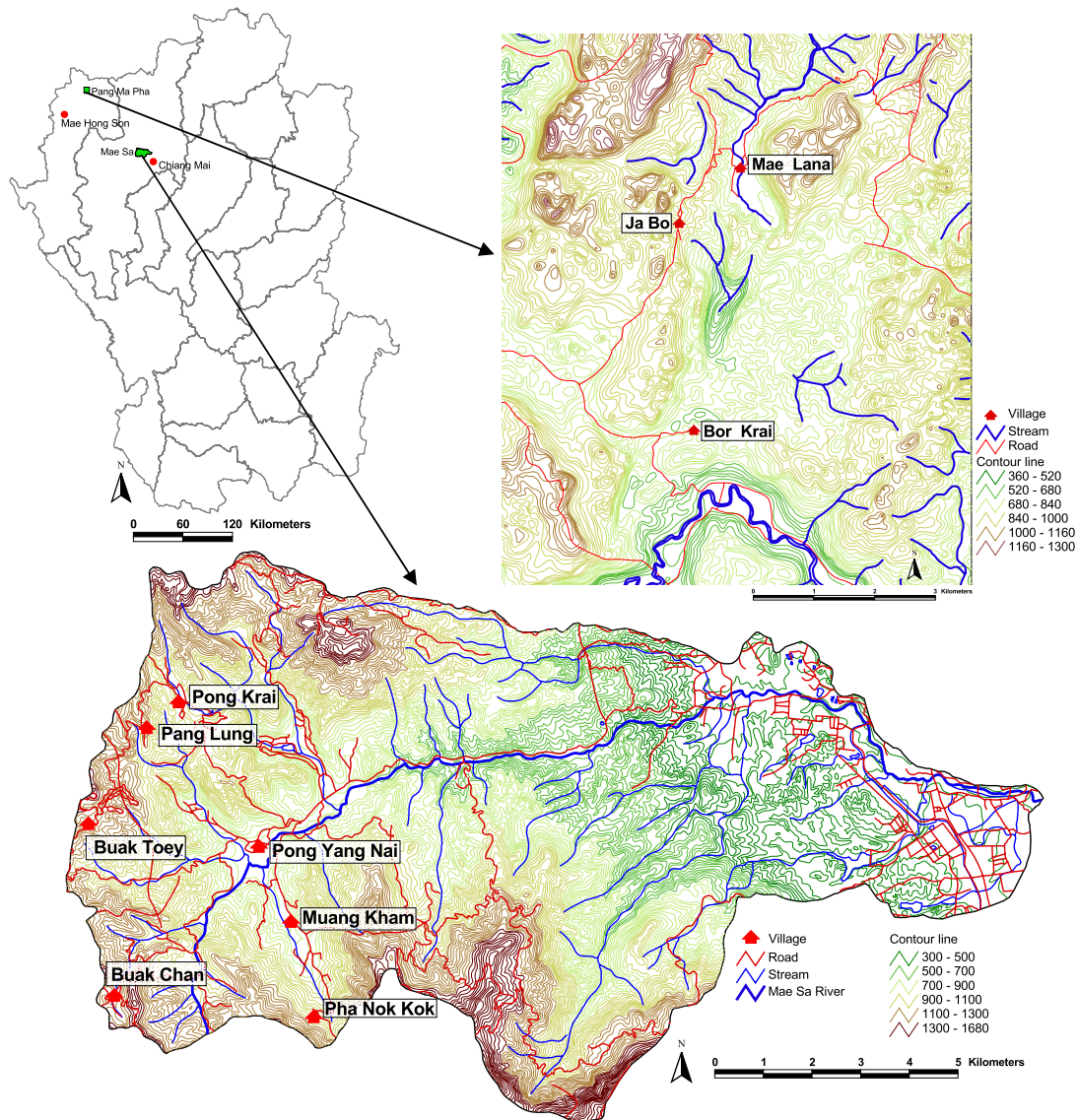


Figure 1. Study areas in northern Thailand

2.2 Data collection

The research is based on a survey at the village and household level conducted in 2004 and 2006 in all villages. In open and semi-structured interviews with key persons such as village headmen, local committees, and individuals responsible for water management information about the structure and the management of the household water system were obtained. All household supply systems were surveyed with the help of key informants. Spatial information was obtained by a mobile Global Positioning System (GPS) and integrated into a Geographical Information System (GIS).

In the Mae Sa Watershed a survey with standardized questionnaire of 30 households in each study villages was carried out, which gave insights into the use and management of household water. In a pair-wise ranking exercise in each village with a selected group of farmers, the value of water for different purposes, such as household use, agriculture and others were investigated.

3 Results

3.1 Household water management systems

3.1.1 Communal household water systems without water fee

Communal systems without water fee are characterized by water supply from springs and creeks using gravity flow to direct the water to storage tanks and households. In all villages categorized under this system the source for household water is exclusively used for this purpose and is protected by local regulations and religious rites. The supply systems were established with the help of local organizations or government agencies, but all users are responsible for management and maintenance, which requires a strong social cohesion and collective action to prevent free-riding behavior.

The Lahu village **Bor Krai** belongs to the more than 16,000 villages in Thailand that still have no permanent access to safe drinking water. The household water supply system was established by a development project and is now maintained by all villagers. The former community system which distributed water to each household is not in use anymore, because the water quantity had not been sufficient to supply all households. Households at the head of the pipeline were advantaged at the expense of the tail-enders, leading to internal conflicts. Today, the villagers, mainly the women, have to fetch water at a communal tap in the village. All users participate in the maintenance work, which includes repairs of broken pipelines and cleaning from limestone deposits to ensure the water flow.

During the rainy season water is abundant and no regulations restrict water access and use. In the hot and dry season in March and April water becomes extremely scarce and villagers are permitted only to use water from the common pipe for drinking and cooking. Personal hygiene and washing of laundry has to be done at other water sources outside the village. The current system reflects a communal sense of equity, in which local elites do not seem to be privileged with respect to water access.

The water source is protected by religious symbols, and in times of water shortage the shaman, together with other villagers, would hold a ceremony at this source which serves to ensure the abundance of water. In addition, several old trees around the water source have been protected by customary regulations for decades. According to key informants the major reason for the protection was that villagers feared the quantity of water would decrease without trees. After the sources were connected to the household water system, the fields located above the water sources were abandoned and the protected area was extended. Under the initiative of the Thai-German Highland Development Program, the villagers designated an area of 64 ha as conservation forest which implies prohibition of cutting trees, land clearing and hunting to protect the essential source of water supply.

Due to the low water availability of individual sources and the low difference in altitudes the household water for the communal system in **Mae Lana** is derived from three sources in the surrounding mountains (see Figure 2). The “Ja Bo source” was part of the exchange of water sources (see section 3.2.2) and provides water for the zone 1 and 2 of the village. The “mountain source” is located upstream from the valley and supplies water to zones 3 to 6. Due to its location outside of the main residential area, zone 7 is not connected to any of these supply systems, but had to establish its own system. The users are managing the system in a labor-sharing arrangement. In case of any damage the costs for repair will be shared by the users and all will help to repair the pipeline.

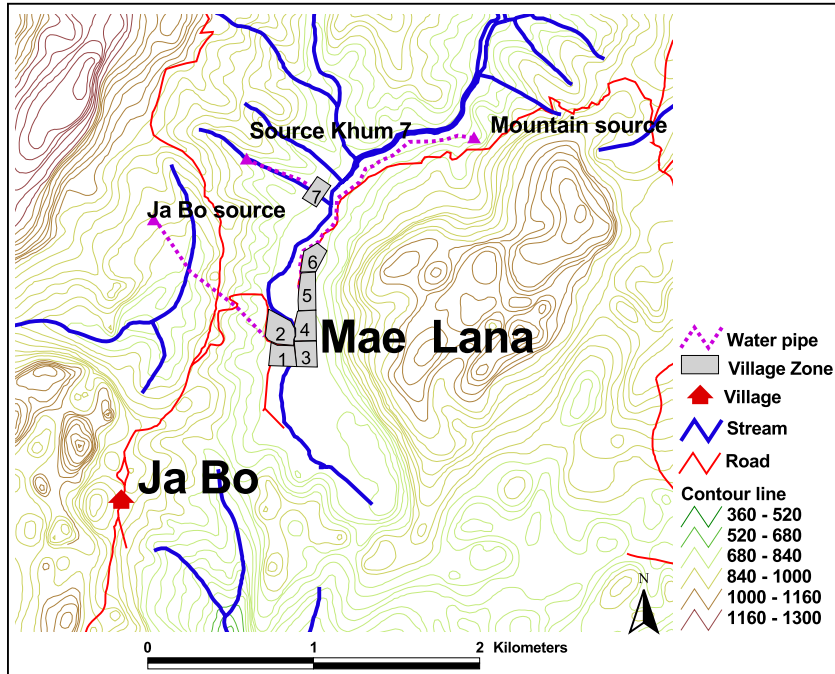


Figure 2. Communal household water system in Mae Lana

None of the three sources provides enough water in the dry season, and villagers have to use water from communal wells near the river, from the irrigation canal, from the river itself, or from private rainwater storage tanks. The villagers prefer collected rainwater as drinking water because they are concerned about the pollution of the household water source through a neighboring village upstream.

Different government agencies have tried to improve the household water supply system by installing modern conveyance and storage systems. In many cases, these systems interfered with the customary water management systems and their construction often lacked transparency and coordination. The last project was the construction of a water tower to ensure water supply to the whole village. However, the tower has never been completed and a continuation of the construction work is not very likely. This example is rather typical for the failure of government agencies to adapt their technical solutions to the social setting in the target villages.

3.1.2 Communal household water systems with water fee

In these systems users have to pay a fee for the water, either as a monthly lump-sum amount or a fee according to water use. This fee is used to compensate the responsible persons for their work and to cover the cost for providing the water to the household, which is mostly costs for lifting, because of the low elevation of the water source.

The source for the communal household water in **Ja Bo** was part of the exchange of water sources (see section 3.2.2 below) between Ja Bo and the neighboring village Mae Lana and is located at a distance of 4 km from the village. Villagers from Mae Lana agreed to protect the forest around the main water source of Ja Bo by local regulations to ensure a constant water flow, even after transferring their use rights to the village Ja Bo. Water from this source flows by gravity to the storage tank in the village. The distribution of the water is regulated by a valve, and every household stores water in private water tanks. In the past conflicts emerged

in the dry season when some households withdrew a bigger share of the water. Upon intervention of the village headman, the system was changed to supply all households with equal shares. Two respected persons are responsible for the maintenance of the water system and the villagers pay a fixed fee per month. This fee is used to compensate the two responsible persons and for maintenance costs.

During the dry season communal regulations determine the use of water, and whoever breaks these rules would be fined. Villagers are not allowed to do the laundry in the village, but have to go directly to the remaining water sources outside the residential area. Water for livestock has to be taken from sources with lower water quality. One of the water sources of Ja Bo, located in a small cave, is considered as sacred and is mainly used for ceremonial purposes. The area around the water source is strictly protected, and nobody is allowed to cut trees.

Since the foundation of **Pha Nok Kok** the villagers have organized the household water supply on a communal basis. The reason mentioned by the villagers is that an individual system would create competition for water and conflicts due to the limited water resources. The communal system guarantees an equitable distribution of the water. The water source for the households is a creek which is exclusively used for this purpose. Water is conveyed by gravity to storage tanks from where it is distributed to all households. Increasing population and demand of household water made regular extensions and enhancement of the water supply system necessary. These improvements were funded by different local and state organizations (Table 3). The water system is managed by three voluntary persons, who periodically changing the duty. Thus, all households are responsible for the control and maintenance of the water supply system for a certain period of times. Money needed for maintenance is taken from a central village fund, where money from different state organizations and taxes from the villagers are collected. Thus, villagers pay the water fees indirectly. In times of water scarcity local regulations permit only the use for drinking and cooking. Water for washing and bathing has to be taken from other sources.

Table 3. Improvements in the household water system in Pha Nok Kok

Year	Activity	Organization
1970	Construction of water reservoir, a basin made from soil	UN Development project
1988	Construction of first concrete basin	Private investor
1994	Construction of 3 water tanks	Community Development Department
1997	Construction of four tanks	Department of Social Welfare
2002	Construction of small dam at Don Dua creek	Royal Forest Department
2002	Construction of new tank (~18m ³)	Tambon (Subdistrict) Administration Organization (TAO)
2006	Construction of groundwater well	Office for Developing the Village / Community Efficiency (SML)

Source: Neef et al., 2004, updated

In the Hmong community **Buak Chan** the communal system is used by 75% of the households. 25% of the households use their own individual supply system mainly from the same source as the irrigation water. The only water source for the communal system is a spring which is exclusively used for household purpose. Because the water source is located below the settlement, the water needs to be lifted to a storage tank located at a high altitude, from where the water is distributed by gravity flow to the households. The water consumption

of each household is measured by a water meter. This system has been installed in 1997 as a response to the increasing scarcity of water for household consumption and to equitably share the running costs of the pump. The water use has been substantially reduced since the water meters have been introduced. Villagers use other water sources with lower quality for purposes like car washing. The tank and the pump were financed by governmental organizations (Department of Public health and subdistrict organization). The system is managed by three volunteers who are responsible for maintenance and for collecting the water fee.

In addition to the communal system, zone 1 and zone 2 (Figure 3) have their own household water system. **Zone 1** uses water from a spring by gravity to the storage tanks and then distributed to the households. The households do not have to pay a fee for this water. This system is mainly used during the rainy season when water is abundant. During the dry season Zone 1 has to use water from the communal system. There is one pipe with a water meter connected to the storage tank. The costs for the water from the communal system are shared equally between the families of Zone 1. **Zone 2** uses water from a spring, which is pumped to a storage tank. The system is used only in the rainy season. All households of Zone 2 shared the costs for the pumping. The system in zone 1 and 2 were established before the communal system but served only a few households. All other households had to fetch water directly from the different water sources.

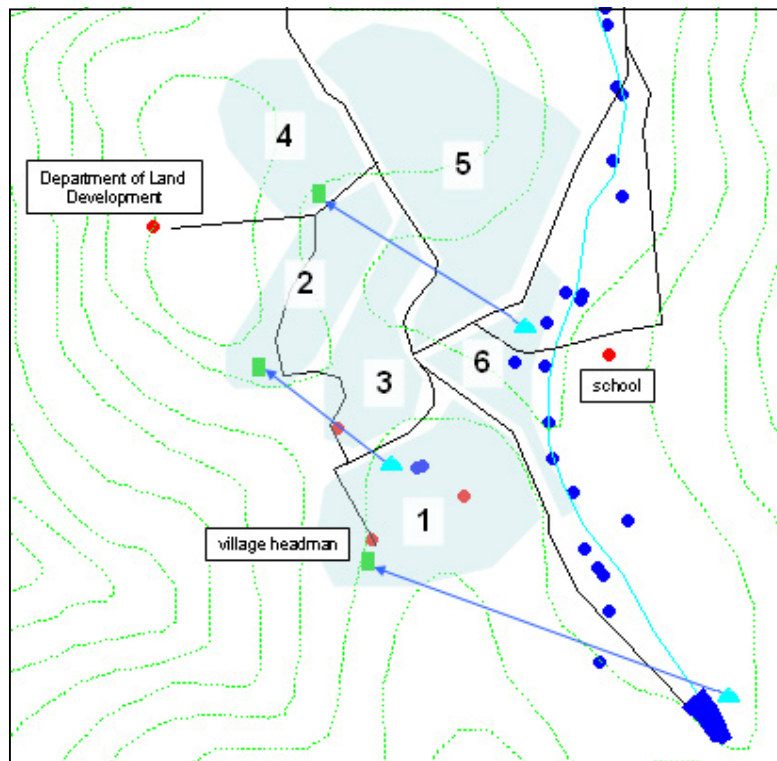


Figure 3: Water supply for households in Buak Chan

- Legend: ▲ spring/well for household water,
 ■ storage tanks for household water,
 ● ponds for irrigation

In the communal system in **Pong Krai** water from the upper zone of the main creek in the village is used for the households. 73% of the households use this system, while 27% of the

households have an individual supply from creeks or ponds. Water from the storage tank is distributed by separate pipes to three different zones of the village as well as to the temple. Each user has to pay a lump-sum fee per month for the water supply. One villager has been assigned to control and maintain the system and collect the water fees. The fee is used for the compensation of the responsible person and for the maintenance costs. In order to guarantee a good water supply and water quality, there are regulations that no farmer is allowed to take water for irrigation above the household water source. In cases of water shortage, the supply is regulated through the rule that every zone takes turns in getting water and each household stores water in a private tank near the house. Conflicts emerged with an outside investor who owns a resort on the village territory. The resort owner also uses water from the communal system and has several big storage tanks, which would allow him to take a lot of water at the expense of the locals. Therefore, in times of shortage the resort owner is permitted only to fill one tank.

The communal system in **Buak Toey** was established several years ago on the initiative of the villagers. The majority of the households use the communal system. There are only a few families which use water from their private source. Water from the upstream part of the village was transferred through pipes and gravity flow to a storage tank. As the water quantity was not sufficient, water from downstream was collected in a tank built by the subdistrict administration and pumped up into the main storage tank. To share the costs for lifting the water equitably water meters were installed, and water consumption is charged per unit of water. The price was set particularly high in order to give an incentive for the villagers to use water economically, since the water availability is very low and the villagers face frequently water shortages. The village headman regularly organizes meetings to discuss the water use and ways how to save water. One person is responsible for the maintenance of the water supply system and for collecting the water fee.

There are also two other water supply systems providing additional water during the rainy season for different parts of the village. Water from creeks is conveyed by gravity to storage tanks and then distributed to the households and to a communal water tap. There is no fee and no regulation for the use of this water.

In the past villagers of **Pong Yang Nai** organized their household water supply individually using groundwater wells. On request of the villagers the current communal system was established with financial support of the government in 2002. Nowadays, the communal and individual systems exist side by side and are used by 67% and by 40% of the households respectively, whereby some households get water from both systems. The water source for the communal system is the main creek in the watershed, the *Mae Sa River*, and the water is pumped to a storage tower. Before distribution to the households the water is treated with chlorine to improve the water quality. The water consumption is measured with water meters, and households are charged per unit of water. Three persons are sharing the tasks for the management: 1) control and operation of the pump, 2) checking and repair of the water pipes and 3) collection of the water fee. These persons receive a monthly compensation at a fixed rate.

Even after treatment most villagers do not use the water of the communal system for drinking, because they are concerned about pollution with agrochemicals. The water is mainly used for other household purposes, like washing and bathing. For drinking water the villagers prefer the water from the groundwater wells because they assume the water quality is better.

Moreover, bottled water from local water companies is gaining importance as source for drinking water.

Due to the location of the water storage tank the communal system supplies water to the households on lower elevations, which constitute the majority of the village. Around 70 households are located on higher elevations and therefore have established their own water supply system. They use water from a spring which also serves as water source for irrigation. This source is located in a forest and each year during the dry season the village headman and other selected villagers perform a ceremony on the source to ask the water spirit for abundant water and to protect the sources. The maintenance of the system is the common task of all users.

3.1.3 Individual household water supply systems

In two villages household water supply is mainly organized individually from private sources. In **Pang Lung**, the smallest Thai village in our sample, most farmers use water for the household from the same source as the irrigation water or/and buy bottled drinking water. A few households share water from a reservoir built in an area above all private ponds by a local politician. Users of this system do not pay any fee and they share the maintenance work and costs. This system can not provide water for all households because the storage tank is located at a lower altitude.

Similar to the case of Pang Lung farmers in **Muang Kham** use water for household consumption from springs, wells, or irrigation canal, which is also the source for irrigation water. Springs are used by a group of villagers, and numbers and diameter of the pipes are regulated according to the irrigation area in former times. As the water is scarce most user groups do not allow newcomers to use water from the spring. Wells were mainly constructed for irrigation, because the cultivation of sweet pepper requires clean water. With this shift in the agricultural production, many households also improved the quantity and quality of their household water supply. Wells are private and either individually used or by several relatives which shared the investment of the construction.

The irrigation canals were part of the traditional irrigation system, the so-called *muang fai*. Today, only a few canals still exist and water cannot be used for drinking owing to the low quality. Many farmers are concerned about residues of agrochemicals in the water, thus bottled drinking water is getting more important. In August 2002 a villager of Muang Kham established a drinking water company located at the village center. It was built on a private initiative but declared as a communal village project, and therefore received government support. The company is organized as a cooperative with 60 members from Muang Kham. The water company draws water from a well which is then treated with ozone and UV.

In one residential zone of Muang Kham 15 households manage their household water as a group because of the location they have limited access to other water sources. The households do not need to pay a fee for the water, and all users are responsible for the maintenance.

3.2 Dynamics of household water systems and coping strategies in times of water scarcity

With changing ecological, social, economic and institutional conditions villagers adapt their household water supply systems to ensure and improve water quantity and quality and to reduce costs by: a) changes in the management, b) getting access to new water sources, c) establishing better storage and conveyance systems.

3.2.1 Changes in the management

The management system in **Ja Bo** has changed after regular internal conflicts over water. In the past the household water system was managed by groups of households, and each group had to take care for the water management for one month. This system failed because some villagers did not fulfill the task resulting in an unreliable water supply. The situation improved after assigning two respected person to be responsible for the maintenance of the water system and the villagers agreed to pay a monthly fee. In contrast to Ja Bo the system in **Mae Lana** changed from an group-based system with individual responsibilities to a communally managed system based on collective action. In the past a water user group existed which assigned two persons to be responsible for maintaining the system. Each household had to pay a fixed fee per month for the maintenance. This management system failed because the fee did not provide enough compensation for the two persons, resulting in a bad performance. Hence, the management system was changed and nowadays all users collaborate in the maintenance work and share the costs.

3.2.2 Getting access to new sources

A remarkable example how villagers improved the household water supply is the case of the **exchange of a water source** between the villages Ja Bo and Mae Lana. Before 1980 the residential area of Ja Bo was located in a valley with reliable waters sources. Following a malaria epidemic associated with this location, the settlement was moved to a higher altitude. Today, all water sources within the village boundaries are located on a lower altitude than the residential area. Hence, the use of these sources would require investments in pumps and water conveyance systems which villagers have not been able to afford to date. One water source of Mae Lana was located at a higher altitude which allowed water conveyance to Ja Bo by gravity flow (see Fig. 4, Mae Lana Source).

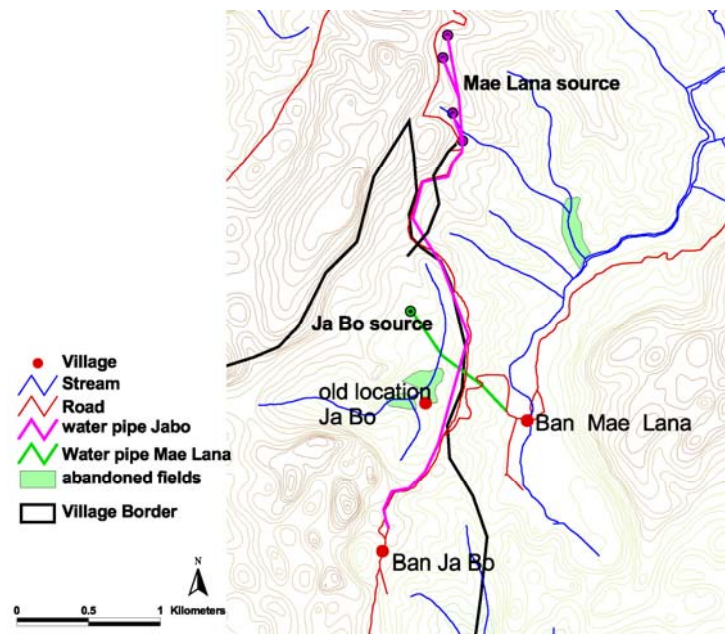


Figure 4. Exchange of water sources between Ja Bo and Mae Lana

After negotiations it was agreed that Ja Bo is entitled to use this water source of Mae Lana. In exchange, Mae Lana got the permission to use water from a source in the area of Ja Bo (Ja Bo

source) to meet the increasing demand for household water. Several farmers in both villages agreed to abandon their irrigated fields next to the respective water source or further downstream (see Fig. 4) in order to ensure provision of household water for the other village. This willingness to sacrifice individual benefits in favor of the welfare of the community is an expression of the priorities given to a secure household water supply, but also reflects the high degree of social capital and potential for collective action in the study area. In sum, the exchange of water sources between the villages Ja Bo and Mae Lana – which belong to different ethnic groups – demonstrates the flexibility and pragmatism of local communities to ensure their own water supply and that of their neighbors and to prevent and resolve resource conflicts (cf. Elstner et al., 2004).

Villagers of **Buak Toey** faced regularly water conflicts with outside investors, who own large areas of farmland upstream of the residential area and claimed also all water sources in their land as private property. After the water shortage in 2005 the villagers solicited from one investor to use water from a source on his land, which was at that time only used for agriculture purposes. The villagers argue that household water should have higher priority than irrigation water. Due to this additional reliable source, the water source located at a lower altitude is not used anymore for household water, which saves costs for pumping and reduces the price per water unit.

3.2.3 Establishing better storage and conveyance systems

Several villages in the Mae Sa Watershed are increasingly facing problems with scarcity, especially during the dry seasons. Thus, to improve the reliability of the water supply has a very high priority to the villagers. In **Pha Nok Kok** the villagers agreed to use the government funds provided for the year 2006 to improve the water supply by a groundwater well. Water from this well will be mainly used during the dry season when the creek does not provide enough water. The running costs for the pump will be shared between all households equally. With this improvement to ensure the water supply the villagers will have to pay for water in the future.

As the current communal household water system in **Pong Yang Nai** does not provide water for all households, an additional water system was established in 2006. The water source is used by other villagers for household and irrigation. In a village meeting all current users agreed to use this source from now on exclusively for the new system which will provide water for all households. Thus, individual households sacrifice their private supply system and economic benefit in favor of the community. For this new water system a storage tank was constructed at a high altitude to provide water to all households. The water can be transferred by gravity thus there are no costs for pumping. The water quality is good enough for all household purposes, even for drinking. However, until today, the distribution system to the households has not yet established due to lack of funding.

Until today, villagers in **Muang Kham** are using the individual system for the supply of the households, although the government has commenced to build a communal system in 2001. Three groundwater wells were constructed which are supposed to supply the whole village with household water. However, the villagers could not yet obtain the fund from the government for the construction of the storage tank and conveyance system. At the moment, these wells are used only by some farmers for irrigation of their farmland.

Although the water supply in **Buak Chan** has been quite reliable, villagers are increasingly concerned that with growing population pressure household water could become scarce in the

future. For this reason they plan a project to establish a new system funded by the government with a storage basin near the current water source and a new tank on higher elevation to provide water with sufficient pressure to all households. All households already contributed to a fund to buy the land where the new tank will be constructed. This demonstrates the high priority of household water.

4 Comparative analysis and synthesis

4.1 The value of household water

Water is essential for a range of purposes. With the increasing scarcity users have to decide about the allocation of water for different purposes. Participatory methods of water resource valuation can help to identify the values that water has for different stakeholders and their priorities of water allocation. Table 4 presents the results of group-based pair-wise ranking of the value of water for selected purposes in the villages of Mae Sa watershed.

Table 4. Villagers' ranking of the value of water for selected purposes in villages in Mae Sa Watershed

Village	Pha Nok Kok	Buak Chan	Buak Toey ^{a)}	Pang Lung ^{a)}	Pong Krai	Muang Kham ^{b)}	Pong Yang Nai
Location	Up-stream	Up-stream	Up-stream	Up-stream	Up-stream	Down-stream	Down-stream
Drinking	1	1	2	2	1	5	7
Household	2	2	1	1	2	6	3
Agriculture	3	3	4	4	3	4	1

a) Villagers in Buak Toey and Pang Lung ranked the value of water for religious purposes on third

b) Villagers in Muang Kham ranked ecological services, religious purposes and sharing with upstream communities higher

c) Villagers in Pong Yang Nai ranked religious purpose (2), bequest value (4), ecological services (5), and sharing water with upstream communities (6) higher

Villagers in upstream communities attributed the highest importance to both drinking and household water whereas downstream villagers gave higher values for water use in agriculture and for other purposes, such as ecological services. These findings reflect the scarcity that most upstream villages – which rely on one water source for drinking and household water – are facing. Strict regulations and sanction mechanisms for non-compliance in these villages confirm the high importance of the drinking and household water sources. Although drinking water is a fundamental need for humans, the downstream villages ranked water for household and drinking comparatively lower than water for other purposes. This is an expression of the much higher diversity of water sources and the relative abundance of water in the mountain valleys. Villagers are able to gain access to other water sources to satisfy their most basic needs, e.g. from private groundwater wells and through the possibility of buying bottled water.

The high priority of drinking and household water in the ecologically less favored karst area in Mae Hong Son province (where no resource valuation study was done) is underscored by the exchange of water sources between the two villages Mae Lana and Ja Bo (see 3.2.2).

4.2 Factors influencing the evolution of household water supply systems

Household water supply systems need to provide water in sufficient quantity and of good quality at all times. Most villagers seem to believe that a communal management is best

suitable for this purpose, particularly in times with increasing water shortages. This explains why today even villages with a predominantly individual system apply for funds to establish a communal system that constitutes an additional source and thus provides higher water security. This is in stark contrast to findings of parallel studies on tenure and management systems for irrigation water which suggest an ongoing process of individualization of resource access (cf. Neef et al., 2004). The management systems for household water have evolved depending on a variety of factors, namely physical, socio-cultural, economic, and institutional. Table 5 provides an overview of the major factors.

Table 5. Factors influencing the evolution of household water supply systems

Location	Mae Hong Son province			Chiang Mai province	
Market orientation	Subsistence-oriented			Market-oriented	
Name of village	Bor Krai	Mae Lana	Ja Bo	Pang Lung	Muang Kham
Ethnic group	Black Lahu	Shan	Black Lahu	Thai	Thai
Village size	Small	Large	Small	Small	Large
Social cohesion, collective action	High	High	High	Moderate	Moderate
Degree of commercialization	Low	Low	Low	High	High
Predominant water supply	Communal, without fee	Communal, without fee	Communal, with fee	Individual	Individual
Diversity of water sources	Low	Moderate	Low	Moderate	High
Level of water scarcity	High	High	High	Low	Low
Local regulations and sanctions	Strong	Strong	Strong	Moderate	Weak
Influence on local politics	Low	High	Low	High	High
Level of external support (GOs/NGOs)	Moderate	Moderate	Low	Moderate	Moderate

Location	Chiang Mai province				
Market-orientation	Market-oriented				
Name of village	Pha Nok Kok	Buak Chan	Buak Toey	Pong Krai	Pong Yang Nai
Ethnic group	Hmong	Hmong	Hmong	Thai	Thai
Village size	Small	Medium	Small	Medium	Large
Social cohesion, collective action	High	High	High	Moderate	Moderate
Degree of commercialization	Low	Low	Low	High	High
Predominant water supply	Communal, with fee	Communal, with fee	Communal, with fee	Communal, with fee	Communal, with fee
Diversity of water sources	Low	Low	Low	Moderate	High
Level of water scarcity	High	High	High	Low	Low
Local regulations and sanctions	Strong	Strong	Strong	Moderate	Weak
Influence on local politics	Moderate	Moderate	Low	High	High
Level of external support (GOs/NGOs)	High	Moderate	Low	Moderate	Moderate

A comparative analysis of the different driving forces in the study villages suggests that communal systems can be mainly found in upstream areas which are characterized by a limited access to suitable sources for household water. Given this fragile condition, the villagers are forced to organize the access to this crucial resource collectively. This is confirmed by the fact that most of the household and drinking water sources are exclusively used for these purposes. An individual use of this scarce resource would trigger competition and conflict between the villagers. The unfavorable geographical conditions bring about high investments costs in tanks, pipelines and pumps for the establishment of the supply system, which can be easier born by a whole community than by an individual household. Moreover, if the source is located at a lower altitude than the village – which is typical for the ethnic minority villages on mountain ridges – water needs to be lifted which entails relatively high variable costs for the provision of the water, which can be shared between the users in form of water fees.

To ensure the quantity and quality of the supply, the water source and the surrounding forest area are usually protected by communal regulations. The use in times of water scarcity is also regulated by local agreements which include mainly the reduction of the demand through measures like schedules for the water supply and restriction of the use for certain activities. If the communal system can not provide sufficient water, villagers are forced to seek access to water from other sources on their own.

An important factor for the management system is the external support for the establishment of the communal system. In order to comply with the national policy of meeting the basic needs of rural communities, the government provides funds for the establishment communal systems or for the improvement and maintenance of existing systems. Our findings suggest that where external funds are provided by government or non-government organizations, communal systems are favored, while the villagers continue to use their individual systems as an additional source.

The results also indicate that in areas with mainly subsistence-oriented production systems household water is predominantly managed on a communal basis. The choice between the system without or with fee depends on the opportunity costs of labor and on past experience with the management system. If the current system does not provide a reliable water supply, villagers adapt the management as the examples of Ja Bo and Mae Lana show.

In areas with market oriented production systems both communal system with water fees and individual management systems can be found. In the upstream areas communal system dominate where the responsibility for maintenance has been transferred to individual persons. In these highly commercialized systems the opportunity costs for the farmers are very high; hence the villagers prefer to pay a fee to compensate the persons for their work instead of managing the system collectively on the basis of reciprocity.

Individual systems exist mainly in villages with diversified and abundant water sources, which reduces the need for collective action to establish a communal system. The Thai villages Muang Kham and Pong Yang Nai are located in a valley, which results in a large area where water is easily accessible. The settlements and the agricultural area are located close to each other, which facilitates the use of the same water source for irrigation and household water. Hence, investments in the agricultural system, e.g. construction of a well, can have a positive impact on the security of the household water supply. Whereas for upstream villages water quality seems to be a minor concern, downstream users are increasingly worried about

residues of pesticides and other agrochemicals, as the example of Muang Kham and Pong Yang Nai showed. This apprehension results in the use of individual water sources or the purchase of drinking water. In general, regulations and sanction mechanisms for domestic water use are relatively weak in these villages.

5 Conclusions

Management of household water supply systems in the two study areas is characterized by a high degree of complexity and dynamic. Villagers have developed a variety of management systems with different allocation mechanisms, cost-sharing arrangements and regulations for water source protection. Our findings suggest that the evolution of household water supply systems does not follow a general trend (e.g. from communal to individual management or from water as a free good to water as a commodity, as can be observed for the case of irrigation water), but is rather influenced by a range of determining factors that in their site-specific interaction can lead to diverse trajectories of the management systems.

Acknowledgement

We would like to thank Liane Chamsai for her assistance in carrying out the field survey. The financial support of the Deutsche Forschungsgemeinschaft (German Research Foundation), Germany, and the National Research Council of Thailand in carrying out this study is gratefully acknowledged.

References

- Elstner, P., Neef, A. and Chamsai, L. 2004. Interdependencies and dynamics of land, forest and water rights – The case of a karst region in northwestern Thailand. Paper presented at the International Transdisciplinary Conference “Development and Conservation of Karst Regions”, Ha Noi, Vietnam, 13-18 September 2004.
- Neef, A., Chamsai, L., Hammer, M., Wannitpradit, A., Sangkapitux, C., Xyooj, Y., Sirisupluxuna, P. and Spreer, W. 2004. Water tenure in highland watersheds of northern Thailand – Tragedy of the commons or successful management of complexity? In: Gerold, G., Fremerey, M. and Guhardja, E. (eds.) Land use, nature conservation, and the stability of rainforest margins in Southeast Asia, Springer-Verlag, Berlin, Heidelberg, New York, London, Paris and Tokyo, pp. 367-389.
- Sethaputra, S., Thanopanuwat, S., Kumpa, L., Pattanee, S. 2000. Thailand’s water vision: A case study, In: Ti, L.H. and Facon, T.G. (eds.) From vision to action: A synthesis of national water visions in Southeast Asia. Bangkok, Food Agricultural Organization (FAO) / Economic and Social Commission for Asia and the Pacific (ESCAP).
- UNESO/WHO/UNEP 1992. Water quality assessments – A guide to use of biota, sediments and water in environmental monitoring – Second Edition.
- World Health Organization (WHO), United Nations Children’s Fund (UNICEF) 2000. Global water supply and sanitation assessment 2000 Report. WHO, Geneva and UNICEF, New York.
- World Health Organization (WHO) 2003. The right to water. WHO, Geneva.