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Coping with resettlement: A livelihood adaptation analysis in the Mekong River basin

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ABSTRACT

A major driver of change in the Mekong River basin relates to hydropower development and the consequent changes in landscape and natural resource access regime that it induces. In this paper, we examine how the livelihoods of resettlers evolve following resettlement, and examine the determinants of that process. The study takes place in the context of the Theun Hinboun Expansion Project in Lao PDR. Based on longitudinal household surveys conducted before resettlement as well as 1, 2, and 3 years after resettlement, we identify the process of livelihood adaptation in resettled communities. Results show varying capacity to absorb shocks and cope with change even within a small village with seemingly equal conditions. Our results suggest that a more detailed understanding of this adaptation process is key to improving interventions for rebuilding the livelihoods of those resettled by development projects in rural areas.

1. Introduction

A major driver of change in the Mekong River basin relates to hydropower development and the consequent changes in landscape and access to natural resource access regime that such development induces. Over 130 large-scale hydropower dams[1] are either operational, under construction, or planned in the Lower Mekong Basin alone (Yermoli, 2009).

Hydropower development has historically been and will continue to be a highly contentious issue in the region. While it continues to be a cost-effective mean of producing large amounts of renewable energy for the region, the environmental and social consequences of hydropower development have never ceased to attract attention. As such, it has been a popular research subject for both natural and social scientists, and has generated a rich literature (see for example, Bakker, 1999; Jacobs, 1999; Mitchell, 1998; Molle et al., 2009; Suhardiman et al., 2012). However, after decades of research, the discussion has rarely evolved beyond sounding alarms on the negative consequences of dams on the environment and local populations, and highlighting the flawed processes and power relations in which development decisions are made, including those pertaining to the design and extent of appropriate compensation packages for those adversely impacted by hydropower development.

In an early phase of the debate in the region, the emphasis was placed on the needs for comprehensive social and environmental impact assessments, and for more transparent and informed planning processes (Keskinen, 2008; Baran and Myschowoda, 2009; Kummu and Sarkkula, 2008). More recently, the nature of the argument has shifted to transboundary cost-benefit and trade-off analysis with the "water-energy-food nexus" serving as a conceptual framework (Ziv et al., 2012; Orr et al., 2012; Kuenzer et al., 2013; Keskinen et al., 2016; Winemiller et al., 2016). The key elements of the debate thus gradually shifted from an emphasis on the threat on endangered species and biodiversity (Dudgeon, 2000), to fisheries production and associated economic benefits (Baran and Myschowoda, 2009), and finally to food and nutrition security of the local populations (Orr et al., 2012; IFReDI, 2012).

At the core of this evolution lies a desire to delay hydropower development, if not to stop it entirely. This message culminated in the 2010 *Strategic Environmental Assessment for Hydropower on the Mekong Mainstream*, by the Mekong River Commission, which recommended a moratorium on mainstream hydropower develop-

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[1] Large-scale hydropower refers to those with an installed capacity of 10 megawatt or higher.

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ment for ten years, while key areas of uncertainty are being resolved by scientific and technological innovations to reduce the magnitude of negative impacts (ICEM, 2010).

Meanwhile, hydropower development continues unabated with over 30 large dams either under construction or soon to be completed in the Mekong River system and local populations continue to be impacted by such development. There is thus a crucial and continuing need to better understand the nature and extent of livelihoods development necessary for mitigating the negative impacts and assisting the affected communities to recover and build on the changes brought about by the development (Dugan et al., 2010).

Hydropower dams have already significantly altered the livelihoods of millions of individuals and households around the world.[2] Assessing the impacts of development projects on resettlers has been a fertile ground of research. While a limited number of studies have documented improved living conditions for households involuntarily resettled by hydropower development (Agnes et al., 2009; Galipeau et al., 2013), the bulk of studies have shown that resettled households generally experience a sharp deterioration of living conditions and reduced income.[3]

Researchers seeking to understand the socio-economic impacts of hydropower development on resettled households face a number of methodological challenges when estimating changes in socio-economic and livelihood conditions before and after resettlement (Galipeau et al., 2013). The most common methodology used is a recall method in which targeted households are asked to assess conditions as they are at the time of the study after resettlement, and as they remember them being before resettlement. This approach may be subject to quantitative errors as interviewed participants may not sufficiently remember how conditions were before resettlement. The extent of this challenge intensifies as more time elapse between the timing of resettlement and the timing of the study. Kura et al. (2014) have addressed this significant difficulty with the conduct of data collection both before and after resettlement with an identical group of (yet to be and then of actually) resettled households.

Other researchers have also recognized that the full impact of resettlement on livelihoods can only be understood many years after resettlement has taken place. For example, Sunardi et al. (2013) examines the livelihoods of resettled households in Indonesia 25 years after resettlement. Souksavath and Maekawa (2013) do so in Lao PDR 36–45 years after resettlement took place as a result of the Nam Ngum 1 project.[4]

Notwithstanding the difficulties alluded to above, comparing livelihood conditions at two points in time – before and one or some years after resettlement – offers important insights as to how resettled communities may have been impacted by development projects. However, it does not allow for a quantitative understanding of the dynamic process of change in livelihoods, and of the possible determinants of these changes as livelihood adaptation (rehabilitation) processes may differ across resettlers.

An important limitation in the resettlement literature pertains to its emphasis on documenting negative impacts and inadequacy of compensation for lost assets and livelihoods, rather than understanding coping strategies and adaptation of the resettled households in a new environment. Cernea (1997, 2003) and Scudder (2012) also argue for the need for shifting the emphasis of resettlement programs, from restoring the lost income back to the state before resettlement, to further development of the livelihoods of affected people above the baseline, through additional investments.

This study aims to elucidate heterogeneity of adaptation strategies within a resettled community and identify entry points for facilitating their longer-term livelihood development. While we do not frame the study within the broader hydropower debate, we hope to bring the debate closer to the reality of trade-offs as experienced by affected households and to inform future direction of hydropower governance debate towards solutions and reconciliation.

The study documents the dynamic process of change in livelihood strategies of households in 4 villages previously located along the Nam Gnouang River in Lao PDR. These households were relocated to a single resettlement site constructed adjacent to the new Nam Gnouang Reservoir which took the place of the river. For this purpose, we conducted longitudinal surveys of 100 resettled households before resettlement took place, and then with the same 100 households 1, 2, and 3 years after resettlement. Kura et al. (2014) have documented the impact on livelihoods 1 year after resettlement. In the current paper, the interest lies in the dynamics of livelihood adaptation. To our knowledge, it is the first study of this nature in the existing literature.

A first research question pertains to assessing how livelihood adaptation takes place over time (trajectory of adaptation). A second research question of interest is to assess the determinants of those changes. Given the multiplicity of adaptation trajectories, it is of importance to identify household characteristics and environmental factors which determine the pursuit of any given adaptation trajectory. We believe that the analysis may provide important insights for the design of resettlement compensation mechanisms and livelihood programs.

The background of the study and the methodological approach are discussed in the next section. Results and policy implications are presented in Section 3. Further avenues of research are suggested in Section 4.

2. Background, data, and method

2.1. Study site

The study site is located within the Nam Theun-Nam Kading watershed, a sub-basin of the Mekong River system in the Khammouane and Bolikhamxay provinces of central Lao PDR. The Theun-Hinboun Expansion Project (THXP) implemented by the Theun-Hinboun Power Company (THPC) is located on the Nam Gnouang River. It includes the construction of a dam, the creation of a reservoir, and the resettlement of 12 and 23 villages located upstream and downstream of the dam respectively (Norplan, 2008a; THPC, 2013). Significant investments from the hydropower company have gone into rebuilding the livelihoods of the displaced communities (Norplan, 2008b).

The 4 villages of interest for this study were located upstream of the dam and resettled in late 2011 to a new site known as Keosenkham. The resettlement site is located in proximity to the new reservoir and to the original villages (Fig. 1). This proximity aimed to allow the resettled villagers to access the reservoir for economic activities, and to maintain some level of continuity with the previous lifestyle and livelihoods. However, within the resettlement site, Phonkeo and Sensi villagers were allocated residential

[2] Estimated number of resettled individuals varies between 40 and 80 million (World Commission on Dams, 2000) and is growing.

[3] Bui and Schreinemachers (2011) has estimated a 66% reduction in net household income resettled by the Son La Hydropower Development project in Viet Nam. Other empirical studies reaching conclusions of a similar nature include Bui et al. (2013), Cernea (2003), Kura et al. (2014), Rampisela et al. (2009), Scudder (2005, 2012), Souksavath and Nakayama (2013), Tilt et al. (2009), and Webber and McDonald (2004).

[4] Other papers of this nature include Akca et al. (2013), Karimi and Taifur (2013), Manatunge and Takesada (2013), Matsumoto et al. (2013), Sisinggih et al. (2013), Souksavath and Maekawa (2013), and Yoshida et al. (2013).

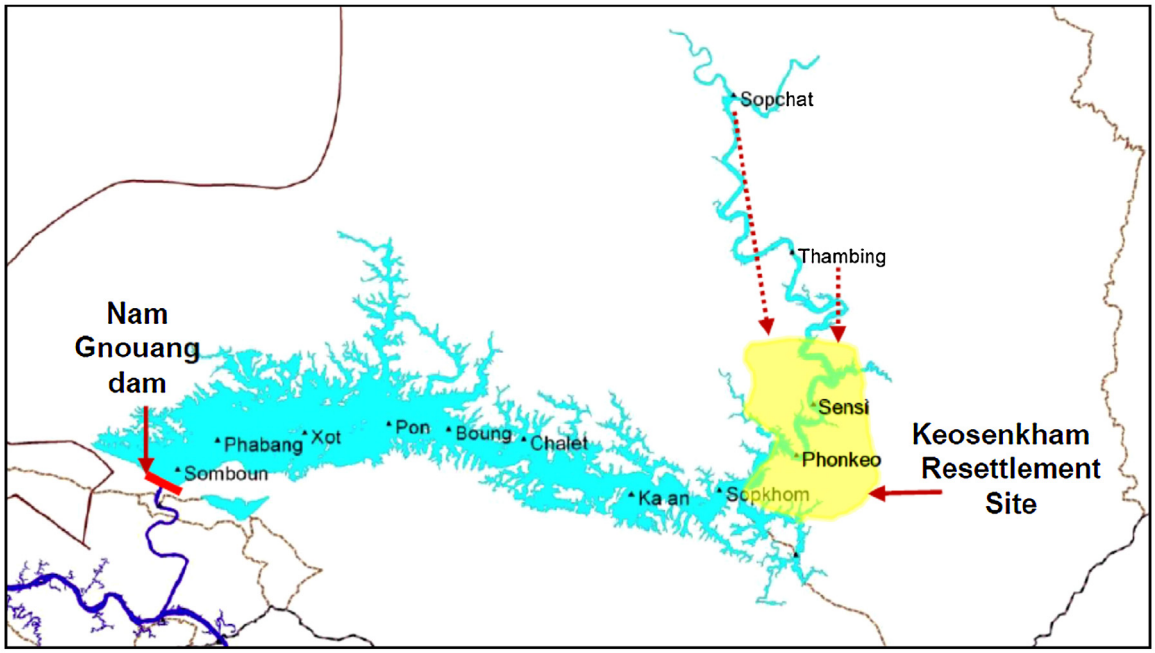

Fig. 1. Location of villages and resettlement site (based on THPC, 2011, with modifications for clarity).

areas closer to the reservoir and of the original villages. On the other hand, Sopchat and Thambing villagers were relocated farther away from the reservoir (Katus, 2012).[5]

In 2011, the 4 villages comprised 180 households with a combined population of approximately 1210 individuals. The study team randomly selected 100 households (55% of the total number of households) proportional to the number of households in each village (Table 1).[6] The number of interviewed households in each village ranged from 21 (Sensi) to 30 (Phonkeo).

The resettled households were individually compensated by THPC for tree crops and other non-moveable assets. In addition to allowances (including food and small livestock), households received benefits in the form of housing (each household received a house, homestead garden, and farmland of 1.5 ha on average), facilities (such as school and health clinic) and services (such as electricity and wells) after moving to Keosenkham (Sparkes, 2014). THPC has also set annual income targets for the affected households, and considers it as its formal obligation to provide support for livelihood developments until these targets are achieved for all affected households. To help the affected families reach this target, a variety of in-kind support is provided to them in forms of agricultural inputs, organizational support, and skills training. The target for resettlement villages in 2012 was 22.6 million Kip (or the equivalent of USD2,825 using the exchange rate of 2012).[7]

2.2. Data collection and survey

A series of four longitudinal household surveys were conducted. The first survey was carried out in April 2011 before resettlement was initiated. A second survey took place in September 2012, approximately 15 months after resettlement was completed (referred to as Year 1 to indicate 1 year after resettlement). Kura et al. (2014) showed that access to domestic water supply as well as water consumption had significantly improved 1 year after resettlement, while livelihoods had for the most part been adversely impacted by the conversion of the Nam Gnouang River into the hydropower dam reservoir. Reductions in cultivated area, the loss of riverbank gardens as well as of grazing land mostly explain this adverse impact. In particular, the sources of income had become concentrated to much fewer options than before resettlement.

In order to assess the process of livelihood adaptation following resettlement, the same set of households in Keosenkham participated in two additional surveys. These took place in December 2013 and in December 2014 (referred to as Year 2 and Year 3 to indicate 2 and 3 years after resettlement respectively). Of the 100 households interviewed before resettlement, 92 households were interviewed for 2 follow-up surveys as 8 households emigrated permanently outside Keosenkham between 2012 and 2014. Only the data of these 92 households are used in the analysis below.

Quantitative as well as qualitative information about economic activities and livelihood portfolio of each household was collected. A set of variables was developed to understand the relative importance of various activities contributing to household income and livelihoods assets. Additional qualitative information about the changes in livelihood activities and the governance regime of natural resource assets were documented during focus group discussions to help interpret the quantitative results. The nature of key quantitative variables is presented in Table 2.

2.3. Data analysis and methodological approach

Concepts of livelihood adaptation and determinants of coping strategies have been well framed and explored in the literature on environmental disturbances and disasters.[8] These provide useful empirical data and framework for analysis on the vulnerability

[5] As indicated in Fig. 1, other villages were also resettled as a result of the development project. However, these other villages had already been resettled to locations further away from the reservoir by the time this study had been initiated. The timing and location of the resettlement of the 4 villages included in this study enabled a longitudinal survey before and after resettlement.

[6] For purpose of facilitating resettlement, THPC assigned an identification number to each household. The survey team randomly selected a sample of households from this set of numbers.

[7] Lao Kip is the currency of Lao PDR.

[8] These include Adger (2010), Below et al. (2012), Kurukulasuriya and Rosenthal (2013), Osbahr et al. (2010), Paul and Routray (2011), Pelling (2011), and Prowse and Scott (2008).

Table 1
Number of Households Resettled and Interviewed.

Village	Number of HH[a] resettled	Number of HH interviewed before resettlement	Number of HH interviewed 3 years after resettlement
Phonkeo	54	30	28
Sensi	38	21	19
Sopchat	49	27	24
Thambing	39	22	21
Total	180	100	92[b]

[a] HH: Households.
[b] By the time of the third and fourth survey conducted in December 2013 and 2014 respectively, 8 households (from the original 100 surveyed households) had permanently left Keosenkham.

Table 2
Key Quantitative Livelihood Variables.

Variables/Unit	Definition
Value of fisheries (Kip/HH/year)	Total annual value of fisheries based on monthly fish catch reported by respondent. In addition to cash income, this variable includes imputed income defined as the market value of fish retained for home consumption
Fish catch (kg/HH/year)	Reported quantity of fish catch per fishing trip per month, then aggregated over the year
Value of agriculture (Kip/HH/year)	Total annual cash income plus imputed income from agriculture
Value of livestock production (Kip/HH/year)	Total annual cash income plus imputed income from small livestock and poultry production. It does not include large livestock (cattle and buffalos) considered as longer-term assets and not regularly sold for income
Number of large livestock (animals/HH)	Number of cows and buffalos held by a household at the time of the survey
Number of pigs (animals/HH)	Number of pigs held by a household at the time of the survey
Valueof forest products (Kip/HH/year)	Total annual cash income plus imputed income from timber and non-timber forest products (NTFP)
Non-farm income (Kip/HH/year)	Total annual cash income generated from activities off own farm
Total river/reservoir-based income (Kip/HH/year)	Total annual cash income from activities that depend on access to river or reservoir including: agriculture irrigated with river/reservoir water, flood recession agriculture, river bank gardens, fisheries, NTFP collection from wetlands and riverine forests, and river/reservoir transportation
Total value of all economic activities (Kip/HH/year)	Total value of all economic activities
Total farmland (hectare/HH)	Total area of land used for farming by a household in a given year
Irrigated farmland (hectare/HH)	Total area of farmland that is irrigated, including pumping from wells, river/reservoir water, flood recession agriculture, and river bank gardens
Total investment in agriculture, livestock, fisheries (Kip/HH/year)	Total household expenditure on purchase of equipment for agriculture, livestock, and fisheries, including construction of barns and storage facilities, purchase of boats and engine
Expenditure on agriculture and livestock activities (Kip/HH/year)	Total household expenditure related to agriculture and livestock activities, including, fuel, feed purchase and transportation of animals by boats
Transportation assets	Total number of boat, bicycle, and motorcycle owned by a household
Importance of river/reservoir-based income (%)	Percentage of income derived from river/reservoir-based activities (irrigated agriculture, fisheries, and wetlands) relative to the total value of all economic activities
Importance of remittances (%)	Percentage of remittances received by households relative to the total value of all economic activities
Importance of forest products (%)	Percentage of income from collecting forest products relative to the total value of all economic activities
Crop home consumption rate (%)	Percentage of all crop produced by a household consumed at home

HH: Households.

and adaptive capacity of populations affected by displacement. The livelihoods approach provides a useful framework for describing the complex nature of economic activities in which rural farming communities are engaged, and their relationship to the social-ecological systems in which they operate (Ellis, 2000; Scoones, 1998, 2009).

We carried out a series of statistical analysis to obtain a typology of household livelihood, of livelihood trajectories over time, and of household characteristics as possible determinants of these identified trajectories.

2.3.1. Typology of household livelihood

A factor analysis (or principal component analysis) was first conducted to develop a household livelihood typology using the entire 4 years of household survey samples as a single dataset (Michielsens et al., 2002; Kobrich et al., 2003; Tittonell et al., 2010). Factor analysis was conducted using 16 variables representing both structural and functional attributes of households that characterize their asset levels and livelihood strategies. These variables include all variables in Table 2 except for "Total River/Reservoir-Based Income" and "Total Value of All Economic Activities" which are themselves aggregation of other variables. All variables were normalized before analysis (Milstein et al., 2005). Using Varimax rotation with Kaiser normalization, five factors or principal components (with Eigenvalue greater than 1) were identified.

Second, households were clustered according to the 5 identified factors using a hierarchical clustering technique (Ward's methods, in Ward 1963) to estimate the number of clusters. A *k*-means clustering method was used to obtain the cluster centers. The clusters were compared for significant difference in their 16 initial variables, using one-way ANOVA and post hoc tests (Game and Howell in SPSS, 2007). Five clusters of households were thus identified.

2.3.2. Identification of trajectories

With the households grouped into livelihood clusters, we then identify whether or not and how households move from livelihood

Table 3
Total Economic Value of Economic Activities per Household (Million Kip per household per year).[a]

Village	Before resettlement	Year 1	Year 2	Year 3
Phonkeo	56.0 ± 42.2	8.6 ± 7.3	24.2 ± 21.8	22.3 ± 15.9
Sensi	48.8 ± 30.1	6.3 ± 8.2	16.3 ± 10.8	22.6 ± 23.1
Sopchat	32.8 ± 16.4	3.9 ± 4.0	15.5 ± 15.0	18.2 ± 15.4
Thambing	38.7 ± 23.7	2.9 ± 1.9	14.6 ± 10.9	13.8 ± 9.5
Total	44.5 ± 31.4	5.6 ± 6.3	18.1 ± 16.2	19.4 ± 16.5

[a] In each cell, the first number is the household average, and the second number is the standard deviation. Kip is the currency of Lao PDR. At the time of the study, the exchange rate averaged 8,000 Kip to 1 US dollar.

cluster prior to resettlement to the same or alternative clusters following resettlement. This analysis allows us to identify coping strategies following resettlement shocks and adaptation. The main trajectories were identified by tracking the households in different livelihood strategy clusters each year. Households following the identified trajectories are compared for their differences in explanatory variables using non parametric test (Kruskal-Wallis) and post hoc tests (Game and Howell in SPSS, 2007).

2.3.3. Identification of determinants

Finally, we also use the livelihoods approach (Scoones, 1998) to frame the analysis of the determinants of livelihood adaptation trajectories, where assets are considered as main indicators of household capability to cope with stress and shocks and are thus key determinants of their strategies to seek livelihood security. Determinants were grouped into 4 types of livelihood asset categories and were tested for their relevance, namely: human capital, social capital, financial capital, and natural capital (see Appendix A). Physical capital, such as access to roads, electricity, wells, and communal facilities, was not included given its relative homogeneity across all households.

3. Results

3.1. Descriptive analysis[9]

Before resettlement, households in the two villages (Phonkeo and Sensi) located closer to the resettlement site and to the provincial town, were on average earning significantly higher income than households in Sopchat and Thambing (Table 3). As shown in Table 3, Year 1 was characterized by a significant reduction in overall income. Year 1 is also characterized by a large reduction of income from agriculture (to less than 10% of that before resettlement), and a notable increase in relative dependence on fisheries as the largest income share across all villages (Table 4). Kura et al. (2014) have presented and discussed the changes in livelihood and income portfolio 1 year after resettlement in detail.[10]

Year 2 is characterized by a significant recovery in overall income (Table 3). This increase is mostly explained by a modest recovery of income from agriculture and an increase in the importance of non-farm wage labor and remittances (Table 4).

Three years after resettlement, overall income continues to recover albeit at a slower pace than from Year 1 to Year 2. Overall income has recovered to 43% of its level before resettlement.

3.2. Statistical analysis

As indicated earlier, the statistical analysis includes identifying a typology of household livelihood, and estimating livelihood trajectories over time. It concludes with assessing the determinants of these identified trajectories. Each is presented below.

3.2.1. Typology of household livelihood

Five factors (principal components) were identified from 16 variables presented in Table 2. These five factors represent the main components of a portfolio of different economic activities that each sampled household is engaged in. These factors explain 61.4% of the total variance in income (Table 5). As shown in Table 5, the 5 factors identified were labeled as crop, fish, cash, livestock and forest.[11]

Using these factors, sampled households were grouped into 5 different clusters each with different livelihood strategies. Fig. 2 shows the cluster centers mapped across the 5 factor axes to visualize the characteristics of each cluster. These are:

- Cluster 1: Diversified livelihoods/well-off households—Diversified overall activity portfolio based on both farm-based production and natural resources, with surplus produce for sale, and high level of financial assets.
- Cluster 2: Diversified livelihoods/low-output households—Diversified overall activity portfolio based on both farm-based production and natural resources, primarily for subsistence, low outputs and financial assets.
- Cluster 3: Natural resource dependent households—High level of effort in continuing livestock raising,[12] moderately high emphasis on fishing and forest products, low crop farming primarily for subsistence.
- Cluster 4: Non-farm wage dependent households—Heavily dependent on cash income from wage labor and remittance from relatives, low emphasis on natural resource-based activities, and higher level of transportation assets held than other clusters.
- Cluster 5: Fishing dependent households—High level of emphasis on fishing, with minor effort in crop farming and livestock.

These clusters are illustrated in Fig. 2 below.

3.2.2. Livelihood trajectories

Before resettlement, Cluster 1 was the dominant household livelihood strategy (65% of the total sample of 92 households). It was followed by Cluster 2 (25% of households). Clusters 4 and 5 were also present but in small numbers (see Appendix B). Immediately following resettlement, Cluster 1 essentially disappeared, as all households lost most of their farm income whereas Cluster 2 and Cluster 5 grew in number. Perhaps more interestingly, Cluster 3 households emerged. However, in Year 2, all but 3 households (3%) disappeared from Cluster 3, and Cluster 4 households increased almost 20 fold. In Year 3, Cluster 2 becomes the dominant category, followed by Clusters 4 and 5.

Adaptation trajectories are illustrated in Fig. 3.

Four main trajectories are identified. Two of the trajectories show coping strategies of families who were Cluster 1 before resettlement, by concentrating their investment in reservoir fishery (Cluster 5) and livestock (Cluster 3) in Year 1 to maximize income in the short term, and then some shifting into non-farm income

[9] All monetary values in this analysis are measured in 2014 real values using the consumer price index in Lao PDR for 2011, 2012, and 2013 (World Bank, 2015).

[10] However, it is important to note that the detailed figures presented here are different from those presented in Kura et al. (2014). This arises because statistics from 92 households are presented here in lieu of 100 households in Kura et al. (2014) and because all income values here are presented in real values of 2014.

[11] In this type of factor analysis, the variables presented in Table 5 are generally referred as "component loadings". For example, the "fish" component has 3 component loadings with values above 0.85 while the "livestock" component has 2 component loadings with a value of 0.56 and 0.78.

[12] Livestock raising is considered here as a natural resource-based activity as the animals need access to natural grazing areas in the forest and wetland areas.

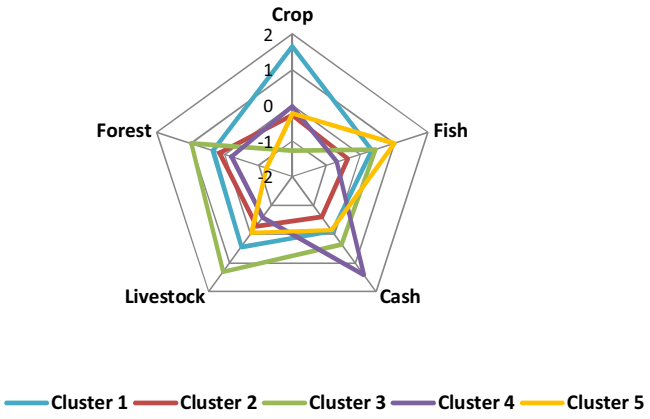

Fig. 2. Households Clusters by Livelihood Strategies.

(Cluster 4) while others becoming more specialized in fishing (Cluster 5) through Years 2 and 3. The two other trajectories illustrate that most of Cluster 2 households and some Cluster 1 households both suffered the blunt of lost farming income after resettlement, and continued fairly diverse activities with low level of investment (Cluster 2), and in Year 2 some turning to wage labor and remittances from relatives (Cluster 4) while others kept the same strategy (Cluster 2). Livelihood strategies in Year 3 are concentrated into Clusters 2, 4 and 5, with overall lower returns than before resettlement.

3.2.3. Determinants of trajectory

The interest is to identify household attributes which may explain the selection of adaptation trajectories. For this purpose and unless otherwise mentioned, we use Year 3 survey data collected at the end of the study period.

Wealth status before resettlement appears to be a significant determinant of households following different adaptation trajectories. Households remaining in Cluster 2 (diversified/low output) throughout the period of analysis had the lowest level of income and of financial capital (land and large livestock) before resettlement, and received less cash compensation from the company than households following other adaptation trajectories. Households that shifted from Cluster 1 (Diversified/well-off) to Cluster 2 had moderate income and financial capital level before the resettlement, but reported receiving less cash compensation than those who shifted to Cluster 4 (Non-farm wage dependent) or Cluster 5 (Fisheries dependent) in Year 3. Trajectory from Cluster 1 to Cluster 4 is clearly characterized by much higher amount of remittance received over this period than the households following other adaptation trajectories (Table 6).

Another notable difference is the level of education and the household labor force across these 4 trajectories. Younger, less educated households did not change their livelihood strategy over time while more educated households are more likely to have shifted strategies between Year 1, Year 2, and Year 3.

Village of origin seems to act as a strong determinant of longer-term trajectories, as more households from Phonkeo village (10 out of 28) is found in Cluster 4, 3 years after the resettlement. On the other hand, more households from Sopchat village (11 out of 24) have remained in Cluster 2 strategy throughout the study period. Tambing village has a high proportion (10 out of 21) of households experiencing the trajectory from Cluster 1 to Cluster 2.

Distance to reservoir seems to have made a significant difference in the choice of shorter-term coping strategies, but has less importance in longer-term strategies 3 years after the resettlement. Only exception is for the households that remain in Cluster 2 throughout the study period, who live farther distance away from the reservoir than the households in other 3 trajectories.

4. Discussion and policy implications

4.1. Coping strategies immediately following resettlement

When faced with risks and shocks, individuals and communities manage their resources and livelihoods, prioritizing between elements of the production, consumption, and ecological systems in which they operate (Adger et al., 2009; Osbahr et al., 2010).

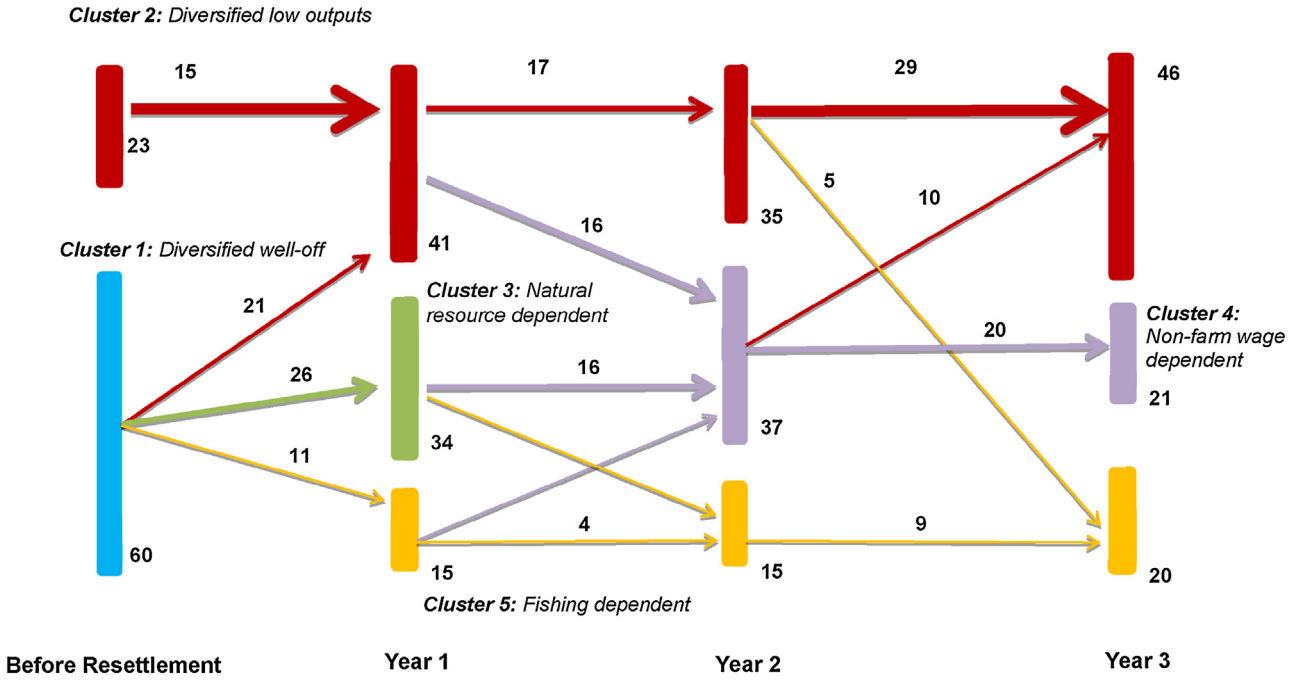

Fig. 3. Adaptation Trajectories.

Table 4
Contribution of Activities to Total Income Before and After Resettlement (Million Kip per household per year).[a]

Activities	Phonkeo	Sensi	Sopchat	Thambing	All villages
Agriculture	22.0 ± 15.8 (39%)	20.8 ± 12.2 (43%)	13.2 ± 8.3 (40%)	15.4 ± 8.5 (36%)	18.0 ± 12.2 (40%)
BR	2.8 ± 3.0 (18%)	1.9 ± 2.1 (15%)	1.2 ± 1.1 (16%)	1.1 ± 0.8 (13%)	1.8 ± 2.1 (16%)
Y1	4.6 ± 2.2 (19%)	5.9 ± 5.2 (36%)	5.6 ± 6.9 (36%)	6.7 ± 6.1 (46%)	5.6 ± 5.3 (31%)
Y2	5.7 ± 4.0 (25%)	10.6 ± 15.3 (47%)	3.9 ± 1.9 (21%)	5.1 ± 4.6 (37%)	6.1 ± 7.9 (31%)
Y3					
Fisheries	9.4 ± 8.0 (17%)	10.6 ± 6.4 (22%)	9.9 ± 6.1 (30%)	11.4 ± 6.7 (28%)	10.2 ± 6.9 (23%)
BR	6.8 ± 5.7 (44%)	6.5 ± 4.5 (51%)	3.5 ± 5.4 (47%)	5.2 ± 6.6 (64%)	5.5 ± 5.7 (50%)
Y1	2.9 ± 4.7 (12%)	3.8 ± 5.2 (23%)	2.2 ± 3.2 (14%)	2.9 ± 6.1 (20%)	2.9 ± 4.8 (16%)
Y2	3.6 ± 6.2 (16%)	3.9 ± 4.9 (17%)	3.1 ± 5.5 (17%)	3.1 ± 5.8 (23%)	3.4 ± 5.6 (18%)
Y3					
Forestry	11.0 ±18.1 (20%)	6.6 ± 6.9 (6%)	5.2 ± 5.9 (16%)	5.1 ± 6.3 (26%)	7.2 ± 11.4 (16%)
BR	0.9 ± 0.7 (6%)	1.1 ± 1.2 (8%)	0.9 ± 0.8 (12%)	0.8 ± 0.6 (9%)	0.9 ± 0.8 (8%)
Y1	0.9 ± 0.8 (4%)	0.6 ± 0.6 (4%)	1.7 ±1.5 (11%)	0.5 ± 0.4 (3%)	0.9 ± 1.0 (5%)
Y2	0.6 ± 0.4 (3%)	0.8 ± 0.7 (3%)	0.8 ± 0.9 (4%)	0.8 ± 0.6 (5%)	0.7 ± 0.6 (4%)
Y3					
Non-farm	11.5 ± 18.0 (21%)	9.1 ± 13.3 (19%)	1.1 ± 2.2 (3%)	4.5 ± 16.3 (12%)	6.7 ± 14.4 (15%)
BR	1.8 ± 3.9 (12%)	2.3 ± 6.5 (18%)	1.1 ± 2.6 (14%)	0.1 ± 0.5 (2%)	1.3 ± 3.9 (12%)
Y1	9.2 ±19.2 (38%)	2.3 ± 3.6 (14%)	1.0 ± 2.5 (6%)	2.3 ± 4.7 (16%)	4.0 ± 11.4 (22%)
Y2	5.0 ± 7.7 (22%)	4.0 ± 10.0 (17%)	5.7 ± 10.8 (32%)	2.7 ± 5.4 (20%)	4.4 ± 8.6 (23%)
Y3					
Livestock	2.2 ± 2.2 (4%)	1.7 ± 1.5 (4%)	2.5 ± 2.8 (8%)	2.2 ± 3.6 (6%)	2.2 ± 2.5 (5%)
BR	2.8 ± 5.0 (18%)	1.0 ± 1.0 (8%)	0.7 ±1.7 (10%)	0.9 ± 1.2 (12%)	1.5 ± 3.1 (13%)
Y1	1.1 ± 1.8 (4%)	1.0 ± 1.6 (6%)	0.1 ± 0.3 (1%)	0.2 ± 0.3 (1%)	0.6 ±1.3 (3%)
Y2	2.8 ± 4.8 (21%)	1.5 ± 3.2 (6%)	0.7 ± 1.0 (4%)	0.4 ± 0.6 (3%)	1.4 ± 3.2 (7%)
Y3					
Remittances	0 (0%)	0 (0%) 0 (0%)	1.1 2.8 (3%) 0 (0%)	0 (0%) 0 (0%)	0.3 ± 1.5 (1%)
BR	0.3 ± 1.0 (2%)	2.6 ± 5.1 (16%)	5.0 ± 12.0 (32%)	2.1 ± 3.0 (14%)	0.1 ± 0.6 (1%)
Y1	5.6 ± 8.6 (23%)	2.0 ± 4.3 (9%)	3.9 ± 10.5 (22%)	1.8 ± 2.9 (13%)	4.0 ± 8.2 (22%)
Y2	4.7 ± 8.2 (21%)				3.3 ± 7.4 (17%)
Y3					

[a] The first number is the average absolute vale of income from each economic activity across households, and the second number is the standard deviation. The number in parenthesis is the contribution of the economic activity to total income.

Table 5
Five Factors and their Component Loadings.

Variables	Factors				
	1: Crop	2: Fish	3: Cash	4: Livestock	5: Forest
Number of large livestock	0.215	0.169	**0.516**	0.395	0.077
Number of pig	0.423	−0.042	0.114	**0.555**	−0.115
Total land size	**0.705**	0.161	−0.04	0.098	0.352
Irrigated land	**0.734**	0.175	−0.72	−0.060	0.259
Investment in farm equipment	−0.55	−0.42	−0.106	0.125	**−0.710**
Cost agriculture and livestock	−0.510	0.255	0.130	0.416	0.388
Transportation assets	−0.280	0.066	**0.659**	0.055	0.063
Fish catch	−0.012	**0.908**	0.071	0.156	−0.059
Value from fisheries	0.313	**0.864**	0.033	0.117	−0.055
Value from livestock	0.033	0.070	−0.011	**0.783**	−0.104
Value from agriculture	**0.735**	0.061	0.038	0.203	0.068
Non-farm income	0.263	−0.157	**0.656**	0.025	−0.057
Importance of river resources	−0.28	**0.850**	−0.174	−0.084	0.119
Importance of remittances	−0.054	−0.334	**0.554**	−0.406	−0.214
Importance of forest product	0.143	−0.136	−0.393	0.015	**0.577**
Home consumption of agriculture	**−0.552**	0.034	−0.066	−0.095	0.243
% of the total variance explained	16.5	16.3	10.5	9.6	8.4

Bold values represent the highest component loading of the different variables among the 5 factors.

In Keosenkham, agriculture production could not be initiated immediately after resettlement as new farmland was not ready for use. While receiving assistance from the company in the form of cash, food, and in-kind support, 45% of the affected households focused on limited economic activities as short-term coping strategies to deal with immediate day-to-day needs after the shock of resettlement. 55% of affected households have continued with a similar livelihood portfolio as before, even with much reduced production output and income (Cluster 2). Coping behaviors include:

- Continued use of upland farming plots, grazing lands, and forests near the original villages;
- Selling livestock-poultry, pigs, cattle and buffaloes; and
- Harvesting of wild animals and plants, such as mushrooms, bamboo shoots, and fish

By Year 2, a large number of households were relying on remittances from family and relatives, while others shifted into wage labor mostly within the resettlement village.

The livelihood strategy has concentrated on a smaller number of activities bringing immediate or short-term returns. For many households, this strategy has persisted 3 years after the resettlement. Although these coping strategies can mitigate the hardship temporarily, it is not sustainable unless the effort is directed

Table 6
Possible Determinants of Adaptation Trajectories.

Asset Variables	Livelihood adaptation trajectories[1]			
	Cluster 2 remaining Cluster 2	Cluster 1 to Cluster 2	Cluster 1 to Cluster 3, then Cluster 4	Cluster 1 to Cluster 3, then Cluster 5
Number of HH	17	26	16	8
% of HH with a member who has completed the 6th grade or higher in school before resettlement	6%[a]	23%[a]	81%[b]	37%[ab]
Age of the head of HH	37.4 ± 12.8	44.1 ± 15.5	46.2 ± 9.3	47.3 ± 12.6
Average age of all HH members	19.5 ± 6.2[a]	23.3 ± 8.6[a]	27.7 ± 9.1[b]	26.7 ± 7.9[ab]
Number of HH members between the age of 15 and 70 years old	2.9 ± 1.2	3.6 ± 1.9	4.2 ± 2.1	4.6 ± 2.3
Number of HH members involved in off-farm work	1.2 ± 1.0[ab]	0.6 ± 0.6[a]	1.6 ± 1.0[b]	1.3 ± 0.9[ab]
Village of origin (# of HH/total # of sample from the same village)	Phonkeo: 0/28 Sensi: 2/19 Thambing: 4/21 Sopchat: 11/24	Phonkeo: 5/28 Sensi: 6/19 Thambing:10/21 Sopchat: 5/24	Phonkeo:10/28 Sensi: 3/19 Thambing:0/21 Sopchat: 3/24	Phonkeo:4/28 Sensi: 2/19 Thambing: 2/21 Sopchat: 0/24
Total remittances received over 4 years (million Kip)	2.1 ± 2.9[a]	2.4 ± 3.8[a]	20.5 ± 17.5[b]	4.8 ± 8.5[a]
Total value of all economic activities before resettlement (million Kip)	22.6 ± 11.4[a]	39.9 ± 13.0[b]	58.3 ± 34.2[b]	41.2 ± 15.6[b]
Cash compensation received as lump sum during resettlement (million Kip)	2.6 ± 3.0[a]	7.6 ± 10.5[a]	19.7 ± 17.5[b]	19.9 ± 39.4[ab]
Land owned before resettlement (hectares)	2.7 ± 0.8[a]	4.0 ± 0.8[b]	5.3 ± 2.9[b]	4.5 ± 1.6[b]
Number of large livestock owned before resettlement	1.7 ± 1.5[a]	5.3 ± 5.2[b]	14.7 ± 15.5[b]	6.4 ± 3.1[b]
Distance to reservoir after resettlement (minutes by walking)	44.7 ± 27.5[b]	26.0 ± 22.9[a]	24.9 ± 28.0[a]	24.4 ± 11.5[a]
Distance to livestock grazing area (minutes in boat transport)	75.0 ± 42.4	76.7 ± 43.2	54.6 ± 36.3	85.0 ± 55.6
Water use in dry season (l/HH)[2]	844 ± 356	860 ± 390	955 ± 355	1136 ± 478
Water use in rainy season (l/HH)[2]	730 ± 329	716 ± 311	1129 ± 1444	971 ± 472

[1] Superscripts indicate whether or not the livelihood adaptation trajectories are statistically different (at $p < 0.05$) for any given asset variable. Except for the asset variable "Village of origin", the absence of superscripts indicates the asset variable not to be statistically different across trajectories. For example, the asset variable "Age of the head of HH" is not statistically different across adaptation trajectories. For any given asset variable, the presence of a common superscript (such as "a" or "b") indicates adaptation trajectories for which the asset variable is not statistically different. For example, the asset variable "Total remittances received over 4 years" is not statistically different between the 1st, 2nd, and 4th adaptation trajectories. However, this same asset variable is statistically different for the third adaptation strategy.

[2] Cumulative water use for Year 1, 2, and 3 after resettlement.

towards graduating into longer-term adaptation and financial stability.

These coping strategies at the study site have depleted financial capital and productive assets significantly. The heavy reliance on natural resource exploitation, namely fisheries and forest products, can put the households who continue this strategy at higher risk of falling deeper into poverty unless access to and availability of these natural resources are secured in a long run.

4.2. Trajectories of livelihood adaptation and the determinants

Characteristics of successful adaptation process can be described in terms of well-being, social networks, institution, and other livelihood outcomes for the households.

The cohort that achieved the highest income level in absolute terms in Year 3 was the most well-off households before the resettlement, who invested in diversification into non-farm income. Moreover, contrary to a common assumption that those endowed with more assets have higher adaptive capacity to shocks, the rate of income recovery of asset-rich cohorts (Cluster 1 before resettlement) after 3 years was not necessarily faster than that of asset-poor cohorts (Cluster 2 before resettlement), despite higher investments in new activities and transformation of livelihood strategy after the resettlement.

Although the study findings do not support the assumption that the asset poor has harder time recovering from the shock, what it does show, is that those with higher asset level have had more options for changing their strategies, and transition into cash and wage-based income portfolio rather quickly while those with lower asset level have continued to rely on natural capital-based activities. We consider the determining factors in more details by asset categories.

4.2.1. Human capital

Level of education, age, and labor force are clear factors in coping and adaptation trajectories among the surveyed households. Younger households with lower education level focused on fishing as a coping strategy in Year 1, whereas households with relatively higher education level had sustained similarly natural resource-based, but more diversified portfolio, with livestock, fishing, and forest products.

Human capital indicators were also significant determinants of adaptation trajectories up to Year 3. The most educated, older cohort graduated to non-farm income strategy. Less educated and younger households with lower labor force did not change their livelihoods strategy significantly over the 3-year period, likely reflecting the inability to change and adapt to a new environment.

The implication of this finding for future resettlement program is that those who are less educated and experienced in a variety of livelihood skills would need extra support in learning farming practices and income generating activities to allow them graduating into strategies that do not overly depend on single source of income.

4.2.2. Natural capital

The role of NTFPs and fisheries as safety net for the livelihood of poor has been documented previously,[13] and our findings are consistent with these previous accounts.

While high dependency on subsistence agriculture and natural resources can make a rural community more vulnerable to environmental changes and shocks, the continuation of natural resources exploitation and subsistence agriculture is an essential part of coping strategy and the transition into more fully evolved livelihoods adapted to a new environment.

Natural capital, especially reservoir fisheries, was found to have played a key role in providing immediate safety net to the resettlers to secure food and income in Year 1. In addition, continued use of upland farms near the original villages for cultivation of food crops, old grazing areas for livestock, and forest product collection have clearly contributed to food security and income generation for a large number of resettled households (Kura et al., 2014). In fact the use of old farming plots increased from 12% of the surveyed households in Year 1 to 22% in Year 3. A great majority of those still using the old farm plots in Year 3 are in Cluster 2 strategy.

In the longer run, the continuation of livelihood strategies that depend on the natural capital near the old villages is not sustainable unless access to these resources is secured. At the study site, local authorities did not encourage the continued use of land and forest around the old villages as these areas now belong to watershed conservation zone. The overall number of livestock has declined significantly due to the lack of grazing land near the resettlement site and high cost of caring for livestock near the old grazing land. The percentage of households involved in fishing, and fish catch per household have both declined between Year 1 and 3. If this trend continues, the livelihood strategies that currently rely on fishing will need to shift to some other options, if such option exists at all.

The households resettled to Keosenkham have had a unique opportunity to access hydropower reservoir for fisheries and water, and part of their previous land and forest to support livelihoods, which is not always the case with hydropower resettlement. In absence of natural capital to exploit, household coping strategies would have been much more restricted. For future research it would be useful to compare the adaptation trajectories observed in other resettlement sites that did not have ready access to the hydropower reservoir to support their coping strategies.[14]

4.2.3. Social capital

The role of social capital in supporting collective actions and responses to climate-related shocks and environmental hazards has been well recognized (Adger, 2010; Agrawal, 2010; Osbahr et al., 2008, 2010). Although our study did not evaluate social capital variables in detail, we found strong indication that social capital is a key element of adaptive capacity in the context of our study site. Remittance from relatives became important in Year 2 for all villages but more so for households from Phonkeo and Sopchat, indicating stronger social network that these two villages can access in time of need. Households from Phonkeo village, originally located closest to the resettlement site, appear to have shifted livelihood strategies more flexibly from year to year and transitioned into non-farm income faster than households from other villages.

In the study site, the hydropower company has provided support for establishing new social structure, including community-based fisheries management organization, which has helped coordinate the resource access and exploitation, aiming for sustainability. It is necessary to integrate this type of interventions as part of resettlement planning in the future, which builds or strengthens social capital within and outside of the affected communities, to speed up their recovery from the shock of displacement.

4.2.4. Financial capital

The finding shows that those with more financial asset before resettlement were able to invest in specific coping strategies in Year 1 and to transition into more wage-based cash income portfolio in Year 2 and Year 3, whereas those with lower financial capital stayed with very similar strategy before and after resettlement (i.e. Cluster 2). Although long-term return on such investment is difficult to assess at this stage, it is possible that having more financial resources enabled some households to change strategy by conscious choice. The implication for future resettlement planning is to ensure that the affected households have sufficient cash up front and some guidance on how to invest their financial capital in longer-term strategy rather than immediate income maximization.

5. Conclusions

The analysis shows that the livelihood adaptation process has taken several different pathways, drawing on and limited by a combination of assets and capabilities of individual households. The trajectories illustrate household livelihood strategies diversifying and changing by necessity or choice, as each family aims to restore or improve income and livelihoods. Some households have utilized the same strategy over 3 years, while others have shifted strategy nearly every year. Oversimplified assumptions that households will follow homogenous pattern of recovery from the shock of resettlement may disadvantage some households and hinder the potential of others to regain self sufficiency above poverty.

The results presented in this study highlight the need in Lao PDR (and in all likelihood other countries of the region and beyond) for ensuring full implementation of, and improving upon, *Compensation and Resettlement Decree* of 2005 and the associated technical guidelines pertaining to the design of resettlement and compensation approaches. The implementation of these policies relies on hydropower developers typically through resettlement action

[13] See for example Béné et al. (2010), Coomes et al. (2010), Shackleton et al. (2011), and Paumgarten and Shackleton (2011).

[14] For example, Bui et al. (2013) reports the intensification of crop production by increasing input use as being the only strategy available for the resettled households at a site in Vietnam, due to the lack of access to grazing areas or water bodies for fishing.

plans (Lao PDR, 2005; STEA, 2006). Future resettlement planning requires consideration of more tailored approaches to supporting households with lower capacity for adaptation, rather than providing homogenous compensation packages. Our results suggest that a more detailed understanding of this dynamic process is a key to the design of better and more tailored interventions for rebuilding and improving the livelihoods of those resettled by development projects in rural areas, especially those affected by the hydropower development in the Mekong region.

While resettlement impact studies typically use recall surveys, we were able to survey the same set of households every year for 4 years, enabling the analysis of temporal changes in the livelihood activities of the surveyed households. In ideal situation, however, survey control sites should have been established to compare how the livelihood trajectory would have been had these communities not been resettled by hydropower development. In this study, we were not able to establish such control sites.

In future studies, it would be useful to compare the livelihood trajectory experienced by resettled households in Keosenkham with the trajectories in other villages which did not experience resettlement or were resettled to other sites far from the reservoir. Existing studies (including this one) suffer from the absence of including control groups serving as counterfactual and against which changes experienced by resettlers could be compared.

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Appendix A. : Livelihood Asset Variables

Explanatory variables	Asset category
Presence of a HH member with a 6th grade schooling or higher(education)	Human capital
Age of the head of HH (life experience)	Human capital
Average age of all HH members (life experience)	Human capital
Number of HH members between the age of 15 and 70 years old (labor force)	Human capital
Number of HH members involved in off-farm work (social network)	Social capital
Village of origin (social network, access to knowledge and information)	Social capital
Remittance received from outside of the village (access to social safeguard)	Social capital
Total value of all economic activities before resettlement (income)	Financial capital
Cash compensation received as lump sum during resettlement (income)	Financial capital
Size of land assets owned before resettlement (wealth)	Financial capital
Number of large livestock owned before resettlement (wealth)	Financial capital
Walking distance to reservoir after resettlement (access to fishing grounds)	Natural capital
Distance to livestock grazing areas after resettlement (access to grazing areas)	Natural capital
Water withdrawal/use (access to water)	Natural capital

Appendix B. : Proportion of Households in Each Cluster

	Before	Year 1	Year 2	Year 3
Cluster 1: Diversified/well-off	65%	0%	2%	2%
Cluster 2: Diversified/low output	25%	41%	38%	50%
Cluster 3: Natural resource dependent	0%	37%	3%	3%
Cluster 4: Non-farm wage dependent	2%	2%	40%	23%
Cluster 5: Fishing dependent	8%	16%	16%	22%

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