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Full Length Research Paper

The future impacts on downstream communities: A case study of the multipurpose Nam Mang 3 hydropower Project in Lao PDR

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Considering future projects, this paper examines the effects of hydropower dam projects on downstream communities. This study was conducted in the multi-purpose hydropower and irrigated areas of the Nam Mang 3 hydropower. Using a survey study with various stakeholders, household survey, several interviews were held with key informants in addition to field work observation. It was determined that this project has caused a number of negative impacts on farmers, especially those in downstream areas, directly concerned water releases from dam and affecting the benefits from irrigation. The main findings show that farmers are able to grow a second season of rice crops, but the electricity generated in the rainy season from the dam leads to the rice fields flooding along the downstream areas.

Key words: Lao PDR, Nam Mang 3, hydropower impact, downstream community, benefit sharing.

INTRODUCTION

Lao People's Democratic Republic (Lao PDR or Laos), the most mountainous country in Southeast Asia, benefits from its huge potential for hydropower, the extent of which still has yet to be exploited. This potential gives to the Lao State a number of prospects, specifically, the chance of creating large sources of revenue from the export of electricity to Thailand and Vietnam. This revenue can then be mobilised to alleviate poverty, reach the country's Millennium Development Goals (MDGs) from 2015, and to achieve the goals set in 1996 by the 6th Party Congress. Namely of which, to exit the ranks of the Least Developing Countries (LDCs) by 2020 (GOL 2004).

Currently, there are more than 20 hydropower plants in operation (including small and big) that produce3,000 MW (Times, 2014) and 17 under construction[1] for a further 3,000 MW[2], which includes 1,850 MW from the Xainyabouly dam in the Lower Mekong Basin (LMB) (Bui and Schreinemachers, 2011; Sayatham and Suhardiman 2015). Another 25 plants are in the planning stage (6,500 MW)[3], while 35 more are undergoing feasibility studies[4], with a total production capacity of 10,600 MW (Chandara, 2013; EDL 2011; Ministry of Energy and Mines, 2011; Mekong Institute, 2012; MEM, 2012a, 2012b; MEM, 2013). If all the planned projects are completed, the Lao

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[1] Concession Agreement (CA) stage.
[2]This does not include the first lignite-fired power plant, which will have a capacity of 1,800 MW (3 units of 600 MW each) and is scheduled for completion at the end of 2015.
[3]Project Development Agreement (PDA) stage.
[4]Memorandum of Understanding (MOU) stage.

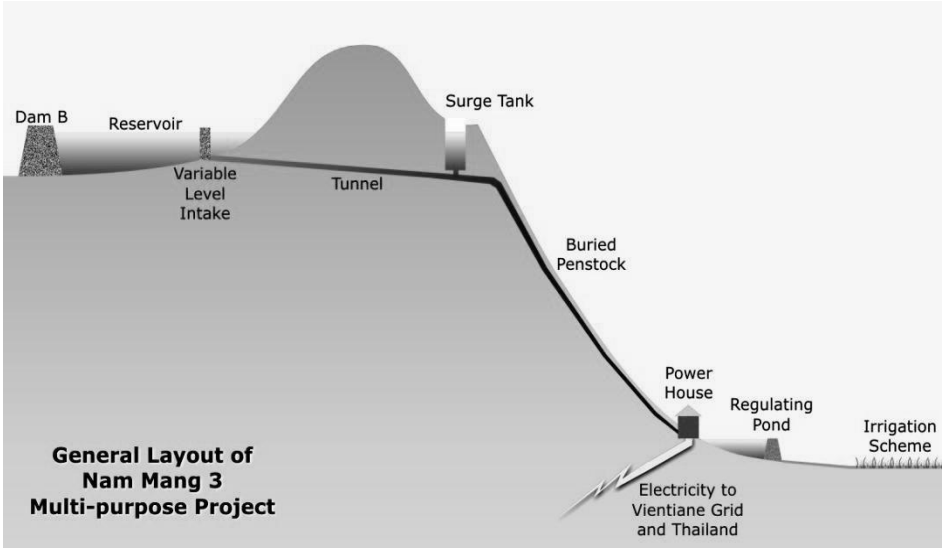


Figure 1. Trans-basin scheme of Nam Mang 3 Hydropower Project
Source: Electricité du Laos (EDL), 2005.

PDR will be able to produce 70% of the basin's energy annually (93,800 GWh) with equal contributions from mainstream and tributary hydropower plants. Cambodia would produce 20%, largely from the Sambor Dam on the Mekong mainstream, whilst Vietnam would produce 9% and Thailand 0.4% (MRC, 2009, 2011).

However, the existing and proposed dams in Laos are the centre of controversy due to their impact on the environment and on people's livelihoods, especially due to changes in the river ecosystems (IRN 2004; Baird, 2006; Baker, 2012). Socio-economic impacts include: resettlement, flooded agricultural land, declining fishing activities, etc (Richter and Thomas, 2007; Kirchherr and Charles, 2016). The debate between the international conservation Non-Government Organizations (NGOs), the government of Lao PDR (GOL), and the World Bank on the dams and hydropower plants impact on the environment and on local populations is a worldwide controversy concerning the Nam Theun 2 (NT2)[5] and has lasted more than 15 years (Porter and Shivakumar, 2010).

The Nam Mang 3 Hydropower Project (NM3HP) is a multipurpose project to provide hydropower and irrigation that began operation in January 2005. It is a transbasin scheme (similar to Nam Theun Hinboun and Nam Theun 2 dam), which diverts water from the Nam[6] Nyong (main river) on the Phou Khao Khouay plateau (PKK) or PKK-National Biodiversity Conservation Area (NBCA), into the Nam Nyam and Houay Hong Pheng (subsidiary rivers) (

Figure **1**). This project was financed by the Government of Lao PDR (GOL) through loans[7], the total of which came to about US$63 million (Jakob 2009).

The 550 m height difference provides hydropower generating power of up to 40 MW, with an average energy production of 138 to 140 GWh/year; 1/3 of this electricity is exported to Thailand. The dam's water discharge released downstream of the powerhouse isretained in a regulating pond to settle and to be used for irrigation purposes in the Nam Nyam valley, Thourakhom district, and Vientiane province, irrigating more than 2,000 ha.

Several scholars have discussed the impacts of hydropower development on resettled communities and on people living downstream of the dams (Baran, 2005; Baird, 2009; Molle et al., 2009; Guan et al., 2015; Sicilianoa et al., 2015; Kirchherr and Charles, 2016; Shabanzadeh-Khoshrody et al., 2016; Tilt and Gerkey,

[5]NT2 is actually the largest hydropower project in operation in Lao PDR, with 1075 MW (6,000 Gwh/year). 1000 MW of power export to Thailand and an additional 75 MW for domestic market [http://www.namtheun2.com/].

[6] Throughout this paper, the words "*Nam*", *"Houay*" are used for "River or stream" and "*ban*" to mean "Village". To avoid repetition, the English word is not repeated after the Lao name.

[7] 80% of the funds came from a loan from the Export-Import Bank of China (interest of 2% per annum during 12 years) and the other 20% from EDL. In addition, the contractor has used the funds (approx. US$2.5 million) to finance the EIA and mitigation measures.

2016; Fearnside 2016; Molinos-Senante, 2016). McDonald-Wilmsen and Webber (2010) argues that dams may tend to have more negative impacts, criticizing that the rights of communities are not adequately considered when it comes to the benefits from irrigation water, flood control or electricity. Tilt et al. (2009) point out that dams may be the source of both direct and indirect impacts. This notion refers to the interlinked nature of dams' impact on social components, e.g., the resettlement of a village may impact its community which, in turn, impacts the rural livelihoods of the people. Indeed, not everyone to be resettled may move to the resettlement location, a few villagers may choose to move to the city instead. Tullos et al. (2010) discuss both the possible positive and negative impacts of dams in their paper on different hydro development scenarios in China. Their findings suggest that there is a crucial need to consider multi-stakeholder perspectives, as different groups view both objective magnitude and subjective salience of impacts differently. This is an important element that should be taken into account in any decision support tool. Sayatham and Suhardiman (2015) examine the impacts of hydropower development on farming households in different livelihood assets and resources, and how they have responded to these impacts. They concluded that while asset substitution generally can improve people's livelihoods, access to land plays a more important role in the process of livelihood reconstruction and improving livelihood outcomes.

The purpose of this study is to explore the impact of the Nam Mang 3 Hydropower Project on its downstream communities and to understand how those communities are affected from this multi-purpose project. The results of this research may also serve as an important planning tool for the GOL and might minimize the negative effects from investments in hydropower projects aiming to respect the natural environment and the social welfare of those affected. As it might be cheaper to avoid the negative effects in the planning stage and decision - making process.

AIMS AND RESEARCH QUESTION

i.) This study aims to address this issue by answering to the following research questions:How were the impacts on downstream communities included in the EIA/design of the dam's operation?
ii.) How are the impacts to the communities involved in dam operation? What impacts have actually taken place over the past year?
iii.) What can we learn from the multipurpose project for future hydropower project development?

THEORETICAL REVIEW

Multipurpose project

This study has researched the case of the multipurpose hydropower project (Nam Mang 3 Hydropower Project), including its electricity and irrigation scheme. In fact, the phase of the project's irrigation scheme along the Nam Nyam valley aims to maximise the water released and to promote rice production in downstream communities. With the dam's irrigation, the farmer can grow a second crop of rice in the dry season (*na xeng*) from December to April and in so doing, possibly reduce the dam's negative impact on downstream areas. Indeed, with the water released during the rainy season in the irrigation channel and subsidiary rivers, large downstream paddy fields have been flooded. Causing many farmers to lose the wet season's rice cultivation (*na pi*) and then cannot grow rice in the dry season.

Normally, multi-purpose projects are designed for sub-optimal outputs of all intended benefits, while single-purpose dams are designed for optimal delivery of a particular targeted benefit. Hence, multipurpose projects aim to maximize economic efficiency achieved through shared costs and the infrastructure of the proposed scheme.

"In doing so, multi-purpose schemes are inherently more complex, and many experience operational conflicts that contribute to under-performance on financial and economic targets" (WCD 2000 p.63).

The World Commission on Dams (WCD), Cross-Check Survey, shows that multi-purpose dams have had a high degree of variability in achieving their physical targets across most benefit streams. This survey also suggests that multi-purpose projects have higher cost overruns and higher variability within these overruns than single-purpose projects(WCD 2000).

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND EIA OF LAO PDR

Environmental impact assessment (EIA)

An environmental impact assessment (EIA) can be defined as: "an analytical process that systematically examines the possible environmental consequences of the implementation of projects, programmes and policies"(Glossary of Environment Statistics, 1997).

According to the World Bank, EIA is:
An instrument to identify and assess the potential environmental impacts of a proposed project, evaluates alternatives, and design appropriate mitigation,

management, and monitoring measures. Projects and subprojects need EIA to address important issues not covered by any applicable regional or sectoral (Environmental Assessment) EA(World Bank, 1999).

In this paper, we would like to discuss the EIA of hydropower project development as a tool for decision-makers to identify potential environmental and social impacts of proposed projects, to evaluate alternative approaches, and to design and incorporate appropriate measures in prevention, mitigation, management, and monitoring. Later, we will illustrate how the local communities were relatively impacted by hydropower projects.

Following the United Nations Conference on the Human Environment held in Stockholm in 1972, environmental agencies and ministries were formed at a rapid rate, with approximately 60 being created by 1988 and at least another 40 by 1992. The World Bank adopted its first dam-related policy in 1977 (on dam safety). During the 1980s the Bank developed policies and guidelines that focused on the social and environmental dimensions of dams and water resources. During the 1980s, the Environmental Impact Assessment (EIA) was adopted and formalized in many countries, although many developing countries only approved EIA legislation in the 1990s. Since then, the EIA has become a major tool used to address social and environmental impacts. The Commission has reviewed extensive literature on this subject as well as hearing directly from those affected by it through regional consultations(WCD 2000).

Most dam proponents see EIA as an administrative hurdle to be cleared, or a requirement to secure funding. This means that substantial political, technical, and financial investment in a project often has already been put into the project before the EIA is launched. If impacts are severe, it is often too late to change the design, and cancelling the project may involve losing face and financial loss. For example, even with improved environmental and social guidelines, the EIA still frequently fails to influence decision-making.

For example: the transbasin scheme, the Theun-Hinboun project[8] in Laos was initiated in the early 1990s. The initial EIA, financed by NORAD, concluded that the dam would have minimal adverse impacts and significant benefits. Most of those who reviewed the document disputed these findings and NORAD undertook supplementary studies. These were completed one year after construction began and had no impact on the decision making process or the design of the dam[9].

[8]http://www.thpclaos.com/index.php?lang=en

[9]Source: the Theun-Hinboun dam in Norpower, 1993, p1-7 as cited in Usher and Ryder, 1997.

Environmental impact assessment (EIA) of Lao PDR

Lao PDR has developed a decree regarding the Environmental Impact Assessment, No. 112/PM (February16, 2010)[10], in order to ensure that all public and private investment projects, both domestic and foreign, operating in Lao PDR (hereafter called 'investment projects') that create or may create adverse environmental and social impacts, are designed with the correct and appropriate environmental and social impact prevention and mitigation measures or with environmental management and monitoring plans (EMMP), as well asocial management and monitoring plans (SMMP).

- To effectively prevent, minimize and resolve adverse environmental and social impacts derived from investment projects;
- To contribute to and make national socio-economic development sustainable (GOL 2010).

This decree is composed of nine parts and 42 Articles. In the Article 3 (Terminological Interpretation) of the first part (Part 1: General provision) of the decree, highlighted the terms used in the Decree. For example, the meaning of the Environmental impact assessment (EIA) is as follows:

"means studying, surveying, researching-analysing and estimating of possible positive and negative impacts on the environment and society, including short and long term impacts on health created by the investment projects classified in Category 2, Article 2 of this Decree[11], as well as offering appropriate alternatives, environmental management and monitoring plan (EMMP), and social management and monitoring plan (SMMP) to prevent and mitigate possible impacts which are likely to happen during construction and operation of the investment projects"(GOL 2010).

[10]Pursuant to the Law on Government of the Lao People's Democratic Republic, No. 02/NA, dated 06 May 2003.

- Pursuant to the Law on Environmental Protection, No. 02/99/NA, dated 03/04/1999.
- Based on a Request from the Minister to the Prime Minister's Office, Head of the Water Resources and Environment Administration, No. 2843/PMO.WREA, dated 21 December 2009.

[11]Category 1: small scale investment projects with minor environmental and social impacts, for which initial environmental examination is required;

Category 2: Large scale investment projects which are complicated or create significant environmental and social impacts, for which environmental impact assessment is required.

Hydropower projects and adverse impacts on local communities

The development of a particular hydropower project may have direct or indirect impacts (both negative and positive) on the indigenous population. These impacts can occur during different project phases and zones, including the planning, construction, or operation phases as well as in upstream and downstream areas, respectively. It could be, for example, the construction phase, which induces involuntary resettlement and may cause the affected persons to lose their houses, land, crops, and animals or affect economic activities which are the source of their basic income. Moreover, the downstream population can be impacted when the dam is in operation, either through soil erosion, the inundation of homes, as well as cultivated land, or a reduction of fishing activities and the loss of a source of protein, amongst others. In such cases compensation may come in the form of cash, the provision of land for land, or food.

According to Wang (2012), hydropower projects may result in a wide range of adverse impacts on local communities depending on their size and location, such as:

"involuntary displacement of significant numbers of people, loss of livelihoods, damage to species and habitats, and altered aquatic and riparian ecosystems"(Wang 2012).

The adverse impacts of hydropower projects are often different from those caused by other large-scale infrastructure projects. In addition to involuntary displacement, hydropower projects can have significant adverse social, economic, environmental, and ecological impacts on downstream and upstream communities.

Though I would like to focus more on the impact that hydropower has on downstream communities in this paper. There are more than 3,000 project affected households (14,000 people) in downstream areas (downstream of powerhouse), mostly along the Nam Nyam valley and National road n°10. In contrast, there were only about 160 households in three project affected villages in the reservoir area of the NM3HP during its construction phase from 2001 to 2004.

According to WCD (2000), downstream impacts can extend for many hundreds of kilometres and well beyond the confines of the river channel. Serious implications have come to the fore only after the completion of the dam and a number of the impacts have only developed over time. In general, the downstream river communities have lacked social, economic, and political power to seek any form mitigation for those negative impacts, let alone the development benefits. Downstream communities throughout the tropics and subtropics face some of the most drastic impacts of large dams, particularly:

"where the changed hydrological regime of rivers has adversely affected floodplains that supported local livelihoods through flood recession agriculture, fishing, herding and gathering floodplain forest products" (WCD, 2000).

In fact, my research was conducted in a small-scale hydropower project (NM3HP 40 MW), but the impact that it has had compared to its megawatt generating power per the affected population is anything but small. This is due to a trans-basin scheme thatdiverts water from one river (Nam Nyong on the PKK Plateau), into other river (Nam Nyam) located in a floodplain (Vientiane plaine) that recieves the released water. If we compare that to a big trans-basin in Lao PDR, the NT2 project (1075 MW), there were more than 6,300 people (16 villages) affected in the reservoir area (Nakai plateau) and more than 100,000 people (159 villages) along the Xebangfai that were affected in downstream areas (Mcdowellet al., 2013; Kouangpalathet al., 2014).

In my own opinion, the quality of the EIA is very important in order to fully consider the early planning process (and all the more so prior to making final decisions) so as to avoid significant negative impacts of an environmental or associated social nature. This could mitigate some of the huge adverse impacts of single and multi-purpose hydropower projects on downstream communities. Since dams affect the livelihood of communities in the immediate vicinity of the project, such as the impoundment zone and downstream areas, communities in the immediate vicinity of the project are logically the ones who should benefit from the project, including in the construction and operation phases. Below, I will discuss benefit sharing within hydropower projects.

Benefit sharing

The notion of benefit sharing has been applied at local, national, and trans-boundary levels in literature and in practice. Hydropower projects tend to be implemented for the long-term benefit of wider regional and/or national constituencies(Milewski et al., 1999). However, the communities that are negatively affected the most by dams, are very seldom the recipients of the long-term benefits that flow from these projects. The objective of benefit sharing is to leverage long-term benefits for those communities negatively affected by hydropower development projects. According to Wang (2012), the definition of local benefit sharing in hydropower projects is:

"*the systematic efforts made by project proponents to sustainably benefit local communities affected by hydropower investments*".

Benefit sharing is also included in the World Commission of Dams (WCD) seven strategic priorities to

Table 1. Benefit sharing can occur in two different spatial contexts; that of a trans-boundary context and also within the context of locally affected communities.

Benefit sharing contexts	Description
Trans-boundary benefit sharing	Trans-boundary benefit sharing is based on the presumption that a common management of water resources generates net benefits, compared to the unilateral development of the water resources. The concept is about the cooperation of riparian states for the use, protection, or joint development of shared water bodies (trans-boundary rivers, lakes and aquifers), whereby the riparian states focus on the benefits of water cooperation and the win-win options instead of a potentially conflicting water sharing
Benefit sharing with the affected local population	Benefit sharing with the affected local population refers to a commitment to channel some of the returns generated by the operation of a project back to the population of municipalities, where water resources are exploited and infrastructure projects are developed. The relevant forms of benefits sharing are presented in detail in this article.

Source: (Parker and Bachurova 2010).

protect fundamental human rights in dam development (WCD 2000)[12]. As stated in the report (WCD):
"Anchoring its framework in human rights based approach, the WCD recognized that dams have made an important contribution to human development, but it also condemned the 'unacceptable' price that has too often been paid to secure those benefits."

According to Parker and Bachurova (2010), the concept of benefit sharing is "*highly relevant both in the political praxis and the scientific literature regarding integrated water resources management. The principal idea of the concept is to share the benefits resulting from the development of the water resources in order to satisfy the needs of concerned populations or directly and indirectly affected communities*." Within this broad definition, two dimensions of benefit-sharing can be differentiated, i.e.:

(i) trans-boundary benefit sharing; and
(ii) benefit sharing with the affected local population.

Benefit sharing at the local level can also involve sharing gains from resource development among residents and other stakeholders. In the context of hydropower, benefit sharing is often used interchangeably with compensation when describing the payments or the in-kind support provided to households and communities displaced by the construction of a dam and reservoir (WCD, 2000; UNEP, 2007). Ideally, one might reserve the term benefit sharing for programs that intentionally distribute the electricity, revenues, or economic rents from hydropower operations across a broader set of beneficiaries, while using the term compensation to describe programs designed to reimburse those directly impacted by hydropower development. Yet the term benefit sharing appears in many reports of compensation programs.
Accodring to Lebel et al*.* (2014) and Prachvuthy et al. (2014) describes compensation as a form of benefit sharing and highlights the role of such programs in assisting displaced households to recover and sustain their livelihoods. In such discussions, the notion of benefit sharing becomes linked to the notions of social and environmental justice.

How can benefits be shared?

Benefit sharing has recently become a key element in strategies for the sustainable development of large infrastructure, such as dams, aiming to equitably distribute project benefits, particularly with the project-affected people (Parker and Bachurova, 2010). Large water infrastructure generates direct monetary revenues. According to Milewski*et a.l*(1999) there is growing consensus that local stakeholders should share the benefits of such projects in addition to being compensated for the inevitable environmental and social costs of developing such projects. Milewski*et al* (1999) and Égré (2007) strongly argue that the only form of benefit sharing mechanism feasible is monetary benefit.
Moreover, Milewski et al.(1999) argue that mitigation measures, compensation, community development, and livelihood restoration initiatives cannot be considered as benefit sharing mechanisms, as those in charge of the project are required to mitigate negative environmental and socioeconomic impacts. My position on the concept of benefit sharing is that it includes a wide range of mechanisms which provide both monetary and non-

[12]See also Martinez-Alier, J. (2014). "The environmentalism of the poor." Geoforum 54 (2014) 239-241.

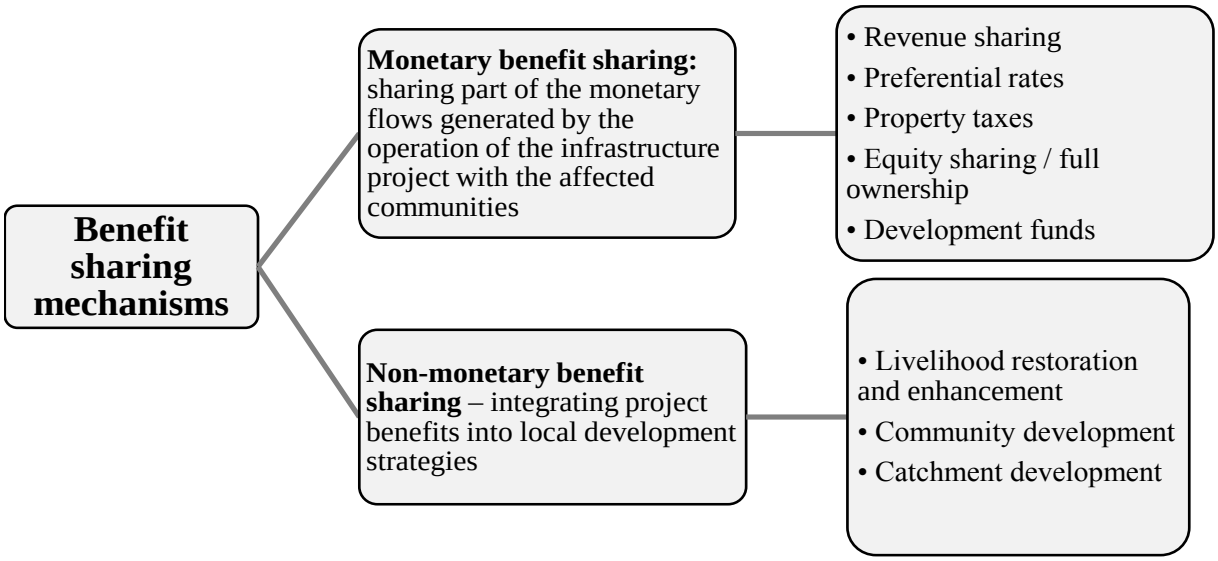


Figure 2. Benefit sharing mechanisms.
Source: based on the UNEP Compendium "Dams and Development Project-DDP" (2007) and on the Report of the World Commission on Dams (2000), they therefore refer mostly to large dam projects.

monetary benefit sharing mechanisms.

Benefit sharing in the Mekong region

We would like to shortly present the entire context of the benefit sharing in the Mekong region and illustrate some relevant case studies conducted in the region. Actually, in the Mekong region and elsewhere, benefit sharing is often presented as a means of reducing negative impacts from hydropower development, without questioning the need for dam development in the first place.

- Private developers promote benefit sharing as an affordable, socially desirable complement to their primary goal of earning profit from the generation and sale of electricity.
- National governments promote benefit sharing in support of economic growth, industrialization, and poverty reduction, while not sufficiently considering the views and needs of those impacted by hydropower development.

Moreover, the design and application of benefit sharing reflects a rather narrow perspective regarding how impacted households and communities can 'benefit' from hydropower development. The objectives of private developers and government officials take precedence over the livelihood goals and constraints of the intended beneficiaries (Suhardiman et al., 2014).

Suhardiman et al.(2014) stated benefit sharing programs have been implemented in the Mekong region in recent years, partly in the context of providing compensation to households directly impacted by hydropower facilities, and also in the form of payments for ecosystem services in areas upstream of hydropower watersheds. The apparent popularity of the notion of benefit sharing has led several governments and organizations to use the term for programs that do not truly involve sharing hydropower benefits.

Indeed, benefit sharing has been described in both local and trans-boundary contexts in discussions regarding hydropower development in the Mekong region (Lebel et al., 2014; Prachvuthy et al., 2014). Sharing revenue from the sale of electricity generated in Laos to customers in Thailand or Vietnam might be described as an application of international benefit sharing. Using a portion of the revenue from electricity sales to support livelihoods in the upper reaches of a hydropower watershed would represent a local benefit sharing effort.

In the Mekong Region, benefit sharing forms an integral part of the Resettlement Action Plans (RAP) defined by hydropower companies. Kura et al.(2014) describe how benefit sharing is included in the resettlement plans of selected hydropower projects in Laos, looking respectively at the redistribution of benefits in terms of water use and access to land and (reservoir) fisheries. Prachvuthy et al.(2014) illustrate how benefit sharing from hydropower projects in Cambodia has been designed and applied within the context of compensation

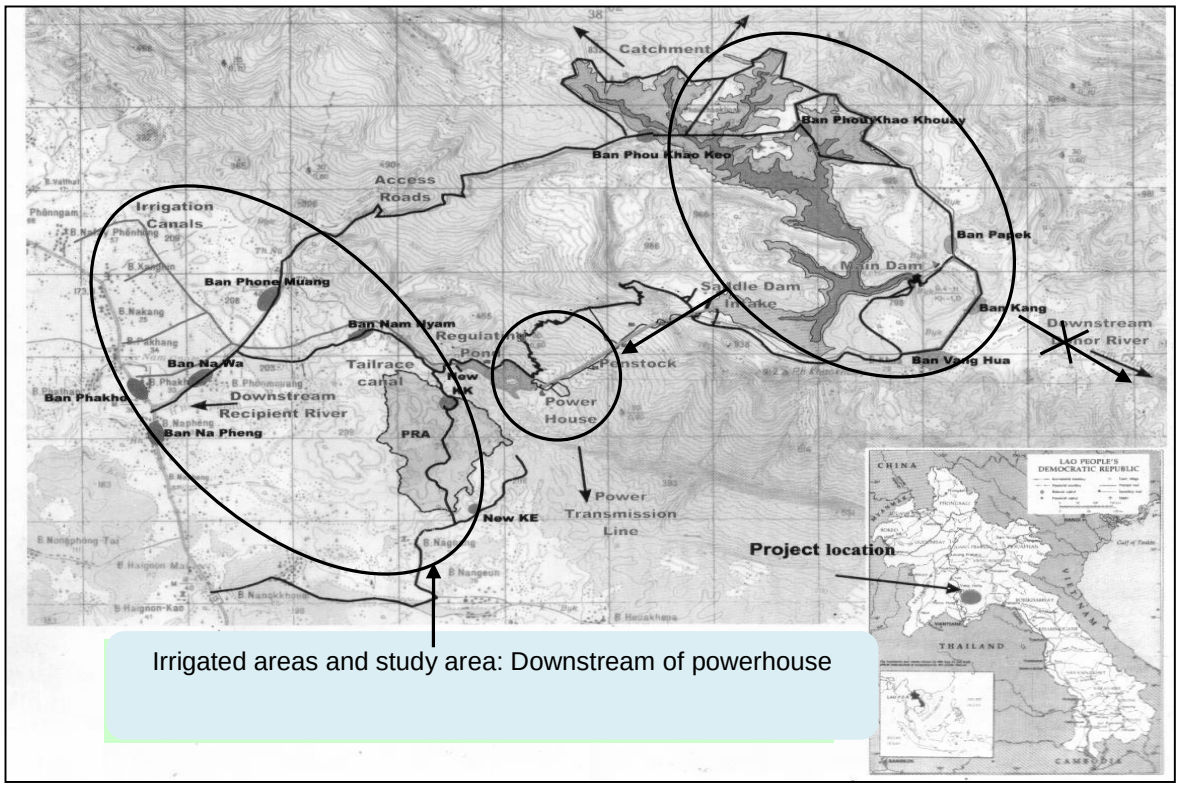


Figure 2. Study area, within the layout of the Nam Mang 3 hydropower project.
Source: Electricité du Laos, 2005.

for resettlement.

In recent years, benefit sharing has been linked to the notions of Corporate Social Responsibility (CSR), Community Development Funds (CDF), and Payments for Ecosystem Services (PES). Lebel et al.(2014)examine the "sharing of benefits" from the Sirikit dam in northern Thailand, illustrating four mechanisms that have been applied in order to support the resettled community and improve their livelihoods. The case study demonstrates the strengths and weaknesses of each mechanism: compensation for resettlement, Corporate Social Responsibility (CSR), Community Development Funds (CDF), and Payments for Ecosystem Services (PES).

The way the term ‘benefit’ is defined in benefit sharing partly overlooks how impacted households and resettled communities might perceive benefits in relation to their livelihood options and strategies. Kura et al.(2014) illustrate how the resettlement process for the Theun-Hinboun Expansion Project in Laos has, to a certain extent, helped the resettled communities gain access to agricultural land and domestic water supplies. They show also that while access to domestic water supplies has significantly improved after resettlement, the resettled communities have lost their riverbank gardens, which is claimed to represent about 60% of the cash generated from agriculture activities.

METHODOLOGY

Study sites

This study was conducted in the downstream areas of the trans-basin scheme in Lao PDR that included the village along with the Nam Nyam valley (and subsidiary rivers). It is located in Thourakhom district, Vientiane province, about 60 km North of Vientiane Capital, Lao PR (Figure 3).

Research approach and method

To examine the profit and background of the project such as the process of the design, planning and the operation of the project overtime. How the project has evolved over time? How are in charge and owned of the project overtime? *etc*. We have summarised the secondary date and analysed the existing documents including

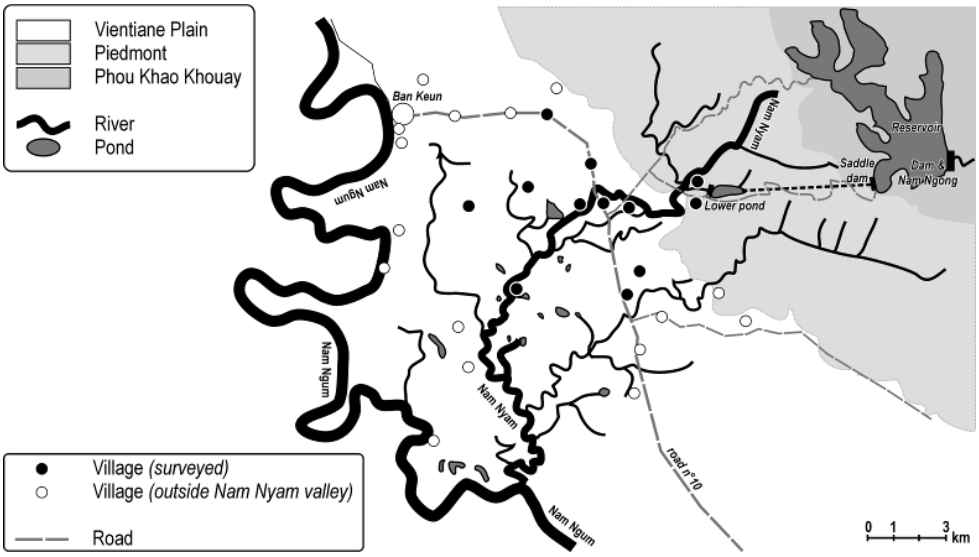


Figure 3. Nam Nyam valley in the Vientiane Plain.

quantitative and qualitative, interviewed key informants and field observation.

To investigate the socio-economic of rural communities in downstream area and the impacts of the dam over the past year? We used a survey the Agrarian System Analysis and Diagnosis, or shortly called Agrarian System (Cochet, 2011; Mazoyer and Roudart, 2005). It is an all-encompassing concept, capable of making sense of agricultural activities at a regional scale in a way that accounts for both ecological and socio-economic dimensions. This methodology is used as a holistic approach to understanding agricultural transformations at the regional level. This approach includes all the fundamental factors that influence farmers' decisions and practices with great ability to analyze agricultural transformations.

A French speaking agronomist created it during the 1970 - 1980s at the same time as the English concept about Farming Systems Research (FSR) approaches promoted by the Association for Farming Systems Research and Extension. But FSR is limited to technical and financial analysis of the farm and rarely takes into account the farm environment and historical change. This approach often uses the Rural Rapid Appraisal methodology associated with statistical analysis tools to perform farm typology.

The agrarian system survey relied on six to ten months of field studies with: (i) First, a Landscape reading in order to understand the agro-ecosystem and zoning the study area. Started by direct observation of the agro-ecosystem and vegetations, the question “why” guides us to meet the elderly and local people for a better understanding of land use change in study zone; (ii) Second, historical study while the current agricultural situation is the fruit of a long or medium term evolution. We interviewed with elderly farmers to understand the historical evolution of the village communities. It allows to model the differentiation of the farms leading to a limited number of categories (typology) based on demographic, technical, economic and social criteria; (iii) Third, detailed farm surveys (production system modelling and performance economic calculation), which allowed to characterise the current agricultural practices and the economic performances of the different farming systems, with a limited sample of three to five households for each category (Dufumier, 2005; Cochet, 2011)

Data collection and analysis

Both a qualitative and quantitative survey, combined with a review of existing documents, was used. The qualitative survey focuses on key stakeholders involved in the project by using key informant surveys with 15 key informants, such as head of Technical Service Centre Nam Mang 3 (TSC-NM3), District Agricultural Extension and Forestry Office (DAFEO), Provincial Agriculture and Forestry Office (PAFO), NM3HP, and Electricity of Lao-Generation Public company (EDL-Gen). The technicians’ interviewed consisted of staff, especially from DAFEO and PAFO at TSC-NM3.

Also for the household surveys was completed in 12 villages[13], by using the interview guidelines. We

[13]Ban Phoukhaokhouay-Mai, 2. Namnyam, 3. Nava, 4. Haiyon, 5. Phonkeo, 6. Napheng, 7. Pakhang, 8.

have selected 106 households to interview in 12, along the Nam Nyam valley and the national road N°10.

RESULTS

Background of NM3HP

The Nam Mang 3 Hydropower project (NM3HP) was never considered a high priority project for construction. Therefore, observers were surprised when construction began in November 2001, before the project design had been finalized and before an environmental impact assessment, social action plan or environmental management plan were produced and without public consultations or participatory planning of mitigation (IRN, 2003). These studies are required under Lao PDR's Environmental Protection Law and Regulations for Environmental Assessment at that time. And later a decree on the Environmental Impact Assessment of Lao PDR was developed in 2010. This decree had also specified that the project developer must, first, obtain an environmental and social compliance certificate before signing any Concession Agreement (CA), Mineral Exploration and Production Agreement (MEPA) or starting construction work, or before any operating permit can be issued (Article 4)[14].

The World Bank and International Monetary Fund have voiced criticism about allowing the project to proceed. The Asia Development Bank (ADB), which funded the original project feasibility study (in 1992/93), was also critical that construction was proceeding without an EIA.

With this poor implementation process and following pressure from the World Bank and ADB, however, the company later commissioned a study to identify the critical information needed for the project's completion in December 2001(RMR 2005).

In 2002, China International Water and Electric Corporation (CWE) provided financial support to Electricité du Laos (EDL) to hire advisory services from Resource Management Research (RMR) in order to develop a "catch up" Environment Emergency Mitigation Plan (EEMP) and the Environmental Impact Assessment-Environmental Mitigation Plan-Social Action Plan (EIA-EMP-SAP).

RMR admits that it normally takes at least two years to prepare these documents. Nevertheless, the studies were approved by the Science, Technology and Environment Agency (STEA), under the Lao Prime Minister's Office, and presented to selected stakeholders at a meeting on September 16, 2002. Upon completion of these series of plans, the construction of the NM3HP officially re-started in January 2002 and while the commercial operation date began in January 2005, the NM3HP Environmental Completion Report was written in February 2007.

Overview of stakeholders

The original dam operator of the NM3HP was EDL, during 2005 to 2010 and then, since the end of 2010, this project has transferred to EDL-Generation Public Company (EDL-Gen) to act as dam operator.

In December 2010**,** the GOL approved the privatization of EDL's power generation business and the establishment of EDL-Generation Public Company (EDL-Gen)[15] as owner/operator. It is the first public company in Laos. On the 15th of December 2010, the Ministry of Industry and Trade (Business Registration Office) issued business license No.4637/BRO.MOIC and EDL-Gen became a public company and was listed in the Lao Stock Exchange[16]. In actuality, 75% of EDL-GEN is owned by EDL and 25% is owned by public investors (domestic and foreign investors) (EDL-Gen 2010).

A new Concession Agreement (CA) signed with the GOL on the 15th of December 2010,in which seven projects[17] are under the management of the EDL-Gen, including the NM3HP. This new CA of the NM3HP will be valid for the next 30 years and can be extended another10 years through negotiation. After these periods, the Company should transfer all assets used in generating electricity to the GOL.

In the CA of the NM3HP between EDL-Gen and GOL was mentioned mainly due to the electricity tariff and Land Lease Agreement. It did not mention any operation rules or regulations related to irrigation systems or any measures to mitigate the impact on downstream communities for the next 30 years of dam operation. Moreover, the CA should also discuss long-term benefit sharing with those impacted downstream communities.

In reality, only three villages[18] affected during the construction phase in the reservoir area received monetary benefit sharing and non-monetary benefit sharing because of their loss of livelihood assets. All of

Phathao, 9. Phonhong-Nafay, 10. Nakeo, 11. Phonkham et 12. Nongphong.

[14]Article 4: General Principles

[15] Decision No 180/PMO on the approval and certification of the creation of the EDL-Gen [http://www.edlgen.com.la/]

[16] According to Decree No.526/PM on the registration of EDL-Gen in Lao Securities Exchange

[17] The EDL-Generation Public Company has 7 hydropower Plant in 2010: Nam Ngum 1 (155 MW), Xe Set 2 (76MW), Nam Leuk (60MW), Xe Set1 (45MW), Nam Mang 3 (40MW) Nam Song (6MW) and Xe Labam (5 MW).

[18]Two villages (Phoukhaokhouay and Phoukhaokeo) have been resettled in the foothill of Phou Khao Khouay in 2004.

which pertained to physical, social, and natural capital that would be substituted by either cash compensation and/or new (farm) land allocation, as well as through food, health, and provision of public infrastructure (e.g. roads, schools, access to electricity). These forms of benefit sharing were included in the Resettlement Action Plan, as I illustrated in the literature review session.

The purpose of the Resettlement Action Plan was to provide each resettled household member with 1600 m^2 of land. The more members in a household, the more land they received. In practice, however, the project could not provide sufficient land to all resettled villagers. There were disputes between original land claimants and project land allocation officers because the offered 470 ha included the paddy and preserved land of the original resettled villagers. As a result, some of the households in Phoukhaokhouay village did not receive the land they thought they were entitled to receive. In Phoukhaokeo, villagers misunderstood that if they refused the offered non-irrigated land, the government would provide them with irrigated land elsewhere. The villagers therefore declined to take the offered land.

As part of the Resettlement Action Plan, the NH3HP company provided food and health care support to the households in the three villages for 18 months. Furthermore, EDL constructed a variety of facilities and infrastructures for the impacted communities, which included: a rural electricity grid, water supply for impacted households, and improved access to roads. EDL also provided assistance in the construction of a new primary school, renovated an existing secondary school in Vangheua village, and provided financial support for the construction of new primary schools in the villages of New Phoukhaokhouay and New Phoukhaokeo. Even though the downstream communities have the irrigation system to grow a second season of rice (in the dry season), more than a hundred downstream farmers lose wet rice production due to large amounts of flooding. Nor have they received any benefit sharing during the operation phase, or any such form of compensation.

Management evolution of the Nam Mang 3 irrigation scheme

EDL and EDL-Gen

The Nam Mang 3(NM3) - irrigation scheme is a gravity irrigation system connected with the NM3HP via water discharge after electricity generation. Since the commercial operation date in 2005, this connected irrigation system has been excluded from EDL and EDL-Gen in terms of operation, organization, and financing. The EDL only funded US$2.8 million for the construction of the canal irrigation network (Nam Mang 3 Irrigation system), offices (Nam Mang 3 Irrigation Project Office), purchase of a number of vehicles, and initial operation costs (2 years). The owner of the NM3HP (EDL-Gen) is only responsible for the maintenance costs of a 2.3 km stretch of a primarily concrete canal (which leads to the regulating pond of Ban Nam Nyam).

Provincial Agriculture and Forest Office (PAFO)

Instead, the PAFO of the Vientiane province are in charge of the NM3-irrigation system, taking care of things such as the management and maintenance, operation costs, and staff allocation. Initially, PAFO received a 2% allocation from theUS$2.8 million for the operation costs and maintenance of the irrigation system for two years (2005 - 2007). Then, the operation costs and maintenance budget came from the water fees that water users paid during the dry season. The NM3-irrigation Office has been reduced by the government, when there were large-scale maintenance works.

Nam Mang 3 Irrigation Project Office (NM3-IPO)

From 2005 to 2009, the Nam Mang 3 irrigation system was under the responsibility of the Nam Mang 3 Irrigation Project office (NM3-IPO). The staff in this office came directly from the PAFO of the Vientiane province. NM3-IPO managed the irrigation system network, collecting water fees for the maintenance of the irrigation system and promoting rice production in the irrigated areas in the Nam Nyam valley and along the national road No.10. At the village level, Water User Groups (WUG) were not set up yet. There was only one Farmer Group "*kum xao na*", consisting of 3 or 4 persons, who worked and coordinated closely with NM3-IPO and irrigated farmers. *kum xao na* - represented the irrigated farmers in the entire irrigation system. Their role included resolving conflicts, organizing meetings with farmers, irrigation scheduling, etc.

There were also a number of concrete diversionary weir schemes, located in Nam Nyam, Nam Teng and Hong Pheng that were directly connected to theNM3-irrigation system and were not included in the operation and management of NM3-IPO during 2005 to 2009. Rather, they were under village authority and the supervision of the District Agriculture and Forest Extension Office (DAFEO) of the Thourakhom district.

In 2010, PAFO decided to merge the Agriculture Technical Centre[19] and NM3-IPOasthere were too many interrupting activities in the same area. The NM3-IPO became the Technical Service Centre Nam Mang 3 Office (TSC-NM3)and has been till the present day

[19]In 2008, the Nam Ngum River Basin Development Sector Project (NNRB) managed by NAFES supported DAFEO of Thourakhom district to create an Agriculture Technical Centre (ATC). This centre was next to NM3-IPO.

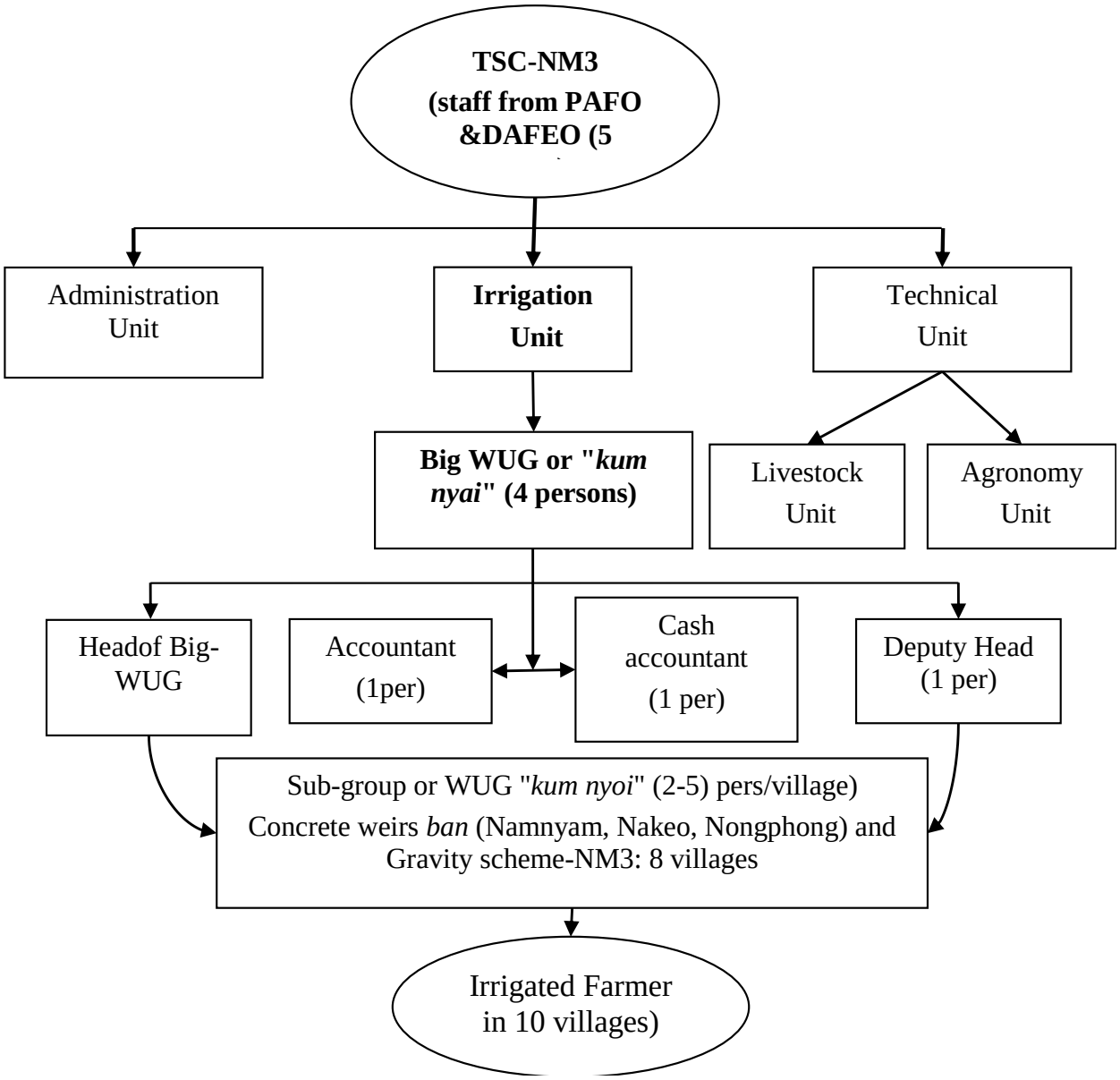


Figure 4. Organization chart of TSC-NM3.
Source: author from field survey.

Figure3). Today, the TSC-NM3 office is responsible for the whole NM3 irrigation scheme and the concrete weir schemes in terms of management and maintenance. This also includes agricultural promotion and technical services to ensure the benefits of irrigation for farmers. The NM3 office staff from of Thourakhom and PAFO of the Vientiane province work together and make monthly and annual reports of their activities. This office is presently composed of three main units.

Water user group

After these institutional changes, a new Head of TSC-NM3 replaced the previous one, though the farmer group or big WUG or (kum nyai) still exists. According to decree No. 071 (February 2010) from the Thourakhom district Governor's "Water User Group Committee "regarding the regulations or rule son theNM3-irrigation scheme, every irrigated village should have 2 members in the Water User Group, called a sub-group (or kum

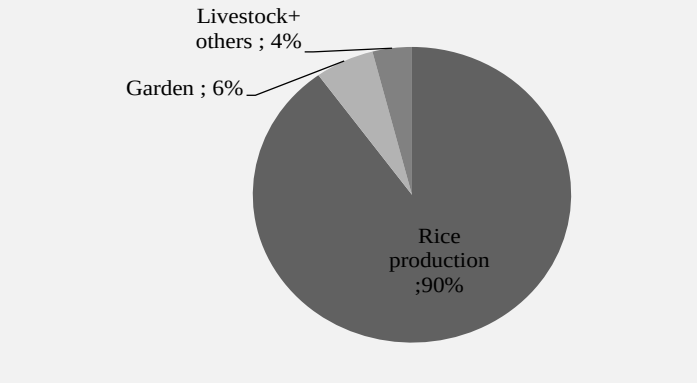


Figure 5. Irrigation usage proportion (%).
Source: Field survey

nyoi) (District 2010; Salyphoth and Mattouvong 2010;Saynirath 2010).

In practice, there were some villages that still have 5 members (Nakeo, Nongphong, Namnyam), including three more people from the village authorities. Actually, this group is responsible for measuring the irrigated areas after rice transplantation (January) and collecting water users fees from irrigated farmers for their dry season rice crops. They are in charge of the secondary channel (*khong xoy*) and tertiary channel (*khong sai kai*) water allocation upstream and downstream of the canal network. They also solve problems in their own villages and coordinate vertically with village authorities, such as the big WUG and TSC-NM3. They are responsible for informing the farmers to participate in irrigation channel cleaning and irrigation scheduling...etc.

Water user fees

Again, the irrigated famer's only pay irrigation water user fees in the dry rice season (20,000 kip/Rai or per 1600 m^2), because most of them do not need water irrigation for wet rice production. 80% of the water user fees collected from irrigated farmers are managed by the big WUG or *kum nyai* and 20% are managed by WUG at the village level or as a sub-group (or *kum nyoi*) for their remuneration[21] and basic operation costs.

The big-WUG is responsible for managing water user fees and collecting fees from each sub-group. For the maintenance, cleaning, and rehabilitation of the primary channel, they have a budget of 15 million kip each year, but this amount is not enough and sometimes irrigated farmers have to contribute extra money for maintenance due to irrigation channel flooding regularly in the wet season.

The irrigated area in the NM3-irrigation scheme

The NM3 irrigation scheme is a gravity or reservoir irrigation scheme. It is a large-scale[22]irrigation scheme related to power generation when water discharged from a Regulating Pond is used for irrigation. The NM3 irrigation schemes comprises about 27 km of primary and secondary channels fed from a gated sluice on the Regulating Pond via a concrete lined channel of 2 km.

The NM3 irrigation also directly and indirectly feeds other existing and new concrete diversionary weir schemes along the Nam Nyam[23], Nam Teng[24], and Hong Pheng, which benefit from water releases to Nam Nyam and Nam Teng, including overflows of drained downstream rice fields.

Before 2005, farmers along the Nam Nyam valley grew rice in the rainy season (*na pi*). After the NM3-irrigation scheme started, farmers in this area can now grow a second rice crop, which is the most represented crop in terms of cultivated areas; about 90% while 6% are various vegetable gardens along the canal banks in the dry season. Another 4 % are made up of livestock activities; aquaculture and other purposes (Figure 5).

[21] sub-WUG' member salary 500,000 kip/year, if some villages have less irrigated area, 20 % it not enough to for the salary, so big-WUG have to subsidy their salary per year.

[22] The size of irrigation schemes (article 18) of the Law on Agriculture N°105/PO (1998) is "*Small-scale irrigation [refers to] irrigation that serves a production area of less than 100 hectares; medium-scale irrigation [refers to] irrigation that serves a production area of 100 to 500 hectares; large-scale irrigation [refers to] irrigation that serves a production area exceeding 500 hectares*".

[23] At *ban* Namnyam, Nakeo and Nongphong

[24] At *ban* Namnyam

An earlier estimation of the irrigation potential of the NM3HP was 2,900 ha, while the actual irrigated areas in the dry season of 2011/2012 were a total of 2,220 ha (with more than 1,500 households). Which had increased to 92 % of its potential if we compare it with the dry season of 2005/06 (around 1,200 ha, with 600 households), including the entire NM3-irrigation scheme and connected schemes, such as: concrete diversionary weirs of “Napheng, Nakeo and Nongphong”, which consist of 400 ha in the dry season.

Based on field surveys, the irrigated area of rice in the rainy season increased around 5% over the past five years, yet farmers lost more than 40% of their paddy fields during those times.

Nam Mang 3 hydropower project and its impacts

Comparing upstream and downstream impacts

Actually, the Nam Mang 3 dam has less impact on upstream and downstream of the donor river, because the dam located upstream, where there is a narrow and small watershed. Downstream, there weren’t any villages and there are more other small streams feeding the Nam Nyong before flowing to Nam Mang 3, which limits impacts on the water debit. Three villages[25] (about 2,700 people) were affected from the reservoir area and needed to relocate. But we can observe a big change in Nam Nyam valley. The Nam Nyam valley was considered as poorly drained. Nam Nyam (subsidiary rivers) is a small watershed receiving indirect water releases of the dam especially during the raining season: if too much water feeds the irrigation canals, the water is conveyed to the Nam Nyam, which causes inundation of paddy fields, grasslands, parts of villages, the main road, destruction of fish ponds, *etc*. Actually, there are more than 3,000 households settled along the Nam Nyam valley, downstream of the NM3HP. i.

Geography of the Nam Nyam valley

The Nam Nyam valley is considered one of the poorest ii. drained valley in the country. The geography will help us to understand more about the flooding along the Nam Nyam valley as well as its downstream impact. Indeed, the Nam Nyam River is a tributary of the Nam Ngum River, 25 km flowing from the steep sandstone slopes of the Phou Khao Khouay mountains (500 m asl) down to the slightly undulated Vientiane Plain (160 m asl). More than 12 villages (about 14,500 people) live in the watershed. The hydrological network of the Vientiane Plain is very rich, structured by the Nam Ngum, which runs from the reservoir of the Nam Ngum 1 hydropower to the Mekong river. Many tributaries supply the Nam Ngum with watershed extended toward upstream reliefs that border the plain, including Nam Nyam. Water flows could change according to the seasons in the lower part of the tributaries. Most of the time, it flows towards the main river; but during the rainy season, water can flow from the high-level Nam Ngum into those tributaries to submerge the flood plain behind the bankside ridge. Flooding occurs when the valley receives a large amount of water released from the dam during the rainy season because the Nam Nyam valley forms a "U valley" and is considered to be a poorly drained area (160 - 200 m altitude). We observe that the large amounts of downstream flooding occurred every year since the operation of dam in 2005, mostly in zoning (iii) - "various levels of alluvial terraces".

The zoning of the area is based on the difference of altitude at different scales:

-At macro-scale (a few hundred meters) between the Phou Khao Khouay mountain and the plain (hundreds of meters).
-At meso-scale (a few meters) in the plain between high and low alluvial terraces and between terraces and hillocks (upland), or between the flood plain and the bankside ridges.
-At micro-scale (a few decimetres) between the active flood plain, flooded each rainy season, and the old alluvial terrace, upper and never flooded.

By combining criteria based on the different levels of altitude, the hydrology and land use, the Nam Nyam valley can be zoned in three different components. The "Phou Khao Khouay slope and foothill", are mostly covered by old forest, secondary woodland (fallows), swidden cultivation fields, pasture, plantations and some villages;
The "Vientiane Plain hillocks", covered by swidden cultivation fields, young fallows, rain-fed paddy field, plantations, enclosed pastures, domestic garden , and villages;
The "Various levels of alluvial terraces", with irrigated paddy fields, cash crop cultivation on the river bank and irrigation channel, and fish ponds.

Socio-economic differentiation in the Nam Nyam valley

According to the diversity of village households in the Nam Nyam valley, currently we can be summarised in a typology of four categories of socio-economic differentiation:
i.) 17% of landless households, living off the precarious renting of upland from well-off families for shifting

[25]Ban Phoukhaokeo, Phoukhaokhouay-Kao andVangheua

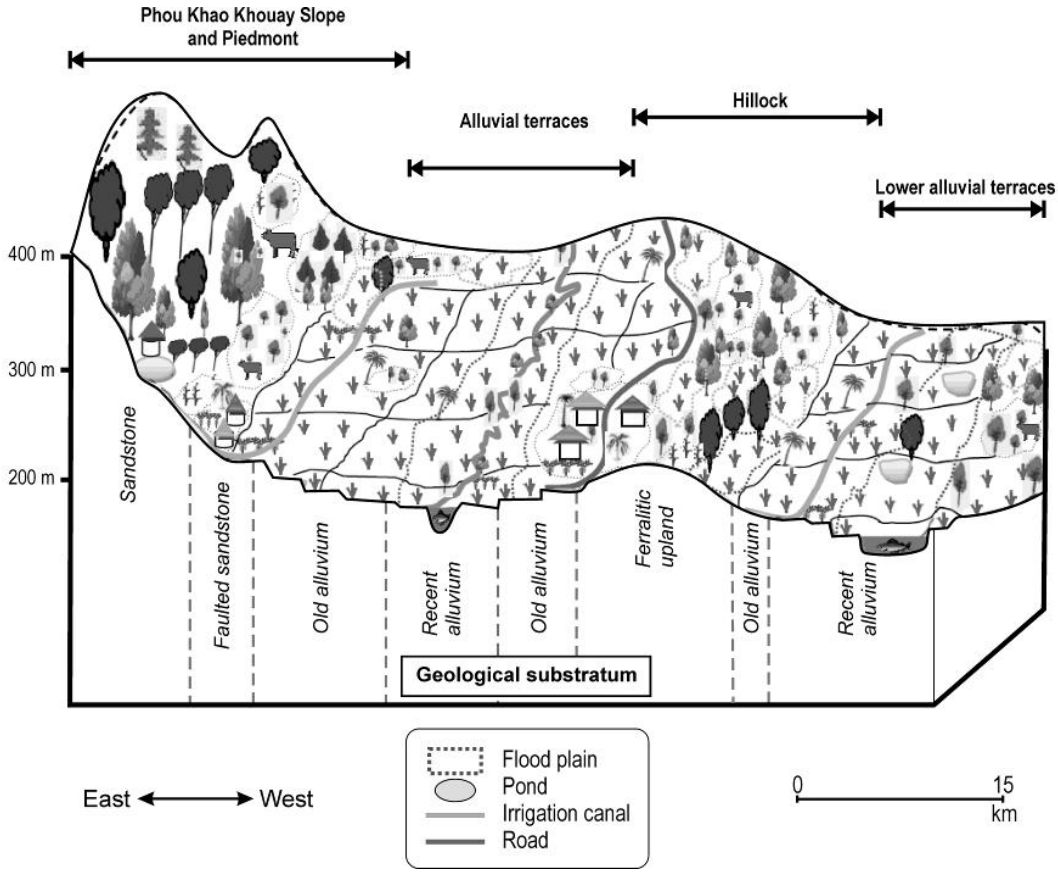


Figure 6. Zoning.

cultivation, and daily labour in larger farms or outside the village. Only 30% of these households found the paddy field in the valley and outside and they presented the household the most vulnerable in the study area.

ii.) 60% of small-farm households, with enough paddy field (0.1-2 ha/household) to cover the family needs and provide limited surplus, and small pieces of enclosed upland (0-2 ha/household) for raising a pair of bovids. About 5% of these households still rent the paddy field from another farmer to ensure the rice consumption during the year. They presented also one of the most vulnerable households.

iii.) 17% of middle-farm households, with 2,5-5 ha of paddy to cover family needs and to sell regular surplus, 0.3-5 ha of enclosed upland for raising one to four bovids. Occasionally, they can employ a few daily workers. About 50% have the paddy field in irrigated area that they can grow second rice crop in dry season.

iv.) 6% of well-off households, with diversified activities. Some are still closely involved in farm production, with more than 5 ha of paddy field allowing them to sell a large surplus, up to 10 ha of upland for raising tens of cattle or planting rubber trees and teak. To increase their income, many have also diversified their investment in non-agricultural sectors, and even quit farming: business of agricultural produces or wood, grocery, and services (husking and threshing, transportation, restaurants, bars, etc.). They regularly employ day labourers.

A phased impacts

The construction of the Nam Mang 3 dam affected marginally people from the villages of the Nam Nyam valley. Most of the civil work took place along the Nam Nyong, on the top of Phou Khao Khouay mountain, far from the villages in the Nam Nyam valley. Due to the distance and the limited size of the dam, the building site did not offer work opportunity to local people.

As the reservoir was filled with water diverted from Nam Nyong on the top of mountain, the Nam Nyam in the downstream of powerhouse flow was not affected. In 2004, there were two villages (Phoukhaokeo and Phoukhaokhouay) relocated from the top reservoir area towards the downstream plain and one village. The district authorities granted limited upland (1 ha/household) to resettled people. This is not sufficient to meet the family needs. The well-off households, who moved with some capital, were able to invest in off-farm

Table 2. Rice growing in dry season for each category of farmer.

No.	Type of farming	Percentage of rice growing	Paddy field flooded in rainy season
1	Landless households	Less of 20% from rent	Non-owned paddy fields
2	Small-farm households	Less 40% and more than 5% from renting another farmers	More than 30% rice fields flooded
3	Middle-farm households	More than 40%	About 40 % rice fields flooded and abandoned
4	Well-off households	More than 60%	More than 45 % rice fields flooded and abandoned

Source: Field work survey.

activities such as trading or transportation, or even to move away from the valley, while poorer people had to look for daily jobs in the neighbouring villages and in town. Some of them have to look each year to rent the land far away from the valley to practice the shifting cultivation.

The operation phase, if people from the Nam Nyam valley were only marginally affected by the construction and filling phases, they are clearly impacted during the power production phase that began in 2005. The water diversion from the Nam Nyong into the Nam Nyam increased the daily stream, including in rainy season when the Nam Ngum adds to the Nam Nyam flow. It has induced large flooding of the lower terraces in the valley. Farmers from villages downstream of the Nam Nyam lost every year about 500 ha of paddy including the paddy field that they had built up previously in the Nam Ngum flood plain. In addition, flooding occurs more frequently in the high alluvial plain. Unfortunately, the Nam Nyam downstream villages are not involved in the dry season irrigated scheme, designed for the upper villages. Only half of the villages in the valley are involved, and within these villages, the access to new dry season irrigated paddy fields benefited mainly to the well-off households.
The flooding of the rice field during the rainy season in the Nam Nyam Valley frequently and longer.

About 30% rice fields of the small-farm households are flooded in the rainy season (Table 2). This makes life very difficult for poor families who do not have a lot of rice field and rice field non-irrigated dry season. They do not have the ability to invest in off-farm activities. We find that many head of these families have to work as agricultural wage or seek non-farm work in seasonal or permanent in the city (Ban Keun and Vientiane,) or neighbouring country (Thailand) and work at the building site of the dam.

More than 40% rice fields of the medium-farm and the well-off households were flooded in the rainy season: But, they are also rented out to other farmers, who wanted to take risk of flooding and they also abandoned these flooded rice field, but they have the ability to invest in other economic activities such as fish farming in the irrigated perimeter, shops, transport services, the restaurant, leisure, or non-agricultural activities (threshing, husking, etc.) are also possible for these households. Their revenues still increased.

Today, many hectares of rice fields are abandoned (

Photo **4**). The more well-off farmers are able to invest in other economic activities, but poor farmers face livelihood problems. In the dry season, the quantity of water for irrigation is not enough to supply the whole network downstream of the NM3-irrigation scheme, such as Ban Phonkeo, Haiyon, and Phonhong-Nafay. Also, the concrete diversionary weir schemes that are indirectly connected downstream of the Nam Nyam and Hong Pheng at Ban Napheng, Nakeo and Nongphong face water scarcity. Moreover, the rice fields of poor families are non-irrigable in the dry season, but flood during the rainy season, and they have to search for new rice fields by renting in another region and then have to look for a job in town.

Because of the problem with flooding during the rainy season and the scarcity of water for dry rice production, the GOL has funded the Nam Mang 3 irrigation expansion project thanks to a loan from the Chinese government (The EXIM Bank of China). The project includes new construction as well as upgrading the existing irrigation channels and streams, totalling around 17,700 metres in length, which will link the three reservoirs. The system was then fed by an additional reservoir, Nam Pod, about 7 km from the existing Nam Mang 3 reservoir in the mountainous area of Phou Khao Khouay. The construction phase of the Nam Mang 3 Irrigation Development Project (Nam Pot) began in February 2012 and concluded in November 2013, six months ahead of schedule. The cost of construction totalled some US$8.5 million and was funded by a special low interest loan from the Chinese government and a 5% contribution from the Lao government. The project was able to supply water to about 1,560 hectares of rice paddies in the dry season and more than 2,000 ha

Table 1. Dam operation and water irrigation need.

Dry season (DS)				Rainy season (RS)						DS	
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Dam operation (0-6 hours/day)				12-24 hours/day						0-6 hours/day	
Dry season rice crop											
				Rainy season rice crop							
Vegetable garden											
aquaculture, livestock, and fishing											
Take a bath, wash clothing and others											

Source: Field survey.

in the wet season(Times Reporter February 16, 2015)(Photo 4)

Incompatibility dam operation and irrigation need

The powerhouse of NM3HP mainly runs during the rainy season (12-24 hours per day), and 6 hours per day during the dry season to guarantee 6-GWh of energy production for every month of the year (Table 1).

Moreover, the water discharged from the regulating pond after power generation is sufficient to irrigate less than 2,000 ha in the dry season and not 2,900 ha as initially planned.

In contrast, about 95% of farmers (water irrigation users) need irrigation water during the dry season for rice production (December to April) and 5% during the rainy season. In fact, for the wet rice production or rain fed rice, farmers need irrigation water only at the beginning of the rice season, in May and June (to prepare seedlings), and during the rice flowering period, in September, in order to insure the yield in case drought at the end of the rainy season.

However, the dam operator tries to maximise their electricity generation as much as possible during the rainy season in order to supply the peak energy demand as well as to allow additional energy production to be sold for cash to Thailand. Which is expected to generate annual revenues of US$6 million[26] when the turbine generates electricity 24 hours/day with a maximum operation discharge (9.14 m³/s). The water released thought the small regulating pond and water released immediately to Nam Nyam, Nam Teng and later joining the Houay Hong Pheng via a spillway in the regulating pond and two drops between the first two kilometre concrete channel [see (

Photo **1** and

Photo **2**), causes a large amount of flooding in downstream areas during the rainy season, as I will illustrate later, is the key factor of the inundation and overflow of recipient rivers. However, I did not find any rule or measure in print about dam operation in relation to flood management downstream of the NM3HP. However, there was a hard rain for example in 2010 and 2011 during the monsoon period, while dam operator could freely generate electricity at full capacity and produced a large irrigation channel, there was road damage and about 1,000 rice fields flooded. Including already transplanted rice areas, seedlings, fish ponds, irrigation canals and roads, even flooding homes in the village.

[26] 26-55 Gwh is for export to Thailand with revenues of about US$6 Million expected annually, which include US$1.2 -2.0 million from Thailand. The remaining 67-97 Gwh is for local use

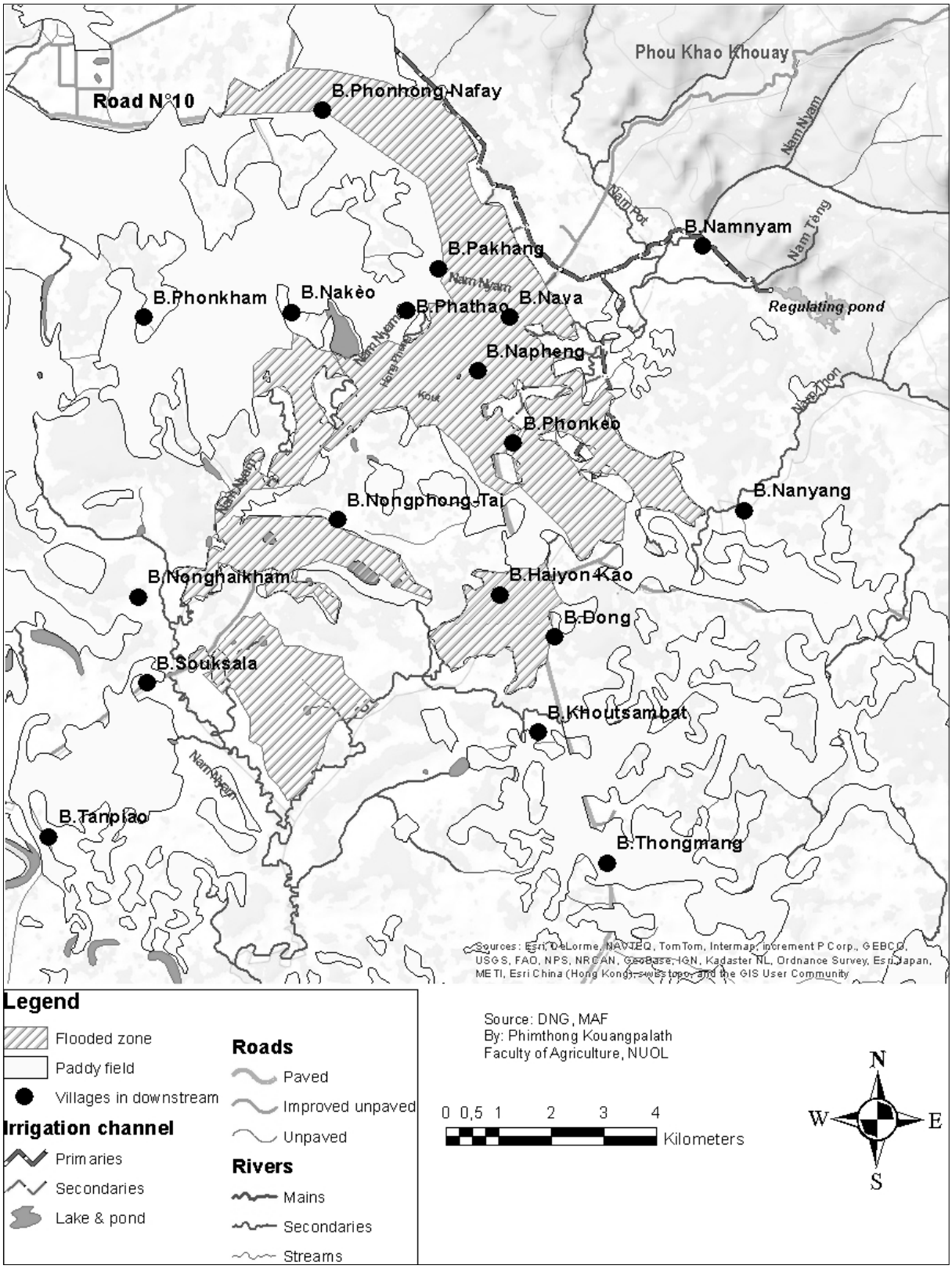
Photo 1. First drop on the concrete channel for water releases to That Nam Dan waterfall and Nam Teng in dry season. (Namnyam, May 2012)

Photo 2. Second drop on the concrete channel for water releases to Nam Nyam in rainy season (Namnyam, August 2010).

Photo 3. Nation road N°10 inundation (Ban Phonkeo, August 2010).

Photo 4. Rice field inundation and abandoned rice field. (Napheng, July 2009).

We would like to illustrate a good practice of the Nam Theun 2 Hydropower project (NT2) concerning flood management measures. In order to avoid NT2 exacerbating the floods, the Nam Theun 2 Power Company (NTPC) has a contractual obligation to cease



Map 1. Flooded areas along the Nam Nyam valley.

power production when pre-defined flood risk levels are reached in the Xebangfai. The NT2 power purchase agreement with the Electricity Generating Authority of Thailand (EGAT) recognizes this obligation, and NTPC do not suffer any penalties for ceasing operation under these circumstances. In 2011, NTPC ceased generation in early July and again on August 2nd, and did not restart for almost a month following some particularly extreme weather in the Khammouane province. The Xebangfai is very significant part of NT2, as it receives the water discharged from the hydropower plant.

Some key cause of flooding

Small regulating pond

The NM3HP is composed of a small regulating pond in the foot hills of Phou Khao Khouay. The full supply level of this pond is 200 masl, with 0.2 km² of concrete dam across the Nam Teng.

This regulating pond has a spillway designed to discharge 22 m³/s into the Nam Teng (tributary of Nam Nyam), and a concrete lined channel of 2 km that has two drops for releasing water to Nam Teng and Nam Nyam in the rainy season (design discharge 11.5 m³/s).

When the powerhouse works at full capacity during the rainy season (24 hours/day), a small regulating pond is used by the dam operator to immediately release a large quantity of water into downstream areas, which may be one of the reasons for rice field flooding along the Nam Nyam valley and along of the national road N°10.

New infrastructures

Moreover, the drainage ways are blocked by newly constructed roads and Nam Mang 3 irrigation channels networks, particularly the national road N°10, located vertically to the river flow. The national road N°10 mostly has a small water gate under the road to drain water in the rainy season (Photo 3).

In August 25, 2013, Deputy Minister of Agriculture and Forestry[27] urged farmers in Vientiane province's Thourakhom district to boost their rice yields by using every last drop of available water. He met with local authorities and farmers at the district's Nam Mang 3 irrigation project to discuss ways to unlock the full potential of agricultural land in the area. He also discussed a resolution for flooding issues with officials from the Ministry of Agriculture and Forestry's Irrigation Department, district authorities, including the district public works and transport office, and staff from the Nam Mang 3 Technical Service Centre (NM3-TSC). Because of the problems in the project design, like channels blocking natural water flow and roads with poor drainage, flooding occurs, with 1,065 ha of paddy fields across 16 villages being covered with water(Times 2013a, 2015).

In August 28, 2013, the district was given permission by higher authorities to install 15 drainage channels under the main road, but only four were built. The director of Publics and transport of the Thourakhom district[28] said the installation of the remaining 11 channels, each of which has a cross section area of 1 m², will help prevent future flooding in the Nam Nyam valley. Farmers in the Thourakhom district grow rice on 9,150 hectares of wet season paddy fields, and 6,000 ha in the dry season. The government has designated the district as a key rice producer for Vientiane and for export, particularly along the Nam Nyam valley area around the irrigated areas of the NM3. Yet recently, about 1,000 ha of these fields flood every year as natural drainage is blocked by the road (Times, 2013b).

DISCUSSION

The concept of this project also plays an important role on impact of hydropower. As in case of the NM3HP, a trans-basin scheme, which diverts water to another basin, located in a floodplain and poorly drained, causes flooding in downstream areas? The regulating pond is also small and is not able to store a large quantity of water or release immediately. The release of water is not regular, which has an impact on the river ecosystems and on biodiversity. If a dam's regulating pond is too small, then when there is a heavy rainfall and electricity generation 24 hours/day as NM3HP, water must be released from the regulating pond. The sudden release of water floods the area below the dam and causes a rapid change in the river. Sometimes the riverbanks become eroded and a loss of aquatic life occurs, like with the Nam Theun 2, Nam Theun-Hinboun, Nam Leuk, etc.The EIA is just an obligation, but in practice, it is not seriously taken into account. As we see, the construction of the NM3HP started before the EIA was completed. Moreover, the final EIA report was completed with good mitigation measures, but those measures were only good on paper. Which is why monitoring the implementation of each hydropower project is very important. Moreover, the EIA should include upstream and downstream impacts, as in the case of NM3HP, there were more 3,000 affected households in downstream areas and 130 affected households upstream. The CA only presents the duration before handing the project over to the government (30 years), the electricity tariff, and the Land Lease Agreement. It does not mention any dam operation rules

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[28] M. Phouvong Xayasombath

or flood management regulation in order to limit the flooding in the floodplain downstream of the dam. Compensation and benefit sharing has only taken place for those impacted upstream (on Phou Khao Khouay) during the construction phase in the form of cash for rice fields, fruit gardens, and others assets. There were three villages[29] impacted during the construction phase and two villages[30] had to resettle in foothills of Phou Khao Khouay. The EDL was in charge of compensation for assets lost in the reservoir area and for the resettlement process and development program. During the operation phase, farmers have to deal with flooding in downstream areas, especially in the Nam Nyam valley, which does not receive any form of compensation from the EDL.

For example, the EDL-Gen, as dam operator, should allocate or share some of their annual budget to maintain the irrigation scheme caused by flooding. Moreover, The EDL-Gen should share their benefits from electricity generation with affected communities along the Nam Nyam valley. Benefit sharing, such as monetary benefit sharing and non-benefit sharing as a long-term arrangement, can help the affected households find other economic activities, as I discussed earlier. A long-term arrangement is necessary because the downstream communities will suffer the negative impacts the whole life of project.

It is possible to set up rules for dam operation, for example: to shut down or reduce the electricity generation, especially when there is a heavy rain, because the regulating pond is small and the areas have poor drainage. Moreover, water releases for hydropower production at NM3HP should consider the downstream benefits and costs to the users of the water for irrigation, and the impacts of flooding.

It would be very beneficial to have a policy for “irrigated land allocation” for farmers who do not have irrigated paddy fields in the dry season or who have uncultivated paddy fields due to flooding in the rainy season. Mostly, well-off households have irrigated paddy fields and benefit from the project. Even with the hydropower project, the poor households will be still poor, which only increases inequality in the village.

CONCLUSION

The NM3HP is a small dam, but it has an important role in power generation (both for export and domestic consumption) and irrigation. The powerhouse of the NM3HPmainly runs during the rainy season (12 - 24 h per day), and 6 hours per day during the dry season in order to guarantee 6-GWh of energy production for every month of the year. Moreover, the water discharged from the regulating pond after power generation is sufficient to irrigate less than 2,000 ha in the dry season and not 2,900 ha as initially planned. In contrast, about 95% of the irrigation water is needed during the dry season for the rice cultivation (December to April) and 5% is needed during the rainy season. As a result of the project, the downstream farmers often face serious problems when their rice fields flood in the rainy season due to overflowing water from the dam. For example, in 2010 and 2011, about 1,000 of rice fields were covered with water.

Based on the field survey, the areas of irrigated rice during the rainy season increased around 5% over the past five years, but farmers lost more than 40 % of their paddy fields in each rainy season. Some of farmers abandoned their fields and turned to other activities. In this way, vulnerable families encounter more livelihood difficulties. Yet, the irrigation scheme does not have enough water in the dry season for the whole canal network, especially downstream of the canals. This causes some conflict among the water users during the dry season. Moreover, the cultivated rice in the dry season leads to high production costs due to the purchase of improved seeds, chemical fertilizers, and paying irrigation fee seven tough the price of rice in the dry season is lower than in the wet season. Also, in the dry season, the harvest period is risky due to it is also being the beginning of the rainy season, which often can lead to crop losses from heavy rains. The dam operator does not support a budget for irrigation canal maintenance needed because of flooding each rainy season.

Benefit sharing under the form of compensation for farmers has only taken place for the impacts to upstream communities during the construction phase, but the farmers that now face flooding in downstream areas, do not receive any monetary or non-monetary benefit sharing from the dam operators.

The dam operators, for both hydropower and irrigation as in the case of NM3HP,do not really fully consider the downstream benefits and costs to the irrigation water users and the impacts of flooding. The operating system for the dam does not seem to be transparent, making it difficult to take into account the multiple benefits and costs to different stakeholders in this diversion project.

Positive downstream impacts mainly involve villagers with irrigated paddy field and significant available capital, those who can seize investment opportunities. In contrast, poor families are more vulnerable to changes in environmental, technical, economic, or social contexts. Lacking capital, they are prone to having to endure

[29]Ban Vangheua, Ban Phoukhaokhouay-Kao and Ban Phoukhaokeo

[30]Ban Phoukhaokhouay-Kao to new village namely Phoukhaokhouay-Mai and Ban Phoukhaokeo joined with existing village "Ban Nanyang. There were 166 families resettlers.

negative effects because of their limited capacity to adapt. Thus, the project contributes to increased socio-economic differentiation between downstream villagers.

This study demonstrated the need to consider the quality of EIA and project design of such multipurpose projects due to the problems of managing the different needs of different uses (hydropower and irrigation) and users (the multiple stakeholders within communities such as upstream/downstream irrigators), between agricultural communities and others, and between private dam operators and public authorities.

The future challenge will include utilizing dams and reservoirs in order to manage global water resources as a part of the economic development of each nation. The negative effects of the dam can be minimized by planning and designs that incorporate public involvement and input in the early stages of the process. It is recommended that the government, by adopting proper procedures prior to the project's implementation, increase the level of community participation.

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