Linkages between Access to Irrigation Water and Livelihood Strategies Using Sustainable Livelihood Framework[1]

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Abstract

This paper aspires to explain the development of water management system in the highlands of Mae Suk sub-watershed and to evaluate the relationships of access to irrigation water and livelihood assets as well as farmers' livelihood strategies using a sustainable livelihood framework (SLF). The primary data based on interviews with farm households using a structured questionnaire and focus group discussion were collected in four villages of two different ethnic groups in Mae Suk sub-watershed, Mae Chaem district, Chiang Mai. Farm households were classified according to upland and lowland communities, irrigated area representing access to water as well as farm and non-farm income by using cluster analysis. During dry season, water competition is growing as commercial irrigated vegetable production has been more intensive in both lowlands and uplands. Irrigation systems have been developed to cope with the increasing demand. Adoption of water conveyance system using pipes with gravity force and sprinkler irrigation system has been increasing for commercial vegetable production in the upland communities. Several indicators in different components of livelihoods were developed and compared by testing for significant differences between household groups according to different access to water and to characterize vulnerability, livelihood assets, livelihood strategies and outcomes of each group. The SLF used in this study help in understanding how access to water and water availability can contribute to poverty reduction and enhances household income of farmers.

Keywords: *sustainable livelihood, access to water, livelihood assets, irrigation system development*

Introduction

Within agriculture, water is a vital resource for many productive and livelihood activities. Water resource development has been promoted in many developing countries to improve farmers' livelihood (Hussain *et al*., 2003). Farm household with lack or a low level of access to reliable water for both household and productive purposes is one central feature of poverty in developing countries (Merrey *et al*., 2005). Improving the access to water is an important way of helping to diversity livelihoods and reduces the vulnerability of poor farm households. The important questions need to be answered are how to help farmer to improve their access to agricultural water, whether it is related to existing irrigation systems, and what role access to water plays in local livelihood strategies and how it relates to the use or availability of other assets. This paper aims to examine the linkages between access to irrigation water and farmers' livelihood strategies based on a detailed case study. The paper demonstrates how farm households with lack

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or a low level of access to irrigation water affect farmers' livelihoods and how their livelihood strategies are constrained by limited access to water. These linkages will help us to understand how improved access to water can contribute to poverty and vulnerability reduction as well as livelihood security.

Methodology

Sustainable Livelihoods Framework

The conceptual framework guiding this paper is the sustainable livelihoods framework (SLF) (Scoones, 1998; Carney *et al*., 1999; DFID, 2000). The SLF consists of five main components; namely livelihood assets, vulnerability context, transforming structures and processes, livelihood strategies and livelihood outcomes (Figure 1). It presents the main factors that affect people's livelihoods and typical relationships between these. In this study, the SLF used to examine the relationships between the livelihood assets that farm households own or have access to, which are categorized as natural, human, social, financial and physical assets. Each component of livelihood assets is measured using indicators as follows: 1) Human assets: age and education of household head, labor availability in man-equivalent unit and health threats of households 2) Natural assets: agricultural area, irrigated area, fallow areas, number of livestock 3) Physical assets: value of shelter and building, sufficiency of household water supply and sanitary, type and number of vehicles, type and value of farm equipment 4) Financial assets: access to credit, pension and remittance, value of household assets 5) Social assets: membership of water user group, leadership of existing groups, kinship network, and community network. A qualitative scoring system was used to value a household's asset base in order to facilitate comparison between the asset bases of different households groups according to access to water and income. A maximum of 5 points was allocated for each indicator and a maximum possible score of 20 points per assets are given. These scores were given to each household separately. Scores of each indicator under each asset were summed up and make an average for that asset. The individual asset scores can be aggregated to give an overall score for each group of household. The scores of each component of livelihood assets were evaluated and compared by testing for significant differences between groups.

The farm households use these assets in their productive activities in order to create income and satisfy their consumption needs, maintain their asset levels and invest in their future activities. The ways in which they do those activities show the livelihood strategies of farm households. Trend and shock related to water resources which represent vulnerability context of farm households were examined how they influenced access to water and livelihood strategies. Finally, livelihood strategies comprise the range

and combination of activities and choices that people undertake in order to achieve their livelihood goals and livelihood outcomes of each farm household group are presented.

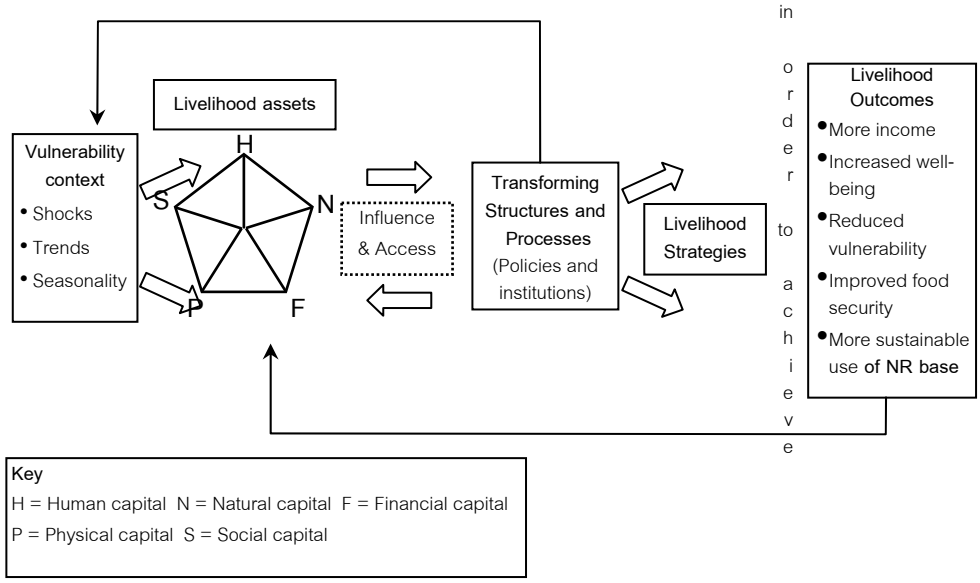

Figure 1 The DFID's sustainable livelihood framework (Ashley and Carney, 1999)

Study area, data collection and analysis

The Mae Suk sub-watershed is a small tributary of the Upper Mae Chaem watershed in Chiang Mai province, Northern Thailand. It covers an area of 96 square kilometers or 60,062.5 rais and has the headwatershed (Watershed class 1 and 2) of 95%. The upper part of the sub-watershed is surrounded by hills with the height of 1,068 metres above sea level where as the lower part is plain areas with paddy fields. Two villages from the Karen upland communities and two villages from the Thai lowland communities were selected for this study. Data collection at the household level was based on interviews with farm families using a structured questionnaire and conducted in 2006. Focus group discussion at the community level was used as a tool to carry out the changes of natural resources and the impact of their changes on agricultural production. A total of158 farm household in four villages was selected using multi-stages sampling. The total of 158 farm households were classified according to upland and lowland communities, irrigated area and sources of earned income using Two step cluster analysis in SPSS. All surveyed households were classified into 4 groups. The first group is the lowland households with bad or a low level of access to water and low income (LL-BadAW). The second group is also lowland households but with good access to water and higher income (LL-GoodAW). The third group is upland households with bad

access to water and mainly rely on farm income (UL-BadAW) but much lower than the income of the fourth group which has better access to water (UL-GoodAW) (Table 1).

Table 1 Result of household classification by access to irrigation and sources of income

Items	LL-BadAW	LL-GoodAW	UL-BadAW	UL-GoodAW
Number of samples	66	13	50	29
Irrigated areas (ha)	0.47 (0.26)	1.17(1.04)	0.31 (0.47)	1.83 (1.04)
Income from crop (Baht/household)	28,890 (24,226)	83,834 (62,973)	40,386 (21,766)	99,477 (68,674)
Income from livestock (Baht/household)	3,085 (7,803)	25,768 (37,256)	27,990 (24,266)	38,313 (31,090)
Non-farm income (Baht/household)	12,180 (21,012)	91,926 (137,519)	6,889 (12,125)	21,518 (23,422)
Family income (Baht/household)	46,352 (28,770)	202,758 (101,031)	77,098 (35,356)	161,939 (88,581)

Note: Figures in parentheses are standard deviation and AW = Access to water

Water use and irrigation management systems in Mae Suk sub-watershed

- Irrigation water use and management in the Thai lowland communities

Traditional irrigation system known as Muang Fai system has been used for distributing agricultural water in the lowland community prior to 1954. After 1957, the irrigation system had been improved along with the change of farming system from subsistence to be more commercialized and the extension of government control on natural resource used in the Mae Chaem watershed, including water resource. Development projects had developed water sources to be more stable such as constructing reservoirs and reconstructing irrigation canals and weirs from earth canals and wooden weirs to be concrete canals and weirs, especially for the main canals and big weirs (The Mae Chaem watershed development project, 1989 cited in Dithaprayoon, 2006).

In the downstream areas of Mae Suk stream, there are main five weirs along the stream for diverting water to the fields. In each main weir, a group of committee, especially the chairman known as *Gae Fai* or *Gae Muang* is selected by farmers who used the water from the same weir (weir members). Regulations and management system are set by the group and the weir members need to follow the regulations and help to maintain the weir. If water is shortage, *Gae Fai* has to manage how the water will be distributed equally to all members. In returns, *Gae Fai* gets some money collected from all weir members according to the size of paddy fields. Access to irrigation water under *Muang Fai* irrigation system was quite related to the location of paddy fields since farmers who have field close to the weir would be the first one who received the water and water left from the first one would flow in sequence to others. Irrigation is required for

the whole year. During rainy season, water from irrigation canals was diverted mainly to terraced paddy field for rice cultivation whereas during dry season, only a part of paddy field was used for shallot and soybean production and irrigation was required. Besides, fruit trees, mainly longan and tamarind, also consumed significant irrigation water during dry season.

- Irrigation water use and management in the Karen Upland communities Crop production systems of the Karen communities have been significantly changed from upland rice or paddy rice with other rain-fed upland crops such as maize and soybean to be mainly upland rice and irrigated vegetable crops, i.e. shallot and cabbage. The commercial vegetable productions were introduced to the Karen farmers by the neighboring Hmong farmers who also hired Karen labors to work on their fields during peak labor demand. Change from rainfed crops to irrigated crops led to increase of demand for irrigation water, especially during dry season and consequently increasing tension over water use between upland and lowland communities.

There are two different systems of water conveyance in the Karen community. For paddy fields, traditionally terraced irrigated rice cultivation is still practiced by the Karen farmers. The *Muang Fai* irrigation system with temporary weirs was used for diverting water from stream into terraced rice fields. The left-over water from rice cultivation is channeled to flow back into the stream again and being available for other downstream water users. Karen farmers considered this water management system as conservative water management system. Contradictory to subsistence crop, irrigation water used for vegetable cash crops is transferred from streams by gravity into crop fields through PVC pipes and sprinklers were used to distribute water into the fields. This irrigation system began to expand on the upland areas of Mae Suk sub-watershed in 2000 (Badenoch, 2006). The Karen farmers have learned to use sprinkler irrigation from the neighboring Hmong farmers on an individual basis. Farmers who have agricultural fields in the upper parts of streams can put their pipes directly in the stream as the quantity of water is enormous. At the lower part of the stream, the quantity of water flow is less. Hence, farmers who occupied the land at the lower areas need to construct a simple small weir from wood or stones to lift the level of water before placing a tube in the small weir areas. The regulation of using this system is that once a farmer has established weir, others can use the same stream but only below the existing weirs but the regulation could be not maintained when the demand for water is higher (Badenoch, 2006). The density of pipes was rising and some users moved their intake pipes upstream to ensure more regular water flows and as a consequence the conflict over water use has been rising between upland communities. Beside, tension has increased as downstream communities also blame that land use practices in the highland created floods, droughts,

sedimentation of water resource infrastructure and perceived decline of water quality (Thomas *et al*., 2004).

Results and discussions on livelihood analysis

Livelihood assets

Scoones (1998) mentioned that the ability to pursue different livelihood strategies is dependent on the livelihood assets that people have in their possession. Table 2 presents the asset scores in each component for each household group. For the human assets which represent farm experience and knowledge of the household head, labor availability and good health, it was found that in the uplands, the human assets of the households with a good access to water were higher whereas there is no significant difference between the lowland households. The natural assets in place of access to land, water, fallow and livestock were weakest at the lowland households with bad access to water and strongest at the Upland households with good access to water. The physical assets, representing basic infrastructure and producer goods, of the lowland households were stronger than the upland households. Within the upland households, the households with bad access to water were weaker in the physical assets. Alike to physical assets, the financial assets were also much weaker for the upland households and they were significantly stronger in the upland households with good access to water. There is no significant difference in the social assets between the households with bad and good access to water but it is significantly different between upland and lowland communities. This result shows the Thai lowland communities have stronger social networks and relations as well as better relationship with state than the Karen upland communities. The relative strengths and weaknesses of individual assets are illustrated in an assets pentagon (Figure 3). The overall strength of an asset is indicated by the area of the pentagon.

Table 2 Average score of each asset of the different household groups according to access to water

Assets/capitals	LL-BadAW (n=66)	LL-GoodAW (n=13)	UL-BadAW (n=50)	UL-GoodAW (n=29)
Human assets	2.83^{a}	3.16^{ab}	2.80^{a}	3.25^{b}
Natural assets	1.90^{a}	2.65^{b}	2.36^{b}	3.76^{c}
Physical assets	2.64^{ac}	3.27^{a}	1.94^{b}	2.32^{c}
Financial assets	2.33^{a}	2.93^{a}	0.93^{b}	1.37^{c}
Social assets	3.15^{a}	3.33^{a}	2.39^{b}	2.72^{b}
Livelihood assets	12.85^{a}	15.33^{b}	10.42^{c}	13.41^{ab}

Note: Letters ‘a’, ‘b’ and ‘c’ show the significant differences between groups.

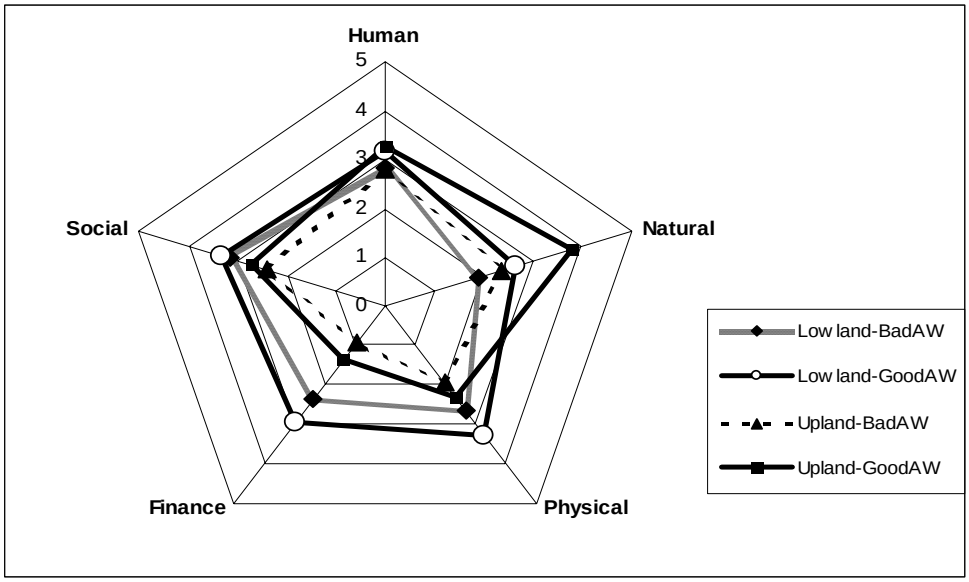

Figure 3 The pentagram illustrating the five components of livelihood assets

The irrigation management system between upland and lowland was quite different. The access to water in the lowlands mainly refers to the access to irrigation canal and weir which are communal property (a community-based management system) whereas it mainly refers to private or individual access to water from creeks or streams in the uplands. The relationships of livelihood assets to access to water are different for different irrigation systems. Almost all component of the livelihood assets show a significant relationship to private or individual access to water whereas only natural assets has a significantly relationship to access to communal water.

Vulnerability context

Indicators for measuring individual vulnerability, mainly related to water resources at the household level were developed for this study. It comprises indicators representing shocks (i.e. natural hazards, likes floods and drought, and conflict over water use), trends (i.e. variation in several sources of income) and seasonality (i.e. fluctuation of output price and lack of seasonal hired labor for agricultural activities). The results of vulnerability context showed that there was not significant difference between the households with bad and good access to water, in both upland and lowland communities. The differences of vulnerability in terms of natural shock as well as income trends between the upland and lowland communities were observed in this study. The Thai lowland households seem to face with floods and drought as well as high variation in farm income rather than the Karen upland households (Table 3).

Table 3 Vulnerability context of the different farm household groups in Mae Suk sub-watershed

Items (% of the household)	LL-BadAW (n=66)	LL-GoodAW (n=13)	UL-BadAW (n=50)	UL-GoodAW (n=29)
Shock: - facing natural hazards	79	77	42	24
- having conflict over water use	18	7	6	3
Trend: - high variation in farm income	30	31	4	3
- high variation in non-farm income	6	8	0	0
Seasonality: - price fluctuations	89	92	90	76
- lack of seasonal hired labor	26	23	14	34

Livelihood strategies

The livelihood strategies comprise the range and combination of activities and choices that farmers undertake in order to achieve their livelihoods goals. In relation to vulnerability, farmers would adopt livelihood strategies to reduce their vulnerability and recover from hazard events (DFID, 2000). In this study, the livelihood strategies are reflected in the land use and farm activities, labor use and expenditures. The surveyed results show that the cultivated areas of paddy rice, shallot, maize and soybean of the households with good access to water were higher but the test of mean difference using ANOVA show that there were no significant differences between groups (Table 4). Additional information from the focus group discussion reveal that shallot, important dry season crop, production requires high capital for buying the ''mother' bulbs which farmers can not produce by themselves. Furthermore, price fluctuation of shallot year by year is another significant factor affecting shallot production. High capital requirement and price fluctuation create a high risk of shallot production for farmers. Limited size of shallot production is a strategy practiced by Thai lowland farmers for reducing the risk.

In the upland areas, the cultivated area of upland rice and shallot as well as fallow area of the Karen households with good access to water were significantly higher. Shallot can not be grown if farmers have no access to irrigation water during dry season. The upland farmers adopted sprinkler irrigation system for growing shallot in dry season but a limited cultivated area of shallot was also observed in the upland areas. Cabbage was grown two times a year for farmers who have access to irrigation during dry season. The use of household labor for own farm activities and as hired labors for neighbor farm or non-farm sector were not significant difference according to the access to water. Similar to the expenditure item, the lowland households spent more cash for buying food than the upland households but there is no significant difference according to access to water.

Table 4 Livelihood strategies of the different farm households in Mae Suk sub-watershed

Items	LL-BadAW (n=66)	LL-GoodAW (n=13)	UL-BadAW (n=50)	UL-GoodAW (n=29)
Total agricultural land (ha)	1.53a (1.06)	1.98ab (1.11)	2.29b (1.47)	3.48c (1.68)
% of irrigated area	31	59	14	53
Land use (ha):				
- Paddy rice (RS)	0.43a (0.25)	0.72a (0.40)	0.07c (0.28)	0.01c (0.06)
- Upland rice (RS)	-	-	1.09a (0.57)	1.50b (0.71)
- Shallot (DS)	0.25a (0.27)	0.54ac (0.61)	0.07b (0.17)	0.61c (0.48)
- Maize (RS)	0.93a (0.91)	0.95a (1.06)	0.20b (0.53)	0.14b (0.42)
- Cabbage (RS and DS)	-	-	0.38a (0.39)	0.56a (0.54)
- Soybean (DS)	0.11a (0.20)	0.36a (0.51)	-	-
- Fallow	0.25a (0.85)	0.37a (0.76)	0.71b (1.01)	1.64ac (1.58)
Land intensity index	126.6a	158.6a	91.5b	96.7b
No. of raised cattle	0.36	5.62	4.18	6.31
Household labor use (person/household)				
- Own farm only	0.17	0.15	0.08	0.24
- Own & other farms as hired labor	0.98	1.15	1.00	0.69
- Own farm & only non-farm labor	0.17	0.08	0.36	0.38
- All farms & non-farm labor	0.68	1.00	1.36	1.98
- Only non-farm labor	0.08	0.15	0.02	0.07
Food expenditure (Baht/year)	26372a	39731a	8683b	6452b

Note: Figures in parentheses are standard deviation. DS = Dry season crop and RS = Rainy season crop

Livelihood outcomes

Livelihood outcomes are the achievements of livelihood strategies. The results of farm income as well as family income show that the households with good access to water had earned more income compared to the households with bad access to irrigation water. Having better access to irrigation water allows farmers to use their available land for crop production to increase their income. However, the increase of income is still limited due to the limitation of other factors such as market risk. The upland farmers with limited access to irrigation improved their income with other strategies such as using labor for livestock production during dry season which contributed to more than one third of their family income. In the lowland areas where the access to non-farm jobs is better, the Thai lowland farmers with bad access to water earned in average one fourth of family

income from non-farm employment (Table 5) In both uplands and lowlands, the farmers having better access to water which are better-off show that they feel more secure in their livelihood. However, more than a half of the upland farmers still did not feel secure in their livelihood which may be explained by land use policy in this area. Researches on land use stated that nearly all land in Mae Chaem watershed is classified as protected watersheds, the 60,000 people living there (72% ethnic minorities) depend on these lands for their livelihoods. But only small areas of paddy field in lowland areas have official land tenure recognition while informal local land use institutions have provided a basis for managing community land for generations, they are vulnerable to pressure and encroachment from more powerful outside forces (Thomas *et al.*, 2002).

Table 5. Livelihood outcomes of the different farm households in Mae Suk sub-watershed

Items	LL-BadAW (n=66)	LL-GoodAW (n=13)	UL-BadAW (n=50)	UL-GoodAW (n=29)
Farm income (Baht/household)	31,975 a	109,601 bc	68,376 b	137,790 c
- from irrigated shallot production	13,571	39,457	3,988	54,398
- from irrigated soybean production	3,053	23,246	-	-
Family income (Baht/household)	46,352 a	202,758 b	77,098 c	161,939 b
- from crop production (%)	62	41	52	61
- from livestock production (%)	7	13	36	24
- from hired agricultural labor (%)	5	1	2	2
- from non-farm activities (%)	26	45	9	13
Farmers' perception in their				
- Livelihood security (% of household)	58	69	18	41
- Land security (% of household)	70	85	10	7

Conclusions

This empirical study showed how sustainable livelihood framework can be applied to explain the relationship of access to water and other livelihood assets as well as farmers' livelihood strategies and thereby with livelihood outcomes. Access to water, in particular private irrigation system, has strong relationship to other livelihood assets. Improving access to irrigation can be done by providing access to other assets such as access to credit for the upland farmers. However, the existing irrigation system as well as possible irrigation system that farmer can have access to should be considered before. Improved access to water can enable farmers to adopt new technologies such as sprinkler irrigation system and cash crops adopted by the Karen upland farmers and intensify cultivation, leading to increased income from farming.

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