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Community-Based Water Resources Management for Livelihood Improvement and Poverty Reduction: A Case Study at Lao Nya Village, Pathoumphone District, Champasak Province, Lao PDR

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ABSTRACT

Water is one of the most fundamental components of socioeconomic development in any society. In the agricultural-based society of Laos, including Lao Nya village, water plays a critical role in livelihood improvement and reduction of poverty. This research focuses on water issues related to both direct consumption of drinking water and also its use in supporting agricultural production for self-sufficiency and for profits from crop sales. The analysis is concerned with people living in the buffer zone of a protected area (a very sensitive upstream landscape). Their livelihood and well-being always have a causal relationship with the quality and quantity of water, as well as with biodiversity in these protected areas. Ensuring sustainable livelihood and the well-being of these people is both critical and necessary.

This research analyzed the livelihood options and poverty conditions of the residents at Lao Nya village. The demand, supply and management regimes of water as well as local practices were assessed. The principal aim of this research was to address the following three questions: (1) How can water be better managed throughout the participatory processes encompassed in the community-based approach? (2) How can local initiatives on water management contribute to livelihood improvement and poverty reduction for local village residents? (3) What appropriate water management practices can be integrated based on existing conditions? Social equity and water governance between upstream and downstream communities are also taken into consideration in order to ensure the sustainability of the whole watershed.

The main findings of the research include the fact that a local initiative on water management (construction of a dam, fishpond and water diversion canal) has increased rice production by 60.4 tons per year and adds some 30 hectares of paddy land (61% of 48.96 hectares) of total that is cultivatable in the dry season. In addition, three more hectares of cash crop land was made available for cultivation by this irrigation, while water quantity and quality increased and improved, respectively. In addition, new integration of water management strategies include a community fishpond, combined rice-fish production in paddy fields, river bank cropping practices and promotion of hygiene awareness among villagers. Benefit sharing from the water initiative within Lao Nya and another village downstream (Na Bon) is being managed through negotiation and cooperation among these village committees. Water governance covers watershed protection, water sharing, and operation of existing water facilities, namely a dam, a canal and water wells.

Keywords: Lao PDR, water resources, livelihood, poverty reduction, water governance, social equity

INTRODUCTION

Lao PDR (Lao People Democratic Republic) possesses great wealth in terms of water resources. The country's northern region captures approximately 1,300 mm of rainfall per annum; the southern region captures much more, about 3,000 to 3,700 mm annually. The watersheds within Lao PDR contribute to around 35% of the Mekong River flow. These watersheds form 26% of the Mekong Basin's total watershed area. About 80% of the water flows during the rainy season from May to October, and the remaining 20% during the dry season from November to April (Anonymous, 2001. State of Environment, Lao PDR).

Water is a fundamental resource that is of paramount importance as a necessity for human well–being, and for fostering socio-economic development in society. Unfortunately, in recent years we have witnessed a serious worldwide decrease in available water quantity and a decline in water quality caused by human activities. It is therefore necessary to manage water resources in a sustainable manner in order to ensure the availability and wise use of this vital resource.

In the Lao PDR's rural areas, water-related problems generally reflect a dependency on rainfall as a needed agricultural input, since irrigation systems are lacking. As a result, farmers have less agricultural production during the dry months. Besides water for production, water for domestic use is constrained due to lack of safe water sources. Lack of water storage as well as inadequate awareness of hygiene practices also negatively impact the local people.

Community-based not only can strengthen the villager's capacity but the knowledge also can be transferred from generation to generation. The community is therefore very important and necessary for the people living in the very remote village like Lao Nya.

Lao Nya is one of the villages located in the corridor areas of two national protected areas called Donghuasao and Xepian, in Pathoumphone District, Champasak Province, Lao PDR (Figure 1). Poverty reduction and livelihood improvements of local villagers are very important to the environment. When villagers have more sustainable livelihood options, especially sustainable agricultural practices using water as a main production input, they will have enough rice to consume year–round. Adequate water allows villagers to generate additional income from other agricultural production, such as cash crop diversification or aquaculture; while at the same time can improve food security and well-being and reduce dependency on forest resources. This will contribute to positive consequences in the broader context of biodiversity conservation.

Water resources are a critical factor for livelihood improvement and require priority attention in order to address poverty reduction in Lao Nya village and other villages. Since productive water is important to villagers' agricultural practices and household income generation, and consumption of water is important to decreasing expenditures and conservation of a finite resource, such resources must be managed in a sustainable way. Inefficient management will affect the well being of the people

and result in negative impacts to biodiversity and habitat. Negative impacts can spread to the whole ecosystem, affecting the well-being of society as a whole.

This research aims to investigate current and improved means for sustainable water resources management at the local level under this particular village's existing conditions. Key research findings and recommendations contribute to improved livelihood and reduced poverty, while being compatible with the biodiversity conservation context. The specific research objectives are (1) To study current water uses, water budgets, and potential water accessibility (2) ,To find out suitable and sustainable ways of water management that blend with the villagers' traditional ways of productive and consumptive water uses. (3) To integrate appropriate techniques and methods from other successful cases - including rules and regulations that can be empowered at the local level – those are useful and applicable to this particular case.

Lao Nya village has four streams: Houay Ban Vang Pa Khao, Huay Lao Nya, Huay Loh, and Huay To Mo (Figure 1). The village also has one common 'protected' pond named Vang Tae (the size is 500mx200mx2m), and three other small ponds (Lao Nya field survey, May 2008).

The village is still lack of basic infrastructure, including water supply, health care, sanitation, irrigation system, and electricity. Because of these constraints, paddy land can only be cultivated once a year pending rain-fed systems, while almost all households (up to 99%) consume untreated water directly from streams; and there are no toilets at all within the village. Bacteria contaminations in local surface waters are believed to be responsible for the villagers' numerous health problems. Diarrhea, in particular, reportedly costs the villagers a considerable portion of their income every year for medical treatment. Such costs not only affect their livelihood but also lessen their well-being because of morbidity and productivity loss.

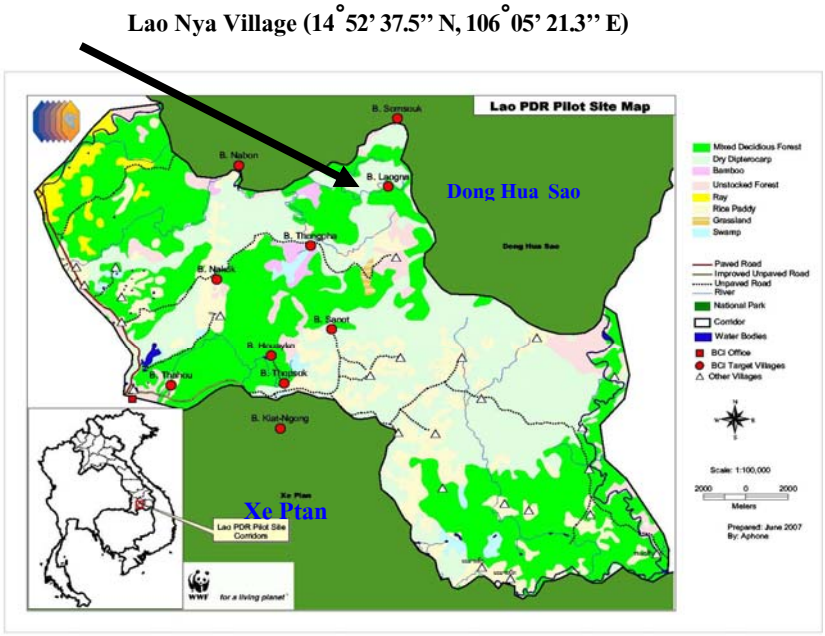

Figure 1 Map of Lao Nya Village with Settlement (World Wildlife Fund, 2007)

METHODOLOGY

A. Community-based approach (CBA)

The critical research model of community-based approach, while drawing on multiple diverse historical influences, is guided by three principles that represent its core tenets (Bacon, 2003):

- It is a collaborative enterprise between academic researchers and community members.
- It validates multiple sources of knowledge and promotes the use of multiple methods of discovery and dissemination of the knowledge produced.
- Its goal is to achieve social justice through social action and social change.

A community-based approach can help communities work together to prevent social problems and to deal directly with problems that do arise, instead of having to have external actors step in and assume these responsibilities. It supports stakeholders in re-establishing familiar cultural patterns and support structures. Indeed, the goals of the community-based approach are to reinforce the dignity and self-esteem of stakeholders and to empower all the actors to work together to support different members of the community exercise and enjoy their innate human rights (UNHCR, 2008).

B. Wealth Classifications

Based on such indicators as housing, land holdings, physical assets, livestock (draft animals), labor, rice sufficiency, and main occupations, villagers here have been classified into four groups: well-off, moderate poor, marginal poor and very poor (village's socio-economic survey, July 2009).

Overall conditions decline markedly when moving from the well off group to the very poor group for almost all indicators used for classifying poverty in the village based on local villagers' perceptions and facilitation by the researcher and field assistants. More details about the characteristics and the indicators used to classify each group are shown in Table 1:

Table 1 Main characteristics of each grouping of villagers

Indicator	Well-off	The poor		
		Moderate poor	Marginal poor	Very poor
Housing	Permanent house: metal roof, wooden walls and floors, large size, some own more than one house	Half permanent and/or temporary house: half metal roof, half bamboo and wooden walls/floors, medium size	Half permanent and/or temporary house: half metal roof, half bamboo and wooden walls/floors, medium size	Temporary house: grass roof, bamboo walls and floors, small size
Land Holdings	Average paddy land: 0.76 ha	Average paddy land: 0.27 ha	Average paddy land: 0.05 ha	No paddy land
Physical Assets	Trucks, Kubota, motorcycles, rice mill, retail shop, color TV, mobile phone, etc	Kubota, motorcycles rice mill, black & white TV, mobile phone, etc	Limited housing materials or physical assets	Limited housing materials or physical assets
Livestock (draft animals)	Own more than 10 buffalos or cows	Own 5-9 buffalos or cows	Own 1-4 buffalos or cows, or none	Own no buffalos or cows
Labor	Have sufficient productive laborers (on average 4 people)	Have almost sufficient productive laborers (on average 3)	Have insufficient productive laborers (on average 2)	Have insufficient productive laborers (on average 2)
Rice Sufficiency	Rice exceeds consumption all year round	Rice is almost enough for consumption, but some HHs lack rice for 1-3 months yearly	Rice is lacking from 4 - 11 months each year	Rice is lacking all year round

Source: village's socio-economic survey, July 2009

C. Rapid rural appraisal (RRA)

Structured interviews, the principal approach under RRA, were used to gather relevant information on village and villagers' water resources, socio-economic indicators (Table 1), incomes and expenditures. The sample size for structured interviews was based on the Yamane formula (Yamane, 1973).

Table 2 Household profiles for RRA interviews

No	Well Group	Total Households	Selected households	Percent
1	Well-off	12	11	92
2	Moderate poor	48	46	96
3	Marginal poor	34	31	91
4	Very poor	4	4	100
5	Total	98	92	93.9

This household questionnaire had four parts: general household profile, socio-economic data, community-based water consumption, and available water for production.

D. Participatory Rural Appraisal (PRA)

Group discussions were used to gather some key qualitative information and indicators that cannot be extracted from household interviews. At the same time, group discussions can enhance environmental governance processes.

Thirty participants (29 males, 1 female) were involved in the group discussions. Key informants were village authorities and other relevant sectors, including village chiefs, heads of administration units, senior citizens, foresters, women representative, health care volunteers, customs representative, communist party secretary, policemen, soldiers, and other villagers.

E. Stream flow measurement

Stream flow measurements were made by using float in the Huay Lao Nya, Huay Loh and Huay To Mo, which traditionally have been very critical water resources for the village. The measurements were taken during the driest month (April) and wettest month (September). Each stream was measured one time during the middle of each above mentioned month with only one station.

F. Water quality assessment

April is the driest month of the year. It is therefore significant in terms of water quality assessment (confirmation from villagers and village's health volunteer), since villagers are most reliant on water from the stream for their daily consumption during this period. Samples of water from Huay Lao Nya and Huay Loh were taken for analysis at the nearest laboratory at the Division of Environment and Water Supply, Department of Health, Pakse District, Champasak Province. Huay Lao Nya is the source for daily water consumption, while Hauy Loh supplies the village's small scale irrigation project. Water from that stream will be diverted to increase the water supply of Hauy Lao Nya. The required parameters for water testing based on Lao government standards are shown in Table 3.

Table 3 Water testing parameters and National Standard on drinking water quality

No	Sampling Parameters	Unit	Standard
1	pH	-	6.5 – 8.5
2	Turbidity	NTU	<10
3	Taste and Odor	Ng/L	Acceptable
4	Conductivity	µS/cm	1000
5	Iron	mg/L	<1
6	Manganese	mg/L	<0.5
7	Arsenic	mg/L	<0.05
8	Fluoride	mg/L	<1.5
9	Nitrate	mg/L	50
10	Thermo tolerant coli form	No/100ml	0
11	Total hardness	mg/L	<300
12	Nitrite	mg/L	3
13	Residual chlorine in chlorinated water supply	Mg/L	0.2

Source: Division of Environment and Water Supply, Department of Health, Pakse District, Champasak Province

RESULTS AND DISCUSSION

Sources of local water use

Water in Lao Nya village comes from three sources: surface water from stream, groundwater, and rain water. Villagers combine those three sources for their domestic consumption such as drinking, bathing, and washing. Water for gardening, especially in riverbank gardens, mostly comes from local streams. Paddy rice cultivations practices mainly rely on rainfall due to the village currently has no irrigation systems. Rainwater is also collected as supplement water during the short rainy season (see Figure 2).

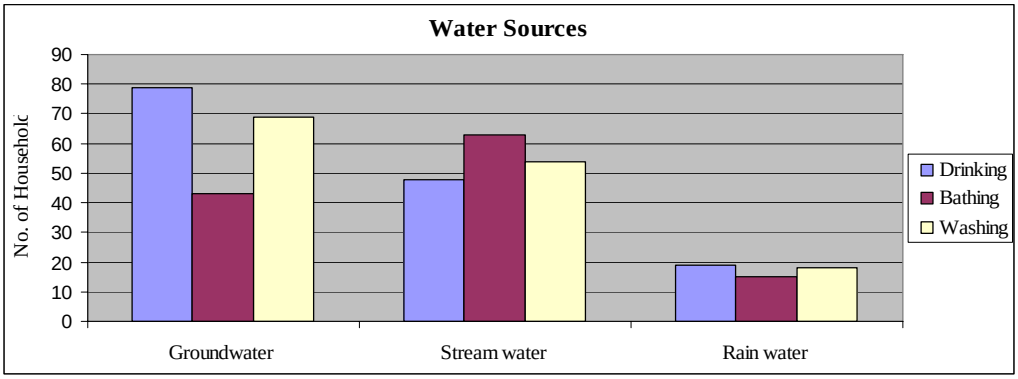

Figure 2 Lao Nya's Water sources and water usage by households

To perform the multiple activities that directly sustain or enhance their livelihoods, people use multiple sources of water. For example, people may make use of a piped domestic system for drinking and other household activities, a well for watering livestock and gardening, and rainwater harvesting for supplementary garden irrigation. Equally, people can make use of a rainwater-collecting tank, originally designed for gardening, as a source of water for drinking and/or cooking. Based on the empirical research, that access to multiple water sources to perform multiple activities is a key issue to ensure multiple benefits to people's livelihoods (Maluleke, *et al*, 2005).

Causes of changes in water supply

Water supply for local communities has changed drastically in the past 10 years due to watershed degradation from shifting cultivation practices and logging in the forest concession area. Other factors affecting water supply include population growth and limited amount of land suitable for cultivation as shown in Figure 3.

Water supply

Water availability was estimated by using float measurement. Water supply in related streams within the village including Huay Lao Nya, Hauy Loh, and Hauy To Mo were assessed in both wet and dry seasons. Wet season flows were measured during September and dry season flows during April. Results of the measurements are shown in Table 4,

Table 4 Dry and wet season water flows of the streams in Lao Nya Village

No	Name of stueam	Water flow (m^3/s)	
		Dry season	**Wet season**
1	Huay Loh	0.0960	0.3500
2	Hauy Lao Nya	0.0015	1.0658
3	Huay To Mo	0.1750	3.9.75

Villagers' expectations on water resource management

Villagers place the highest priority on their community's water wells. Their second priority is on household rainwater containers. The third is on household water supply. Other priority water issues, in descending order, are irrigation water, better water quality, and water to support their cash crops in dry seasons. Details are shown in Figure 3.

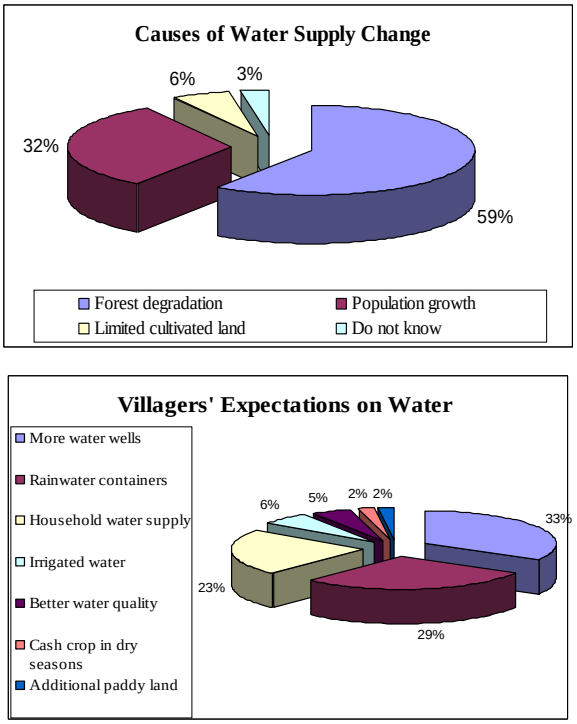

Figure 3 Causes of changes in water supply and Villagers' expectations about water

Water quality

The current status of drinking water quality from the village's two main sources, Hauy Lao Nya and Hauy Loh, are presented in Table 5. Generally all testing parameters for these two main water sources were within the standard value range. However, the pH in Hauy Lao Nya was lower than standard values. In addition, Thermotolerant Coliforms were found in both Huay Lao Nya and Hauy Loh. Unfortunately, the capacity of the laboratory used in this study is too limited to separate parameters into standard values at the 100-milliliter unit level. However, they can be represented as being in excess of the set standard. Water therefore needs to be boiled before consumption.

Table 5 Water testing results compared to Lao PDR drinking water standards

No	Sampling Element/substance	Result		Unit	Standard Value
		Hauy Lao Nya	Huay Loh		
1	pH	6	6.5	-	6.5-8.5
2	Turbidity	0.5	0.5	NTU	<10
3	Taste and odor	Acceptable	Acceptable	mg/L	Acceptable
4	Conductivity	206	284	µS/cm	1000
5	Iron	0.32	0.03	mg/L	<1
6	Manganese	0.005	0.003	mg/L	<0.5
7	Arsenic	0	0	mg/L	<0.05
8	Fluoride	0	0	mg/L	<1.5
9	Nitrate (NO_3)	35	30	mg/L	50
10	Thermotolerant coliforms	Found	Found	No/100ml	0
11	Total hardness	80	100	mg/L	<300
12	Nitrite (NO_2)	0.005	0.013	mg/L	3
13	Residual Chlorine in Chlorinated Water Supply	0	0	mg/L	0.2

Note: NTU stands for Nephelolometric Turbidity Unit, S stands for siemens

Villagers' perspectives on health impacts from water quality

Generally, almost all respondents were aware of the negative impacts of unclean water on their health. During the household interviews many respondents stated that the dirty water caused them to have health problems, especially diarrhea, malaria, skin disease, and stomachache. In contrast, 11 percent of respondents felt that unclean water has no negative impacts to their health. These people see no clear linkage between unclean water and health impacts; they think that their illnesses are not caused by unclean water. Villagers have become accustomed to their present health status and see their illnesses as somehow caused by a lack of immunity against diseases. Perceived links between unclean water and the different disease types are presented in Table 6.

Table 6 Effects of unclear water on health

No	**Disease**	**Number of respondents**	**Percent**
1	Diarrhea	71	71
2	Malaria	13	13
3	Skin disease	12	12
4	Stomachache	4	4
5	Total	100	100

Good health is a key to poverty reduction, directly affecting the quality of life of poor people and an essential pre-requisite for sustainable increases in income. Unhealthy is a double burden: it reduces productive capabilities and means limited resources (time and money) have to be spent on caring for the sick. It is the most vulnerable, women and children, the extreme poor, the elderly, the malnourished, who bear the burden of ill-health the most and are the least ability to cope with it. Sustainable improvement for to health condition is a key for poverty reduction, and which water management is also important for improving health conditions (Soussan *et a*l., 2005).

Access to water resources for household use

Both men and women are involved in collecting water for domestic uses (see Table 7). However, most of this responsibility falls on women. Mothers collect water when the daughter is still young, but the task will fall to the daughter when she becomes older. Fathers also contribute to water collection, especially when mothers and daughters are not at home. Sons sometimes collect water, but not as often as other family members.

Table 7 Responsibility for water collection for household use

No	Family member	Number of respondents	Percent
1	Mother	60	35.5
2	Father	46	27.2
3	Daughter	45	26.6
4	Son	18	10.7
5	Total	169	100

Water quality mitigation-water boiling

Most households in Lao Nya Village do not boil water before drinking (see Table 8). They have many different reasons for instance they have been accustomed to this lifestyle for many generations by drinking raw water, and the raw water has more tasty. Generally, well-off village households are more likely to boil water than other groups. However this group still does not boil their water all the time, and are more likely to boil water during the dry season, as they perceive water to be dirty during this time of the year. Whenever members of the households are sick, they boil herbs along with the water. The other reason, households will boil water to serve guests. Media and training are the informative mean that make villagers want to boil their drinking water.

Table 8 Feedback on boiling of drinking water

Drinking Water	**Sometimes boil (total households=59)**			
Reasons	Media	Medicine boiling	Training	Serve guests
Number of households	35	15	6	3
Percent (%)	59.3	25.4	10.2	5.1

Drinking Water	**Drink Raw water (total households=53)**					
Reasons	Get used to	Lazy	Delicious	No time	No pot	Full
Number of households	14	13	12	9	8	5
Percent (%)	23.0	21.3	19.7	14.8	13.1	8.2

Community-based water resources management in Lao Nya village

The nearest stream for the local community, Huay Lao Nya, has had growing problems with both water quality and quantity during the dry seasons over the past decade. In 2001, a diversion dam was constructed in Huay Loh, 800 meters from the village and from Huay Lao Nya. Construction of this dam was supported by the government along, with inputs from villagers' initiatives and labor. This dam is 1.7 meters high, 12.5 meters long and 2 meters wide. It was designed to divert water from Huay Loh stream to increase water flow in Hauy Lao Nya stream in order to support paddy land rice growing along that stream. The dam is supposed to improve water quality for the villagers' consumption. Unfortunately, the amount of government support at that time was only enough to cover the dam itself, not additional channels required for full operations. Villagers proposed to continue the dam by themselves, but that proved to be beyond their technical abilities since the land along the channel is rocky and cannot be dug like soil. As a result, this dam was essentially unusable from 2001 until early 2009, when the Biodiversity Corridor Conservation Initiative (BCI) provided added funds for construction of the channel. Now the whole system (dam and channel) is ready to be used for the upcoming dry season, especially for improving irrigation. More details about local hydrology can be seen in Figure 4.

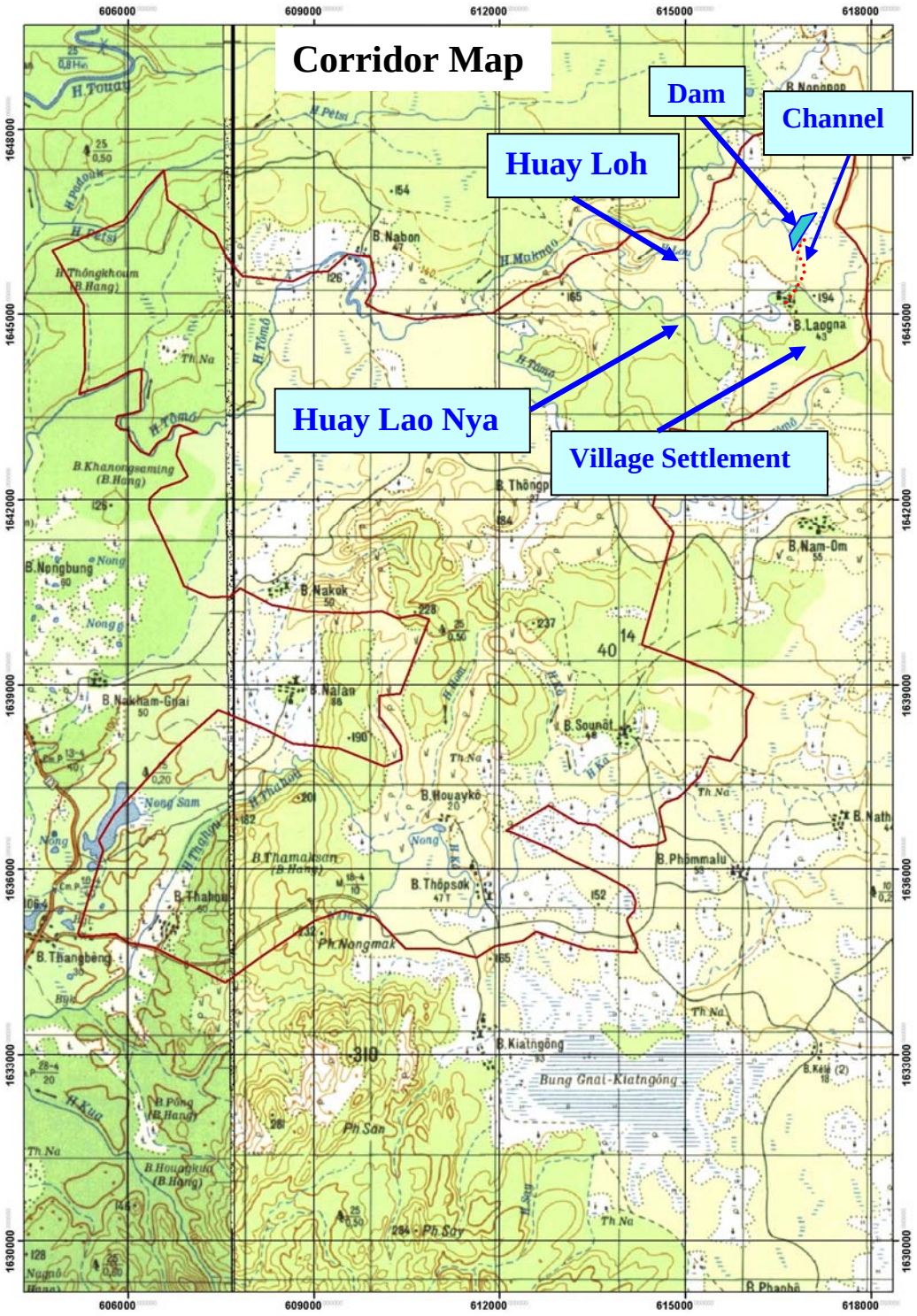

Figure 4 The corridor map with related streams in Lao Nya Village

Benefits from community-based water resources initiative

The sustainability of a Community-based Water Resources Management (CWRM) system is defined by the combination of different key aspects including social, financial, institutional, technical and environmental aspects. There is worldwide recognition that water user-oriented or demand-responsive approaches have had positive impacts on the sustainability of water management systems. Community consensus as a result of social performance has proved a success with CWRM models (Dung and Tinh, 2006).

Community participation in design and realization of small-scale irrigation schemes is the only way to ensure beneficiary appropriation, which in turn will facilitate sustainable management of the investment. In the past, too many irrigation systems were designed without considering people's requirements and management considerations. This resulted in blueprint designs that were not adapted to local conditions, had unnecessarily high operation and maintenance costs, and worked through complex organization settings (Faurès and Santin, 2008).

In Lao Nya, after the local dam's channel construction was finished, villagers will be able to grow paddy rice in the next dry season on 30 hectares, or 61% of their total paddy land, Rice or other agricultural products are the main sources of income for villagers. This particular irrigation improvement will be a major change for villagers' well-being in terms of potential increased income generation and livelihood options. The village authority had already planned to allocate some paddy lands from land-holding households to poor and landless households, under the condition that those receiving land would share in its benefits. The village committee also confirmed that they would try to help each household to receive equal benefits from the dam and its channel through regulations from the village authority. Besides rice cultivation, villagers will be able to conduct more cash crop diversification, which are expected to occur on three or more hectares of land, although no detailed survey of the outcome of this plan has been conducted at present. The dam and its channels will also increase water quantity; especially during the dry season. Water quality will also be improved, which is good for the daily consumption of villagers. Riverbank cropping cultivation will benefit villagers in terms of improved access to water for consumption and increased food security (Lao Nya group discussion/personnel communication, July 2009).

In addition to studying the overall benefits from irrigation at the village level, the profits expected from irrigation improvements were assessed in terms of the different household levels.

Both direct and indirect net benefits of irrigation contribute to poverty alleviation (see Table 9). Evidence from comparisons of poverty across irrigated and non-irrigated settings shows that, on average, poverty incidence is more than 21 percent less in irrigated than in non-irrigated settings, with substantial variation in poverty incidence across countries/systems. Evidence using quantitative methods shows that irrigation and agricultural output are significant positive determinants of incomes/expenditures and negative determinants of poverty (Hussain, 2005).

Table 9 Benefits gained from irrigation improvement, by household (HH)

	Benefit	Other remarks	Number of households	Percent
Direct benefits (80 HHs)	Wage Labor	During the construction period	55	51.4
	Agriculture (planting of second paddy land)	Only those owning land	43	40.2
	More water quantity and better water quality	These two things accrue to the whole village	9	8.4
Indirect benefits (35 HHs)	Paddy land renting	Landless HHs and owners of paddy land located far from water sources	24	68.6
	Sharing agricultural plantings with their relatives	The kinship system is still strong in this village	4	11.4
	Have no idea	Just accept it	7	20.0

Riverbank cropping practices

Almost all households plant vegetables along the river, especially at the nearest water source (Huay Lao Nya). The diverse crops include vegetables, chilies, egg plant, garlic, onion, and other items necessary for their daily consumption; such small-scale planting covers only their household needs. Villagers said this activity contributed to their daily lives because they needed to buy vegetables only for a few months during the dry season. This reduces their food expenditure. These vegetables also provide a supplementary food source during periods when villagers cannot find other food from the forest.

Based on household interviews, the average land size for the riverbank cropping system ranges from 3x3 meters to 5x5 meters per household, while each household requires a minimum cultivation area of about 5x5 to 10x10 meters in order to meet their consumption needs.

Communal subsistence freshwater fishery initiatives

After the channel construction, villagers will have a secure supply of water for their fishpond. They plan to extend and repair the existing wetland area (about 60×80 meters), located about 400 meters from the dam, and integrate it as part of the new community fishpond. The pond will be managed under village rules, and each villager will take turns as pond security guards. This will benefit all households equally especially during village ceremonies, and visits by guests. The pond will also increase villagers' income and contribute to household food consumption. Initial investments are needed for fingerlings during the beginning phase of the pond construction. In following years, less investment is required as new fish can be bred from the pond.

Combined rice-fish production

Almost all villagers (82 respondents, each representing 1 household, or 89% of total respondents) know about combined rice-fish production; nevertheless, they have never before practiced this type of system. From interviews, villagers seem to like the proposed system very much and are willing to try to implement it

Based on the conditions of their paddy rice fields, 31 households (33% of respondents) reported that it would be possible to carry out the combined rice-fish system within their fields, especially during rainy seasons. However, 62 households (67% of total respondents) believe that it would not be possible to do so. They reported that their paddy lands are flooded so many times in a year that fish can easily escape. They therefore cannot feed fish in their fields, especially during dry seasons. Another reason is their lack of paddy land. Within this subset of households, 42 (68% of total respondents) have flooded paddy land and 20 (32% of total respondents) have no paddy land at all.

Rice-fish production is possible under either capture systems where wild fish enter, reproduce and are harvested from the flooded fields, or in culture systems where rice fields are stocked with fish either simultaneously with rice crops. Currently, this farming system is becoming a favorite option among resource-poor fish farmers in the developing world, mainly because of its ability to remove many of the risks associated with the stand-alone pond aquaculture of both intensive and extensive scale (Prein, 2002).

Halwart (1998) reported that, through savings on pesticides and earnings from fish sales, these combined systems contribute to increased yields, resulting in net incomes that are 7% to 65% higher than for rice monoculture.

The recent work in Bangladesh and Vietnam showed that Community-based Fish Culture (CBFC) in flood-prone rice fields is technically feasible, economically profitable, environmentally non-destructive and socially acceptable (Dey and Prein, 2003, 2004a,b). The results show that the adoption of CBFC in flooded rice fields can increase water productivity per hectare per year substantially; it can increase fish production by about 600 kg/ha/year in shallow flooded areas and up to 1.5 tones/ha/yea in deep-flooded areas, without reduction in rice yield and wild fish catch. For the overall system, additional income ranging from US $135 per hectare in southern Vietnam to US $437 per hectare in Bangladesh was achieved, which is an increase of 20%–85% over the previous profitability.

In Lao PDR, especially in the Mekong River plain, rice-fish farming is practiced in rain-fed rice fields where soils are relatively impermeable as well as in irrigated rice fields, which offer ideal conditions for fish cultivation. Accurate data is not available, but the fish production of 125 to 240 kg/ha/year have been reported (UNESCO, 2003)

Potential water sources

Besides Huay Lao Nha and Huay Loh, the area's third stream -- Hauy To Mo – is considered by villagers as another potential source of productive water. This stream is 300 meters away from some existing land (approximately 10 ha) that could possibly be shifted to paddy land rice area or a fishpond if they could import water from this stream. More existing paddy land nearby will be able to grow crops during the dry season as well.

In the village, two waterfalls in Hauy Mak Nao and Hauy Loh could potentially become ecotourism places in order to help the villagers gain more livelihood options and more opportunities to earn income from providing services to tourists.

Upstream-downstream water resource governance

Only one village is settled in downstream: Na Bon. Villagers stated that no any negative impacts from dam construction to that particular village due to Huay Loh as a water source. It is very fortunate that both Huay Lao Nya and Huay Loh are the tributaries of the same water sources. Water left over from Lao Nya will finally go back to the original water source. That is an advantage to both Na Bon Village and Lao Nya Village in order to reduce possible downstream impacts. However, appropriate mitigation efforts are needed in order to minimize the potential impacts to this downstream village by reducing water demand within Lao Nya by selecting a sustainable schedule for water utilization. This requires closing and opening the dam to supply water when it is needed for crops' cultivation, increasing water productivity per unit of water by integrating any possible practices such as combined rice-fish production, and shifting to suitable crops that require less water. Furthermore, downstream impacts can be reduced by controlling water quality upstream such as a ban on application of any chemical fertilizers/pesticide in any cropping patterns, proper domestic waste management (not to litter in the streams), bans on use of inappropriate fishing methods (poisonous substances and explosive devices). However, cooperation between the Lao Nya and Na Bon village committees are strongly recommended to monitor all the activities for the sustainable water management.

Rules and regulations for water resources management

According to Soussan (2004), governance has been stressed in discussions on water and poverty. Good governance will depend on stakeholders (in particular, local communities) having the knowledge and skills needed in water management, infrastructure maintenance, and administration, to fulfill the roles assigned to them. There is a need to make laws and policies more coherent and consistent, to ensure that state agencies in particular are better equipped to respond to and meet the needs of poor people, and to ensure that intentions of more transparent and participatory approaches are carried through into practice.

Currently, Lao Nya has no community-based rules and regulations related to water resources management. There are only regulations on Community Forest, Conservation Zone, and Non-timber Forest Productions (NTFPs) utilization/management in the village's Protected Area. Based on some of those relevant rules and regulations combined with feedback from villagers during

household interviews, as well as group discussions with key informants, proposed rules and regulations were developed. These regulations on water resources management focus mainly on four parts:

a) Watershed area protection (for all four streams: Huay Lao Nya, Huay Loh, Huay Mak Nao, Huay To Mo).
b) Existing stream protections (for all four streams).
c) Operation and maintenance of existing facilities including dams, channels, and three water wells.
d) Water shared among households within the village and between Lao Nya Village (upstream) and Na Bon Village (downstream).

CONCLUSIONS

Physically, Lao Nya village has rich water resources. Water availability is considered high, but the problem involves accessibilities of water sources. In the past, agricultural practices, especially rice cultivation, used to be based mainly on rainfall that only occurs seasonally.

Since the village established a new water resources management initiative by developing a small-scale irrigation system, water plays a more critical role in its livelihood improvement and poverty reduction efforts. Improved water supply contributes to greater on-farm opportunities where villagers can now cultivate some of their paddy land twice a year, contributing to increased income. At the same time, they also have more livelihood options in terms of increased cash crop alternatives and river bank cropping systems during the dry season, resulting in improved food security.

Improved water supply from the village initiative can ensure as stable water consumption during dry months. Proper household water management in terms of water storage, water treatment, and cleaner water will contribute to reduce sickness and health care spending, respectively, maintain availability of productive labor in the family and improve the villages' overall well–being. In conclusion, community-based water management will ensure food security and rice sufficiency as well as improve in overall quality of life and poverty reduction.

Good water governance is also an important and even necessary approach for water management, especially at the community level, in order to ensure that management will be sustainable under present constraints, as well as in the future when population increases. Furthermore, both human capital (knowledge and skills) and social capital (solidarity and community actions) including leadership capacity, and ability of knowledge transfer, are key factors influencing the success of the community-based water resources management.

Multi-purpose water management allows for more successful outcomes. Water supply cannot be based solely on water demand, because water resources availabilities are finite. Therefore multi–purpose water management through effective water usage by increasing productivity per unit of water is one effective alternative. Multi–purpose water management can include practicing combined rice-fish production instead of using rice monocultures, or shifting from higher water demand crops to ones requiring less water, which will result in reduced water

demand and increasing economic value. This approach can also be applied to integration of water for agriculture, aquaculture, domestic use, or recreation.

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