Access to Livelihood Assets under the Influence of a Climate Event in Upland Northern Laos

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Received December 2, 2013; Accepted December 19, 2014

Abstract  This study examines the effects of a climate event on livelihood assets of households in upland northern Laos, when the early onset of the rainy season as a result of climate change led to a failure to burn swidden systems. A Sustainable Livelihoods Framework is applied to estimate rural livelihood assets associated with differences in climate conditions, such as the 2010 normal climate and the 2011 climate event, and to compare household strategies in each climate condition. The findings indicate that natural capital had the highest index value in the 2010 normal climate, whereas human capital had the highest value in the 2011 climate event. Financial capital had the lowest index in both climate conditions. Residents at the research site were better off in terms of natural capital but worse off in terms of financial capital. This indicates that the government and other rural development agencies should not only manage natural resources; income-generation activities are also needed. We conclude that natural resources, as well as non-timber forest product (NTFP) gathering and off-farm activity, were the most important strategies for the entire research site under the normal climate condition. NTFP gathering and outside work are important in meeting subsistence needs and augmenting income levels in households when the rainy season begins early as a result of climate change. Outside employment was an additional strategy in households to achieve their livelihood goals, including food security and household income generation, under conditions of economic change and climate events.

Key words  household assets, climate change, early onset of rainy season, livelihood vulnerability, swidden cultivation

Introduction

In Laos, about 80% of the land surface is hilly or mountainous, and most of the northern provinces continue swidden cultivation (Douangsavanh et al. 2005: 2), an agricultural system which consists of slashing, burning, planting, weeding, and harvesting. In upland northern Laos, people live in permanent areas, and the land cultivated shifts from place to place approximately every 3 years, including 1-year cultivation and 2-year fallow, although this system does not allow the cultivated area a sufficiently long fallow period to recover before being cultivated again (NAFRI 2005: 48). Rice is a major crop for home consumption, and the main income resource is the gathering of non-timber forest products (NTFPs) under natural production and swidden fallow (Yokoyama 2003: 66–70).

Agricultural production on sloping land is unstable and usually influenced by climate. Land preparation, such as slashing fallow forest or shrub vegetation and burning the dry fallow forest or shrub vegetation (Roder 1997) at the end of the dry season in March, is an important activity and sensitive to climate events. Kanemaru et al. (2014) pointed out that the rainy season in northern Laos has begun earlier and its variability has also increased over 56 years (from 1951 to 2007) and climate change has become apparent, as seen in the 2011 climate event at the research site. These climate events face upland farmers with a major problem because they are prevented from burning biomass to begin swidden cultivation to support their livelihoods. Some households may be able to adjust to the change and others may not. Therefore, clarifying the coping strategies to climate change is key to rural development.

Climate change is considered to affect ecosystem services, agricultural production, and livelihoods (Sivakumar et al. 2005); it is associated with limited resilience, subsistence food production, and natural production potential (Mertz et al. 2009). The study of climate change has attracted many researchers over recent decades, who have attempted to understand variability and adaptation to climate change (Thomas et al. 2007; Crane et al. 2011), coping with climate change (Cooper et al. 2008), and improvement of adaptation strategies to climate change (Hallegatte 2009). There continue to be studies on the correlation between rural livelihoods and climate change.
(Ziervogel and Calder 2003), impact of climate change on agriculture and livelihoods (Sissoko et al. 2011), impacts of climate change and variability in fishery-based livelihoods (Badjeck et al. 2010), and others. However, there is less confidence in the impacts of climate change on livelihood assets, and in particular on the types of assets of rural inhabitants who are most affected by climate events. What is happening to such assets?

The livelihoods approach is firstly concerned with people, so an exact understanding of people’s capability, especially on access to five types of asset such as human capital, natural capital, social capital, physical capital and financial capital is crucial to analyses of how people convert these assets in order to achieve livelihood outcomes (Bebbington 1999). Assets are important for people to achieve their livelihood goals; a single asset is not sufficient to produce all livelihood outcomes (DFID 2001: 19). Assets are considered to be direct or indirect stocks of different types of capital that people can use to generate livelihood outcomes (Carney 1998). Assets provide a flow of output, which accumulate as a surplus to be endowed in livelihood outcomes. People have different types of assets that they combine to help them seek and realize their livelihoods, and they attempt to convert assets into their livelihood outcomes (DFID 1999: 17). This paper focuses on the livelihood assets component of the Sustainable Livelihoods Framework (SLF) to estimate livelihood assets under differences in climate, including the 2010 normal climate and the 2011 climate event. There is also a comparison of household strategies that people choose under each climate condition.

Research Site and Methodology

Research site

The research site is Kachet village, Nam Bak District, Luang Phabang Province in Laos (Figure 1). The residential area of the village is at an altitude of about 750 m and is surrounded by mountains reaching about 900 m. The village is at 20°34′N, 102°18′E, about 27 km west of Nam Bak (the district capital) and about 130 km northwest of Luang Phabang (the provincial capital).

In 2011, there were 95 households and 486 residents in the village, of whom 258 were female. Inhabitants belong to the Lao Theung or Khamu minority ethnic group. This is one of three ethnic groups in Laos that have been classified according to habitat location and altitude; these are the Lao Lum as lowlander; Lao Theung as midlander; and Lao Sung as highlander (Yokoyama 2003: 4). The Khamu are one of the original old lines of the inhabitants of Indochinese land who have lived there since before the others arrived (Simana and Preising 1997: 1). Currently, the Khamu are spread throughout northern Laos and still build their village and houses in the mountainous region where agricultural production depends on rainfall. They do not have field and paddy fields as do the other groups. Upland rice cultivation is the main livelihood strategy to ensure food security in the household (Figure 2). The Khamu depend on finding additional food from the fallow forest and the old-growth forest such as edible and medicinal plants, mushrooms, bamboo shoots, and fruit. They also engage in hunting and fishing.

At the research site, agricultural production systems are based on rotational systems or swidden practices. Swidden is the dominant farming system, in which dry biomass obtained by felling fallow forest or shrub vegetation is burned before the beginning of the rainy season (Fox 2000). People cultivate and harvest for one or more years, and then leave the land to regrow secondary forest (Fox 2000). On the one hand, shifting cultivation is a form of agricultural system, indicating the moving from one plot to another, also known as swidden practice (Spencer 1966: 9–11). Swidden based on a short cultivation–long fallow period is commonly practiced at the research site. The cultivation period in the research site is only 1 year followed by relatively long fallow periods of at least 6 or 7 years. Farmers cultivate upland crops such as local maize (Zea mays), sesame (Sesamum indicum), Job’s tears (Coix lacryma-jobi var. ma-yuen) and others together within the rice field for only 1 year then move to other plots in the next season. Farmers begin to slash fallow forest in February and then burn in March through early April. After burning, they clear the land once more before planting rice in May through early June. Farmers must weed the plots two to four times during the rice-growing period. Upland rice is always harvested in late September for early-maturing varieties, in October for mid-season varieties, and early November for late-maturing varieties (Figure 3). However, early onset of the rainy season becomes earlier than April and its variability has also increased from 1975 to 2011 (Figure 4). In 2011, an early rainy season began at the beginning of March. Most households could not burn fallow forest after slashing, and therefore failed to cultivate rice for consumption.

Data collection and analysis

Data collection Household data were collected using a household survey, and by holding semi-structured and structured interviews and participatory rural appraisal
In June 2011, a first field observation survey was made, and the villagers’ situation under the influence of the climate event at the research site was considered. Interviews were held with a head representative of each household. Sixty-three of the 95 households in the village were randomly selected for interview in February 2012. Sample households were categorized into two groups: those with an insufficient labor force (group I = 25 households) and households with a substantial labor force (group II = 38 households). An insufficient labor force refers to a household with the equivalent of two or fewer than two laborers. A sufficient-labor force refers to more than two laborers in a household. In this study, ‘laborer’ refers to adults, but not to students or those over 60 years of age. During interviews, all respondents provided information about the household in the 2010 normal year and in the climate event year of 2011. Household information contained quantitative and qualitative data. In addition to household interviews, group discussions were held with members of the local community. The group discussion technique was applied to assess farmers’ perceptions and awareness of climate change issues.
Framework of analysis In 1987, the Brundtland Commission on Environment and Development first introduced and discussion the concept of sustainable livelihoods. The 1992 United Nations Conference on Environment and Development presented and advocated the concept of sustainable livelihoods as a strategy for poverty reduction (Krantz 2001: 6). The livelihood approach comprises the ideas of capability and well-being, particularly through in-depth analysis of rural poverty, vulnerability, resilience, and natural resource. The SLF is adapted to allow an understanding of the differential capabilities of rural people to cope with extreme climate, crises and other events. It is usually set in the form of a framework which consists of the principal components derived from the livelihood definition. The framework also demonstrates the interaction between each component (Allison and Ellis 2001), showing the main important factors that affect people's livelihoods, and describes the relationship among livelihood factors (Figure 5).

The SLF is a tool to help scholars understand poor people's livelihoods at the local level. Developed by the Department of International Development (DFID), UK, the SLF is a starting point to analysis of the vulnerability context through direct and indirect environmental impacts, which effect livelihood outcomes. The livelihood outcomes refer to the amount of money going to the household, to increased well-being of household members through access to public health services, to improved food security for household consumption, and other factors. A combination of livelihood strategies may be adopted including productive activities, investment, and others, to achieve these outcomes (DFID 2001: 16).
The SLF is built on the belief that people need assets to achieve a positive livelihood outcome. People have different types of assets that they combine to help them achieve the livelihoods they seek (DFID 2001: 16).

Livelihood assets comprise five types of capital (DFID 2001: 19–39): 1) Human capital concerns the skills, knowledge, labor, and good health that enable people to achieve their desired livelihoods. 2) Natural capital refers to natural resource stocks and covers both tangible and intangible factors. Tangible natural resources may be represented by forest resource as well as NTFPs that local people gather for food and cash income for the household, and land. Land is obviously an important natural resource, on which farmers undertake agriculture. Intangible products include the atmosphere and biodiversity, but this study does not address these. 3) Social capital means social resources with which people plan their livelihood goals. Social resources include networks, group memberships, trust relationships, and access to wider societal institutions. 4) Physical capital describes the basic infrastructure and farm inputs that are needed to support the livelihoods that people seek. The infrastructure consists of physical environments, basic needs such as roads and electricity. Farm inputs refer to the tools and equipment that people apply to increase productivity. 5) Financial capital refers to the fund resources that people use to complete livelihood objectives that they need. In other words, financial capital also means cash or cash equivalents, which enhance the ability of people to overcome or respond to an unexpected event (Kollmair and Gamper 2002: 7). However, the results of the literature review show that people with different locations, sources of income, opportunity, and culture have differentiated livelihood (Ellis 1998). An alternative and efficient way of contributing to the research on rural livelihoods would be by studying the specific people residing in a specific location. It is probable that different indicators are also needed to increase the number of indicators to understand local people’s livelihoods.

Data analysis In this paper, the five forms of capital were calculated by using various types of data, and our analysis comprised three steps. In step 1, we used raw data from household interviews and conducted basic processing. In step 2, we normalized these data by using a formula (see below). In step 3, two statistical analyses using Statistical Package for Social Science (SPSS) were carried out: first, a paired sample $t$-test, followed by an independent sample $t$-test. In step 1, we conducted the basic calculation for step 2. Each component of the five capital indicators is explained below.

Human capital had three indicators: labor, education, and health. To digitalize labor, we used the ratio of the number of laborers to the total number of household members. For education, we used the ratio of the number of students to the total number of children from 8 to 17 years old in a household. For health, we used the ratio of number of household members with chronic disease to the total number of household members.

Natural capital had two indicators: NTFPs and land. For NTFPs, we used the ratio of income from NTFPs to total income. For land, we used the area of all agricultural land owned by each household.

Physical capital had four indicators: paddy field, external facilities, farm input, and electricity. For paddy field, we used the area of paddy field of each household. For external facilities, we acquired data by digitalizing frequency of access by each household to markets, hospitals, and schools. In the interviews, 0 was used to indicate that household members never accessed these facilities; 0.333 was used to indicate that they sometimes did; 0.666 was used to indicate that they often did; and 1 was used to indicate that they always did. For farm input, we used the amounts of chemical fertilizer, organic fertilizer, pesticides, and high-yield variety of paddy rice. For electricity, we used the annual sum paid for electricity for each household.
Financial capital had six indicators: agriculture income, livestock income, off-farm activity income, working outside income, credit, and savings. For agricultural income, livestock income, off-farm activity income, and working outside income, we used the ratio of each income to total household income. For credit, we used the total amount of debt from banks or other sources. For savings, we used the total amount of cash savings in each household.

Social capital had three indicators: equity, participation, and social relations. For equity, we used the income per capita in a household. For participation, we acquired data by digitalizing the frequency of participation in community activities such as planting, implementing, sharing of benefits, and monitoring and evaluation. In the interview, we used 0 when household members had never joined in each of these activities; 0.333 when they sometimes did; 0.666 when they often did; and 1 when they always did. For social relations, we used the support by money and rice inside the village each year.

After finishing the basic analysis in step 1, in step 2, we converted the different values in each indicator (e.g., labor, education, health, NTFPs) into the same scale by applying a simple linear scaling method. Because of the different scale of each household characteristic treated as an indicator, it was necessary to standardize them before computing livelihood indices. The linear scale used minimum and maximum values as scaling points of 0–1, except for access to external facilities and participation variables as mentioned in step 1.

According to the linear scale technique:

$$ X_i = \frac{(R_i - V_{\min})}{(V_{\max} - V_{\min})} $$

where, $X_i$ = computed value, $R_i$ = raw value to be normalized, $V_{\min}$ = minimum values of the variable, and $V_{\max}$ = maximum value of the variable.

In step 3, two statistical analyses were carried out using SPSS. First, a paired sample $t$-test was used to examine the significances of difference in access to livelihood assets at two separate points in the 2010 normal climate and the 2011 climate event. Second, an independent sample $t$-test was used to examine the significances of difference in access to source income between two household groups, including insufficient labor (group I) and sufficient labor (group II).

To compare the livelihood of different household groups, group comparison methods by Cramb et al. (2004), Thennakoon (2004: 6–9), Pensuk and Shrestha (2008) and Mahdi et al. (2009) were applied. These researchers had used the average mean value to be the score of livelihood assets. In this study, each capital (human, natural, physical, financial, and social) was derived from the average mean in each group of variable indicator. The livelihood pentagon presents the pattern of change in each household group between the 2010 normal climate and the 2011 climate event.

**Socioeconomic Characteristics of Respondents**

From a total of 63 respondent households, 82.5% of total respondents were male. The average age was 47.7 years, and the range was 28–80. More than half (57.1%) of the respondents had primary school education, 38.1% had no education, and only 4.8% graduated from secondary school. The average number of members in each household was 5.68, with a range of 2–11. About 98.4% of respondents had the principal occupation of farming and of upland rice production and livestock production; only one person was an employee of a private business. Most household respondents had sole land ownership. The average agricultural land area was 5.43 hectares (ha), with a range of 0–22.5 ha (Table 1). Twenty-eight percent of respondents were renting farmland from others.

The average total cash income was 6,481,180 kip per household annually (2011 climate event). The largest component was NTFPs, which constituted 40% or 2,610,783 kip of total income, followed by outside work at 25% or 1,600,000 kip. Then, came off-farm income at 21% or 1,380,079 kip, livestock at 12% or 742,698 kip, and off-farm income at 21% or 1,369,783 kip. In the study village, off-farm works such as construction in urban areas, planting trees, and roadside trading were regarded as important off-farm activities. In addition to off-farm activity, common outside work included employment in factories in the city far from the village.

**Change in Access to Livelihood Assets**

The five capitals were scored and analyzed by comparing their mean values to shape livelihood assets between the 2010 normal climate and the 2011 climate event. In the former, the highest index value of the entire study was for natural capital (0.43), followed by human (0.38), social (0.35), physical (0.25), and financial (0.14). In the 2011 climate event, human capital became more important (0.40), followed by natural (0.34), social (0.31), physical (0.27), and financial (0.14) (Figure 6).
Human capital

The overall human capital had a significant difference at a <0.001 level between the 2010 normal climate and the 2011 climate event (Table 2). The most significant difference was for the labor force in the household at a <0.001 level, while education and health quality did not show any significant difference between 2010 and 2011. Statistical analysis shows that the climate event did not directly impact education and health quality capitals at the research site. However, the results clearly indicate that the labor force is important for human capital. According to household surveys, average labor within a household was greater in 2011, about 3.11, compared with 2.65 in 2010 (Table 1). However, overall human capital showed no significant difference between labor groups I and II in the 2010 normal climate and the 2011 climate event (Table 2).

Natural capital

The overall natural capital showed a significant difference at a <0.001 level. The natural capital index value slightly decreased, from 0.43 in 2010 to 0.34 in 2011. Regarding the two variables of natural capital indicators, only access to farmland had a significant difference at a <0.001 level; access to forest resources had no significant difference between the 2010 normal climate and the 2011 climate event. However, access to forest resources increased, with scores of 0.45 in 2010 and 0.48 in 2011. Access to farmland, however, declined from 0.41 to 0.18 over the period. Most households at the research site could not use their farmland to produce upland rice during the 2011 climate event. Heavy rain, together with early onset of the rainy season in March, affected 76 of a total 95 households (80%) that could not burn fallow to begin rice production. The upland cultivation area declined by 92% or 142 ha in 2011 compared with 2010.

Classifying access to natural capital by labor groups had a significant difference in the 2011 climate event at a 0.5 level (Table 2). However, access to natural capital resulted in no significant difference between groups I and II in the normal 2010 climate. Access to land for two labor groups showed a significant difference at a 0.5 level in the 2010 normal climate and at a 0.001 level in the 2011 climate event.
**Table 2.** Comparison of livelihood assets between group I and group II during period of 2010 to 2011

| Livelihood Assets | Year | Group I | Group II | T-test (I & II) | Paired Sample |
|-------------------|------|---------|----------|----------------|---------------|
|                   | Mean | SD      | Mean     | SD             | Mean          | T-test (2010 & 2011) |
| 1. Human capital  |      |         |          |                |               |                         |
| 1.1 Labor         | 2010 | 0.340   | 0.144    | 0.401          | 0.107         | −1.942                 | 0.38 | −4.088*** |
|                   | 2011 | 0.352   | 0.152    | 0.439          | 0.126         | −2.458                 | 0.40 |                     |
| 1.2 Education     | 2010 | 0.456   | 0.199    | 0.507          | 0.133         | −1.219                 | 0.49 | −4.655*** |
|                   | 2011 | 0.478   | 0.190    | 0.631          | 0.185         | −3.185                 | 0.57 |                     |
| 1.3 Health        | 2010 | 0.142   | 0.238    | 0.157          | 0.153         | −0.305                 | 0.15 | 0.785 |
|                   | 2011 | 0.139   | 0.236    | 0.155          | 0.152         | −0.326                 | 0.15 |                     |
| 2. Natural capital|      |         |          |                |               |                         |
| 2.1 Forest resources | 2010 | 0.434   | 0.264    | 0.460          | 0.207         | −0.439                 | 0.45 | −1.451 |
|                   | 2011 | 0.462   | 0.257    | 0.495          | 0.205         | −0.557                 | 0.48 |                     |
| 2.2 Land          | 2010 | 0.292   | 0.110    | 0.494          | 0.134         | −0.016                 | 0.41 | 7.277*** |
|                   | 2011 | 0.013   | 0.067    | 0.296          | 0.115         | −4.730***              | 0.18 |                     |
| 3. Physical capital|      |         |          |                |               |                         |
| 3.1 Irrigation infrastructure | 2010 | 0.040   | 0.113    | 0.145          | 0.235         | −2.075**               | 0.10 | −1.426 |
|                   | 2011 | 0.040   | 0.113    | 0.145          | 0.235         | −2.370                 | 0.10 |                     |
| 3.2 External facility | 2010 | 0.452   | 0.189    | 0.450          | 0.168         | 0.050                  | 0.45 |                     |
|                   | 2011 | 0.449   | 0.177    | 0.527          | 0.195         | −1.623                 | 0.50 |                     |
| 3.3 Farm input    | 2010 | 0.009   | 0.044    | 0.070          | 0.121         | −2.413***              | 0.05 | 0.186 |
|                   | 2011 | 0.009   | 0.044    | 0.068          | 0.114         | −2.868***              | 0.04 |                     |
| 3.4 Electricity   | 2010 | 0.292   | 0.212    | 0.463          | 0.261         | −2.724                 | 0.39 | −5.372*** |
|                   | 2011 | 0.323   | 0.220    | 0.501          | 0.295         | −2.576                 | 0.43 |                     |
| 4. Financial capital|      |         |          |                |               |                         |
| 4.1 Agricultural income | 2010 | 0.106   | 0.088    | 0.148          | 0.149         | −1.382*                | 0.13 | 6.270*** |
|                   | 2011 | 0.003   | 0.017    | 0.037          | 0.074         | −2.654***              | 0.02 |                     |
| 4.2 Livestock income | 2010 | 0.132   | 0.158    | 0.136          | 0.172         | −0.085                 | 0.13 | 2.152* |
|                   | 2011 | 0.106   | 0.141    | 0.106          | 0.134         | 0.006                  | 0.11 |                     |
| 4.3 Off-farm income | 2010 | 0.224   | 0.253    | 0.162          | 0.188         | 1.129                  | 0.19 | −1.412 |
|                   | 2011 | 0.269   | 0.273    | 0.159          | 0.190         | 1.755*                 | 0.20 |                     |
| 4.4 Working outside | 2010 | 0.104   | 0.196    | 0.096          | 0.148         | −1.156                 | 0.10 | −3.578*** |
|                   | 2011 | 0.165   | 0.249    | 0.224          | 0.215         | −0.990                 | 0.20 |                     |
| 4.5 Credit        | 2010 | 0.026   | 0.064    | 0.079          | 0.222         | −1.382*                | 0.06 | −2.122* |
|                   | 2011 | 0.081   | 0.150    | 0.130          | 0.225         | −0.959                 | 0.11 |                     |
| 4.6 Saving        | 2010 | 0.247   | 0.276    | 0.198          | 0.243         | 0.738                  | 0.22 | 0.104 |
|                   | 2011 | 0.219   | 0.258    | 0.210          | 0.256         | 0.139                  | 0.21 |                     |
| 5. Social capital |      |         |          |                |               |                         |
| 5.1 Equity        | 2010 | 0.520   | 0.253    | 0.360          | 0.171         | 3.000*                 | 0.42 | 6.229*** |
|                   | 2011 | 0.367   | 0.161    | 0.246          | 0.102         | 3.339                  | 0.29 |                     |
| 5.2 Institutional  | 2010 | 0.564   | 0.146    | 0.628          | 0.225         | −1.251                 | 0.60 | 9.907*** |
|                   | 2011 | 0.453   | 0.190    | 0.529          | 0.257         | −1.262                 | 0.50 |                     |
| 5.3 Social relationship | 2010 | 0.057   | 0.199    | 0.002          | 0.014         | 1.685**                | 0.02 | −5.642*** |
|                   | 2011 | 0.202   | 0.256    | 0.094          | 0.135         | 1.941***               | 0.14 |                     |

*Mean significant difference at <.05 level, **at <.01 level, and *** at <.001 level.

Source: Analyses by authors.
Physical capital

The physical capital index value slightly increased from 0.25 to 0.27, a significant difference at a $<0.001$ level between 2010 and 2011. Two variables of the physical capital index, access to irrigation paddy fields and farm input, did not show any significant differences. However, access to external facilities and electricity did have significant differences, at the $<0.01$ and $<0.001$ levels, respectively. The external facility index increased, with scores of 0.45 in 2010 and 0.50 in 2011. Access to electricity increased during the period, from 0.39 to 0.43.

The overall physical capital showed no significant difference between groups I and II in the normal 2010 climate. However, there was a significant difference in the 2011 climate event year at a 0.5 level. Access to the physical capital index was higher in group II than in group I in both the normal 2010 climate year and the 2011 climate event (Figure 7). Two group households had significant differences in access to irrigated paddy fields at a 0.01 level and farm input at a 0.001 level, while the external facility and electricity variables showed no significant differences in 2010. In the 2011 climate event, only farm input showed a significant difference at a 0.001 level, while other variables showed no significant differences between groups I and II.

Financial capital

The overall financial capital had the lowest index value compared with other capital indexes for both the normal 2010 climate and the 2011 climate event (Figure 6), and showed no significant difference. However, income from agricultural production, livestock, outside work, and credit had changes significant at the $<0.001$, $<0.05$, $<0.001$, and $<0.05$ levels between 2010 and 2011 (Table 2). The average index of agricultural income dropped from 0.13 to 0.02, and livestock income from 0.13 to 0.11. In contrast, income from outside work increased from 0.10 to 0.20, and access to credit from 0.06 to 0.11.

Reductions in income from agriculture and livestock resulted from the 2011 climate event in March, because people could not cultivate upland rice. Normally, most cash crops and food crops are planted in the same plot as upland rice. Therefore, food crops and commercial crops could not be cultivated either. Livestock is important in the household economy, especially when it is used as a means of saving. Generally, people in the village raise cows, water buffaloes, pigs, chickens, and ducks. Cows and buffaloes are raised in traditional systems, particularly in fallow and forest. The household survey showed that early rainfall and heavy rain occurred from March to June, foot and mouth diseases killed about 45% of the total 96 cows, and 24% of the total 17 buffalo. In addition, 67% of the total 619 poultry, and 20% of the total 99 pigs were also killed by unknown diseases in 2011.

The overall financial capital index showed no significant difference between groups I and II in both 2010 and 2011. However, the overall financial capital index was similar at 0.14 for both groups. The normal 2010 climate, access to agricultural income, and credit were significantly different between the two groups at a 0.5 levels, while...
livestock income, off-farm income, working outside, and savings variables were of no significant difference. In the 2011 climate event year, there were two variables, agricultural income and off-farm income, which had significant differences at the 0.001 and 0.5 levels, respectively. However, livestock income, working outside, credit, and savings variables showed no significant difference.

Social capital
A pentagonal diagram of livelihood assets shows that the overall social capital index was higher in the normal 2010 climate (about 0.35) than in the 2011 climate event (0.31) (Figure 6), with a significant difference at a <0.001 level. The overall social capital was assessed through three variables: equity, participation, and social relations. There was significant change at the <0.001 level between 2010 and 2011. The social relationship index increased from 0.02 in 2010 to 0.15 in 2011, but the equity and institutional participation index decreased. This is because many heads of household went outside the village to earn more additional income, in response to food insecurity, so could not always attend village and community activities during the period. In addition to institutional participation, equity index also decreased from 0.42 in 2010 to 0.29 in 2011. As mentioned above, the climate event in March influenced NTFPs, agriculture, livestock, and off-farm income, which all decreased. Therefore, the average total household income was higher in 2010 at about 8,173,704 kip or 1,438,389 kip per capita in 2010, compared with 6,481,180 kip of total household income in 2011.

The overall social capital index showed no significant difference between groups I and II in both the 2010 normal climate year and the 2011 climate event year. Interestingly, a household with insufficient labor (group I) had higher index values than a household with sufficient labor (group II) in both years (Figure 7). In the 2010 normal climate year, two variables were significantly different at a 0.5 level for equity and a 0.01 level for social relationship, while the institutional variable showed no significant difference between groups I and II. In 2011, social relationship variable had significant differences at a 0.001 level, while others had no significant difference between two groups.

Change in Household Income Sources under the Climate Event
Household strategies are a way to understand how people at the research site responded to an early onset of the rainy season. This section provided results of the study on livelihood situations for groups I and II in different years. In Figure 8, we compared each source of income in different years for each group. In contrast, we compared each income source for the two groups in the same year in Figure 9. Residents there engaged in a combination of activities and choices to achieve their livelihood goals.

The comparison of income source revealed significant differences in agriculture at a <0.001 level and livestock income at a <0.5 level for group I. However, income from NTFPs, off-farm activity, outside work, and total income did not show a significant difference between the normal 2010 year and the 2011 climate event (Figure 8). For group II, each income showed a significant difference: NTFP income and agricultural income had significant differences at <0.001 levels; livestock income at <0.01 level; and off-farm activity and outside work had significant differences at <0.5 levels. However, total income in group II showed a significant difference at <0.5 level. The results indicate that households with sufficient labor (group II) had changed in income compared with those with insufficient labor (group I) between the normal climate year and the climate event year.

The comparison of household income in the normal climate year between groups I and II did not present any significant difference in NTFPs, agriculture, livestock, off-farm activity, outside work, and total income between groups I and II (Figure 9). In the 2011 climate event year, agricultural income had significant difference between the two groups at a 0.01 level and at a 0.5 level for off-farm activity. However, NTFP income, livestock, outside work, and total income had no significant difference between two groups in the 2011 climate event.

For group I, NTFP income was the largest component of household income, followed by off-farm activity income, outside work, livestock income, and agricultural income in 2010 (Figure 10). In the 2011 climate event, NTFP income was still the highest component, followed by off-farm activity income, outside work, livestock income, and agricultural income. The percentage of total income declined slightly. NTFP income declined from 2,637,860 kip or 33% of total household income in 2010 to 2,440,280 kip or 37% in 2011; agricultural income declined from 848,000 kip or 11% in 2010 to 20,000 kip or 0.3% in 2011; livestock income declined from 1,205,200 kip or 15% to 784,800 kip or 12%; off-farm activity income declined from about 2,087,000 kip or 26% to 1,951,400 kip or 30%; and outside work income increased from 1,296,800 kip or 26% to 1,364,000 kip or 30% during the same period. Household income group I
declined from 8,074,860 kip in 2010 to 6,560,480 kip in 2011, but income from outside work increased. Group II households also showed NTFPs to be the largest proportion of total income at 39%, followed by livestock and off-farm activity income at 17%, agriculture at 15% and outside work at 12% in the normal 2010 year. Income sources altered in the 2011 climate event. Group II again had NTFPs as the largest proportion of total income, at 42%. The remaining proportions were outside work at 27%, followed by off-farm activity at 16%, livestock at 11%, and agriculture income at 4%. NTFP income declined from 3,218,733 kip in 2010 to 2,722,957 kip in 2011. Agricultural income declined from 1,210,526 kip to 231,579 kip, livestock income from 1,387,895 kip to 715,000 kip, and off-farm activity income declined from 1,396,579 kip to 1,004,211 kip between 2010 and 2011. However, outside work income increased from 1,025,000

Figure 8. Average household incomes in 2010 and 2011 of group I (a) and group II (b).
Note: * the mean significant difference at < .05 level, ** at < .01 level, and *** at < .001 level. One U.S. Dollar (USD) was equivalent to 8,029 kip on average in 2011, and 8,269 kip in 2010 (NSC 2012).
Source: Analyses by authors.

Figure 9. Comparison of average household incomes between group I and group II in 2010 (a) and 2011 (b).
Note: * the mean significant difference at < .05 level, ** at < .01 level, and *** at < .001 level. One U.S. Dollar (USD) was equivalent to 8,029 kip on average in 2011, and 8,269 kip in 2010 (NSC 2012).
Source: Analyses by authors.

Figure 10. Proportion of incomes by economic activity in 2010 and 2011.
Source: Analyses by authors.
killed to 1,755,263 kip during the same period, but total household income declined from 8,238,733 kip in 2010 to 6,429,003 kip in 2011.

At the research site, livelihood strategies for both household groups did not differ between the normal climate and climate event years. In the normal climate, all households in the village paid attention to cultivating upland crops including rice as a major activity in the household. Upland rice was the staple food and income was earned from upland crops. In the 2011 climate event, local people engaged in various activities including collecting NTFPs, agriculture, livestock, off-farm activities, and outside work. There were no different livelihood activities between the normal climate and climate event years, but the ratio of labor input to each activity was different between the two household groups.

**Discussion**

**Change in access to household capitals**

The pentagonal diagram of five capitals shows change in access to capital between the normal 2010 climate and the 2011 climate event. Every livelihood index value indicated poor access, except for natural capital, which was the primary source of income in both climate conditions. Residents at the research site generated household income by gathering NTFP such as bamboo shoots (*Indosasa sinica, Dendrocalamus* spp.), rattan shoots (*Calamus* spp.), broom grass (*Thysanolaena latifolia*), cardamom (*Alpinia cardamomum*), peuakmeuak (*Boehmeria* spp.), and benzoin (*Styrax tonkinensis*). Most important NTFPs are found during long fallow periods of 4 years or more (Yokoyama 2004). Currently, population pressure, land use policy, and promotion of commercial crops are the main causes of forest degradation (Thongmanivong and Fujita 2006; Fujita and Phanvilay 2008). The fallow period has become critically short, and fallow rotations are down to 3 years (NAFRI 2005: 48). Therefore, if local residents lack optimum fallow management, long-term access to natural resources will be uncertain in the future. We suggest that long fallow period management should be promoted together with natural resource management. In addition to NTFPs, the land variable of natural capital shows that local residents had different numbers of plots and average land size of about 5.43 ha per household (range, 0–22.5 ha). These figures were not substantially impacted by the climate event. The findings indicate that land is not a significant factor in helping local people cope with and overcome early onset of the rainy season. In other words, land area was an important capital under the normal climate but not under the climate event. However, land size is an important factor related to production volume; larger farm size means greater amounts of produce (Roder 1997; Southavilay et al. 2013).

The human capital and labor force in the household became more important in the 2011 climate event. At the research site, upland rice is a major crop for household consumption, and is based on slash-and-burn systems. In a normal year, upland rice production requires about 300 person days/ha/year, including 20 person days/ha/year for burning dry biomass (Roder 2001: 9–10). Normally, land for swidden is prepared by cutting fallow forest or shrub forest and by burning the dry biomass before planting. On the other hand, in the 2011 climate event and early onset of the rainy season at the beginning of March, farmers missed the timing of burning and the biomass became wet. Therefore, farmers had to remove the biomass from the farmland by hand. In the village, about 100-person days/ha are needed for land preparation by hand for cultivation. Therefore, many lower-labor households were unable to cultivate upland rice, while sufficient-labor households could do so. This indicates that labor became more important in the normal year at the research site, emphasizing that access to labor is a challenging capital for households under climate events. Moreover, the demand for labor in a household affected the education of children. In the climate event, about 50% of children in households dropped out of school to respond to labor shortages in household activities and agricultural production.

The overall physical capital index had a significant difference between 2010 and 2011. Two variables of the physical capital index, access to irrigation paddy fields and farm input, did not show any significant differences. This is because the paddy area on the sloping mountain at the research site is limited. In addition, the research site lacks agricultural extension support including local authority and private investment.

Access to external facilities and electricity have changed in the short period between 2010 and 2011. Laos is a member of the Association of South East Asian Nations (ASEAN) in 1997, investment legislation and laws have provided incentives to investors for both joint ventures and foreign direct investment in the country (Phanvilay 2010: 3). Vietnamese and Chinese investors established electrical shops beside national road No. 13 from central Laos through the northern provinces, near the borders with China and Vietnam. Color televisions, CD-DVD players, refrigerators, and mobile phones are available at the research site. In addition to electricity, facilities
including hospitals and schools were provided loans and financial support by the World Bank and Asian Development Bank to increase infrastructure and human resource development in rural areas. However, some variables had significant difference and others did not. We believe that changes in overall physical capitals were influenced by the rural development program of the Laotian central government rather than by the climate event. The present findings indicate that political and development programs were associated with changes in physical capitals at the research site.

Residents at the research site were better off in terms of natural capital but worse off in terms of financial capital. The findings show that the education level did not support residents’ wages and salaries, but experience was an important indicator. According to interviews with factory employees in 2011, more experienced people earned higher monthly salaries, about 800,000 kip, compared with 600,000 kip for the less experienced. These findings contradict those of Morse et al. (2009) who asserted that education was important in augmenting off-farm sources of income; they stated that educated persons had increased opportunities to earn a wage or salary (Morse et al. 2009: 8). However, this was not the case for the rural uplands of the research site. The pentagonal diagram of livelihood revealed that most residents there were dependent on natural resources as a means of living, and income-generating activities were limited in both the normal climate and climate event years. We recommend that access to sources of income and short-term income-generating activities for rural people should be promoted and implemented, rather than promoting commercial trees and long-term investment in rubber plantations (Manivong and Cramb 2008) and forest land allocation. The latter activities have impacted upland farmers in mountainous areas, where people are heavily dependent on swidden cultivation (Yokoyama 2014).

Interestingly, Figure 7 shows that the overall social capital index of group I was higher than that of group II in both climate conditions. This is because neither group I nor group II made a significant difference in participation in the village’s activities, including decision making, planning, meetings, and implementation; however, they had different social relationships such as helping each other. Villagers frequently exchanged labor in the swidden agriculture system, including planting, weeding, and harvesting. In the climate event year, the role of labor exchange became less important, while food sharing, rice, and money borrowing became more important than in the normal year. This indicates that households with a substantial labor force tended to be better adapted to the climate event, but had fewer social relationships in a climate event year.

In fact, decision making in households remained the main driving force behind change in social capital between 2010 and 2011 at the research site. Household heads also strongly influenced decisions related to crop production, livestock production, and farm management. In some cases, heads of households went outside the village to earn additional income in response to food insecurity. As a result, women and children lost the opportunity to make decisions and provide their opportunities. The social capital of any society is very important, because mutual trust and connectedness help people to cope with shocks in any vulnerable situation (Shah et al. 2005). Therefore, the related policy sector response to this issue should be to improve social capital and strengthen local institutions, together with providing income-generating activities in the village rather than outside of it.

Change in livelihood activities

Our study indicates that households at the research site changed their livelihood strategies and sources of income in response to an early onset of the rainy season. This corresponds with the meaning of livelihood as “A livelihood comprises the capabilities, assets (stores, resources, claims, and access), and activities required for a means of living” (Chambers and Conway 1992: 6). Figure 9 shows that NTFP gathering and outside work were important income sources under the 2011 climate event for households with sufficient labor. NTFP gathering and off-farm activity were the most important strategies in households with insufficient labor during the climate event and the normal climate year. Outside work was a strategy implemented by local people in order to cope with the lack of food security during the climate event year, and when the price of labor increased, there was a corresponding increase in the number of outside workers. Labor shortages and less attention to community activities were challenges. However, household strategies were mainly short-term responses, and a consumption response rather than a productive response. Consumption responses are directed toward ensuring income and sufficiency in the consumption needs of the household (Satanto 2008: 139). The current finding indicates that diversity of local activities is a fundamental characteristic to cope with short-term impacts from climate change. People did not create new livelihood strategies for coping with the climate event; they dealt with the early rainy season onset by increasing the ratio of labor input to time spent on each activity dur-
ing the climate event.

Conclusion

This study analyzed differences in peoples' livelihoods between climate conditions, in this case the normal 2010 climate and the 2011 climate event. We adapted the SLF developed by DFID, with selected livelihood assets, and formed a pentagonal diagram of five forms of capital of respondents, to determine any change between the normal climate and climate event years (2010 and 2011, respectively). The study concludes that households with a substantial labor force tended to cope better with the climate event than those with a small labor force. They had good access to natural capital but less access to financial capital. The study found many factors that enhance the ability of local people to cope with short-term impacts and most of the factors are also useful in long-term change. Those factors play different roles in short- and long-term events.

We also conclude that livestock plays an important role in the household economy, especially when it is used as a means of cash income and saving. Agricultural production and gathering NTFPs are a response to food security in a household and some may be sold at market. Off-farm and outside work are a way to earn income or savings. The finding concludes that there were no different livelihood activities in the normal climate and climate event years, but the ratio of labor input and time spent on each activity was different between the normal 2010 climate and the 2011 climate event.

Changes in the livelihood assets of local people at the research site resulted from the climate event. However, socioeconomic and political factors are also relevant in changing livelihood strategies. We suggest that this issue should be investigated further.

Acknowledgements

We are grateful for the support and information provided by Kachet residents during our field survey. We would also like to thank all reviewers for their valuable suggestions and comments on this paper.

Notes

1. One U. S. Dollar (USD) was equivalent to 8,029 kip on average in 2011. This paper used the same exchange rate of USD in 2011.
2. One U. S. Dollar (USD) was equivalent to 8,269 kip on average in 2010. This paper used the same exchange rate of USD in 2010.

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