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Livelihood Factors and Household Strategies for an Unexpected Climate Event in Upland Northern Laos

Phanxay INGXAY[1] http://www.orcid.org/0000-0002-6981-0146; e-mail: phanxay_@hotmail.com

Satoshi YOKOYAMA[1] http://www.orcid.org/0000-0003-0008-2408; e-mail: s-yokoyama@nagoya-u.jp

Isao HIROTA[2] http://www.orcid.org/0000-0003-3138-3027; e-mail: isao@nagoya-u.jp

1 Department of Geography, Graduate School of Environmental Studies, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan

2 Graduate School of Bioagricultural Sciences, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-4601, Japan

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Abstract: Climate events pose major challenges to food production and the livelihoods of rural inhabitants in northern Laos, where upland rice using swidden production is an important crop. The onset of the rainy season in this area is one such climate event, and it has occurred earlier and with less regularity in recent years. Not all households are able to cope with these changes. This study examines the ability of local farmers to cope with rice insufficiency. This investigation also clarifies household strategies in dealing with the climate event. We randomly interviewed 63 of 95 household heads, and performed a paired sample *t* test to examine the significance of differences in three household groups between the 2010 normal climate and the 2011 climate event. The groups were categorized according to rice self-sufficiency in 2011: groups I are households with rice self-sufficiency, group II are those facing a rice shortage of up to 3 months, and group III are those with insufficient rice for over 3 months. We also conducted a one-way ANOVA to examine the significance of differences in livelihood strategies among the three groups. We found that the household labor force was the most important factor in enhancing the villagers' ability to deal with the climate event and that the level of impact of that event shaped their coping strategies. Households with substantial labor force had more options for coping strategies than those with smaller ones. The villagers faced different levels of impact and adopted different coping strategies accordingly. Non-timber forest product collection was the principle livelihood strategy in response to non-climate factors such as education, access to health services, provision of equipment and clothing, and overcoming the impact of the climate event. Households heavily affected by the early rainy season onset tended to engage in intensive activities such as off-farm activity and outside work, rather than their major livelihood activities in the village (upland crop and livestock production).

Keywords: Climate events; Livelihood factors; Livelihood change; Household strategy; Swidden

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Introduction

Climate change adversely affects water resources, agricultural sectors, forestry, human settlements, ecological systems, and human life in many parts of the world (Elasha et al. 2005). Climate change is also a challenging issue in rural development and imposes impacts on agricultural production, ecosystem services, and people livelihoods (Sivakumar et al. 2005). These problems are attributable to limited resilience, which involves the inherent abilities and adaptive responses of local people to outside impacts, subsistence food production, and natural

production potential (Mertz et al. 2009). Adger (2000b) defined resilience as the ability of individual or household to cope with external trends and stresses such as social, economic, political, and environmental changes. Resilience is thus the ability of people to cope with or respond to unpredictable events or suddenly change (Pike et al. 2010). Climate constitutes one aspect of vulnerability: it frames the external setting in which people live and encompasses aspects that are far beyond their control (DFID 1999). People in the developing areas of Southeast Asia face multiple climate stressors, such as increased droughts in the northwest and eastern coastal regions of Vietnam (Yusuf and Francisco 2009), early season typhoons in northern Vietnam (Adger 1999), and increasing flooding in Thailand (Duan et al. 2009; Lebel et al. 2011). In addition to climate stressors, economic, political, and social factors are major driving forces of change in local livelihoods (Mertz et al. 2009).

However, most inhabitants of developing countries still depend on traditional agriculture (Marten 1986). The places are characterized by high dependence on natural resources for livelihoods, low productivity (Hoekman et al. 2005), and lack of education in rural areas (Jansen 2003). Measuring the direct impact of climate change on local livelihoods is therefore important for sustainable development in such countries. At the local level, agricultural surpluses are small, and a major climate event may seriously diminish agricultural production (Shrestha et al. 2012). Accordingly, it is necessary for local inhabitants to adopt a strategy of risk management to sustain their livelihoods. Sustainable development in developing countries demands a clarification of how people respond and successfully adapt to local environmental change (Adger et al. 2005; Aalst van et al. 2008).

Recently, many authors have focused on adaptation strategies with respect to adaptation and response of local inhabitants to the long-term impacts of multiple stressors, such as drought (Ali 1999; Kurukulasuriya et al. 2006; Thomas et al. 2007; Paavola 2008; Stringer et al. 2009; Sissoko et al. 2011), flooding (Schreider et al. 2000; Booij 2005; Lebel et al. 2011), and weather hazards (Adger 2001; Gaillard et al. 2009; Nguyen et al. 2013). These various studies have been conducted about local livelihood response and vulnerability to climate change toward understanding their implications for adaptations to such change. Many efforts have been directed at reducing vulnerability by means of local adaptation strategies in response to climate change. Adaptation strategies are used when local inhabitants reduce overall vulnerability to climate events or change (Morton 2007); these strategies aim to reduce vulnerability to such events or longer-term change (Eriksen and Silva 2009). Adaptation offers effective measures to reduce climate sensitivity (Eriksen et al. 2005). Empirical studies have examined on adaptation, with particular focus on the condition of adaptation which actually occurs within social and economic systems (Smithers and Smit 1997). Morton (2007) stated that farmers decreased on access to agricultural markets resulting from global socioeconomic changes and population growth leads to fragmentation of landholding. These trends limit a smallholder's capacity to adapt to climate change. People live with high rainfall variability, weather hazards and climate shocks had engaged various of livelihood strategies to reduce overall vulnerability from these impacts. Adger (2001) introduced the concept of social capital and demonstrated the collective action for coping with weather extremes by climate change. Adger showed that social capital—both bonding and networking—played a primary role in recovery from the impacts of hazards around coastal northern Vietnam. In central Vietnam, Nguyen et al. (2013) found that adaptation strategies of farmers to high climate variability and frequent weather hazards depended on their access to natural and social resources; the strategies were diverse owing to differences in such access. That study also provided evidence for the importance of home and forest gardens as potential providers of a significant safety net with respect to climate variability.

Reducing overall vulnerability to climatic events includes the impact of extreme events (Downing 1991). Smit and Wandel noted that the "vulnerability of any system is reflective of the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt or recover from the effects of those conditions" (Smit and Wandel 2006). Adger (1999) defined vulnerability as "the exposure of individuals or collective groups to livelihood stress as a result of the impacts of

such environmental change." Kelly and Adger (2000) defined vulnerability as the ability of people or social groupings to recover from, adapt to, respond to and cope with any external stress placed on people livelihoods. Vulnerability is an indication of peoples' ability to cope with the impacts resulting from external trends, shocks, and stresses (DFID 2004). Vulnerability has a longer-term impact, such as technological or population trends. Shocks cannot be predicted at all; they include such events as floods and storms; they are in contrast to seasonality, which refers to the shifting of prices, employment opportunities, and production with the seasons (DFID 2001).

In addition to adaptation strategies, coping is often considered a short-term survival strategy (Eriksen and Silva 2009). A coping strategy involves local inhabitants managing the impacts of climate events (Morton 2007). Coping strategies signifies actions and activities taken when people faced by each crisis or extreme event (Adger 1996). On the one hand, Eriksen et al. (2005) conclude that "coping strategies is a prime means of facilitating adaptation" (Eriksen et al. 2005). Eriksen et al. (2005), Daskon and Binns (2009), Eriksen and Silva (2009), and others have considered household coping strategies to climate stress. In a study on areas affected by drought in Kenya and Tanzania, Eriksen et al. (2005) found that households in which the members were engaged in a range of unspecialized activities faced high vulnerable than households in which the members were able to undertake a specialized activity, such as employment or charcoal burning. They observed that households had limited access to favored coping options owing to a lack of skills, labor, and capital during the drought. Reid and Vogel (2006) reported that the ability of farmers to access to infrastructure and social capital were important factors in enhancing farmers to respond to climate stress. The capacity of local people to cope with and adapt to long-term impacts of climate change is becoming increasingly clear (Adger et al. 2005). It is evident in the literature that adaptation strategies have been employed to reduce the longer-term impact of climate events; by contrast, coping strategies are used to manage the immediate, short-term impact of such events (Morton 2007). Studies have found that when facing similar impacts of climate events, people may adopt similar or different livelihood strategies to cope with them (Eriksen and Silva 2009). Climate events may even lead to different levels of impact within the same household. However, variations in the coping strategies adopted in response to different impact levels of climate events remain unclear and demand investigation.

In northern Laos, there are few areas of flatland and many steep mountains. The inhabitants often engage in subsistence upland rice farming by swidden agriculture. Upland rice is a major crop for household consumption. Therefore, achieving sufficient rice production in this way is the main livelihood strategy in that rural part of the country (Ingxay 2005). Swidden signifies an agricultural system that consists of slashing, burning, planting, weeding, and harvesting. Among those activities in northern Laos, land preparation, such as slashing and burning fallow forests or shrub vegetation in March (the end of dry season), is an activity that is sensitive to climatic events. This is because villagers have to do their burning on the driest day at the end of the dry season before the onset of the rainy season. From an analysis of the climate in northern Laos, Kanemaru et al. (2014) found that the onset of the rainy season became earlier and that its variability increased between 1951 and 2007. This phenomenon, caused by climate change, has been generally observed in mainland Southeast Asia under the influence of the monsoon. If the Sea Surface Temperature (SST) of the Indian Ocean increases and that of the western Pacific Ocean SST decreases, the summer monsoon becomes weaker. If the situation is reversed, the result is a strong summer monsoon (Kanemaru et al. 2014).

Climate change has become remarkably evident in northern Laos. With the early onset of the rainy season in 2011, some households were able to cope with situation, particularly in rice production; some were not. Clarifying the different strategies to cope with rice insufficiency as a result of climate events is of key importance to rural development in that part of the country. Determining climate event and the early rainy season onset aims to understanding the vulnerability to future climate change; this is because some current social factors may exert a similar influence in the future (Kelly and Adger 2000; Eriksen and Silva 2009). However, many

climate stressors (including drought and flooding) and early onset of the rainy season demand consideration. In addition, those stressors occur only once a year in most cases, and it is necessary to determine how the local inhabitants solve those issues within a short period. Climate change and early onset of the rainy season exert an increasing impact on people living in northern Laos. However, the early onset of the rainy season affects not only northern Laos but also other countries where the inhabitants are heavily dependent on natural resources and traditional rain-fed agriculture for their livelihoods. The present study focuses on household coping strategies as a response to early onset of the rainy season in 2011 in northern Laos (short-term impact of a climate event); the strategies were aimed at obtaining rice sufficiency and income over the 1-year period. In this study, "coping with the climate event" refers to responding to rice insufficiency as a result of the early onset of the rainy season.

1 Study Area and Methodology

1.1 Study area

The research site was the village of Kachet, Nam Bak district, Luang Phabang Province, Lao People's Democratic Republic (Figure 1). The residential area of the village is located at an altitude of about 750 m, and the village is surrounded by mountains about 900 m high. The village is at 20°34'N, 102°18'E, about 27 km west of Nam Bak (district capital) and 130 km northwest of Luang Phabang (provincial capital). The average temperature in the rainy season from April to October is over 20°C. However, during the dry season, from November to March, the temperature is under 20°C. The mean annual rainfall in the province is usually 1500–2000 mm (DMH 2012). Luang Phabang Province consists of three main ethnic groups: Khamu (46.8% of the total population); Lao Lum (29%); Hmong (16.1%); other ethnic groups account for 8.1% (NSC 2005). The research site was selected because Kachet is a typical swidden-based village in northern Laos; farmers there still work in their mountain fields, and upland rice is a major food staple. Additional food is collected from the mountain forests. The village is located at a high altitude, and it has low temperatures; therefore, unlike other northern Lao villages, commercial crops such as corn and rubber trees cannot be cultivated. Kachet may be taken as representative of a village in an upland setting.

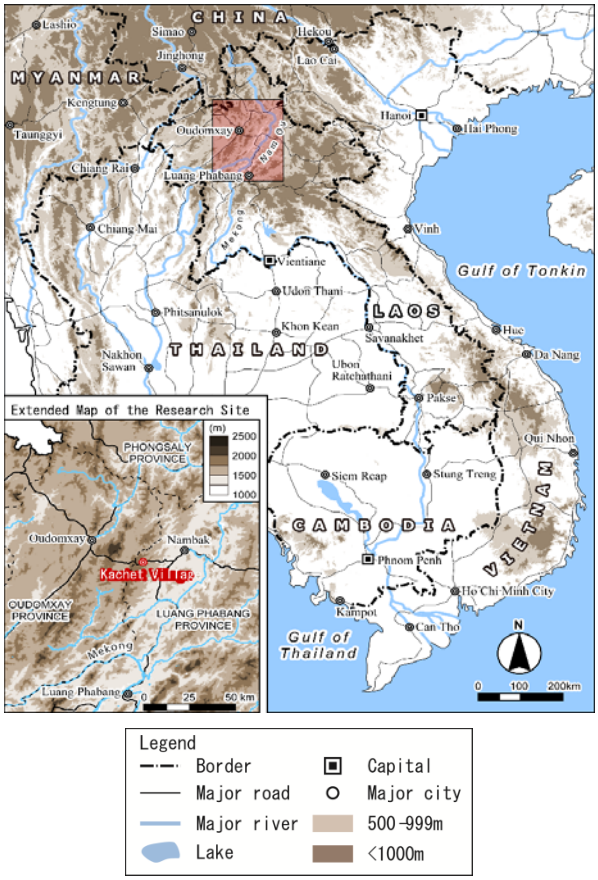

Figure 1 Research site map.

In 2011, the village had 95 households and 486 residents, of whom 258 were female. The inhabitants all belong to the Khamu ethnic group, one of the original Indochinese ethnic groups in Laos (Simana and Preisig 1997). Currently, the Khamu are spread throughout northern Laos and in highland areas bordering Vietnam, Thailand, China, and Myanmar. In Laos, most Khamu still build their villages and houses in mountainous areas, where agricultural production depends on rainfall. Upland rice cultivation is the main livelihood activity to meet rice self-sufficiency in Kachet. Rice self-sufficiency refers to a household being able to meet its consumption needs from its own production rather than by buying or borrowing. The Kachet villagers do no cultivate

glutinous rice in flooded paddies; they cultivate only upland rice on dry soil in the rainy season.

The Kachet villagers also raise domestic animals such as buffalo, cattle, and poultry. Livestock is important to the household economy: households may sell their animals to obtain money for purchasing necessary agricultural tools, equipment, and clothing and pay for child education and health services. The Khamu also depend on finding additional food from fallow forests and obtain edible and medicinal plants, mushrooms, bamboo shoots, and fruit. They also hunt and fish. The Kachet villagers have subsistence livelihoods and essentially consume such food as fish, chickens, small wild animals and vegetables that they catch, raise or grow in their own villages and small home gardens. They buy beef and buffalo meat once every 2 weeks from peddlers.

In Kachet, upland crop production systems are based on rotational cycle systems or traditional swidden practices. In northern Laos, the swidden fallow period in 1950 was about 40 years declined to 5 years in 1993 as a result of increased population density and forestry policies limiting the local people' access to land (Roder 1997). This means that the available land for swidden agriculture has decreased. In addition, government policy has indirectly influenced the local economy. The government has promoted foreign investment in northern Laos, and foreign investors began planting rubber trees there in around 2005. The rubber plantations in northern Laos require a labor force and provide rural people with a new means of income. The Kachet villagers also began doing plantation work then.

With swidden farming, the Khamu first select an area of fallow forest and begin slashing it in February; they then burn it during March and early April. After burning, they clear the land once more before planting rice in May to early June. Farmers plant such crops as rice, taro, large gourds, chilies, pumpkins, cassava, and cucumbers in the same plots. In Kachet, only cucumbers are cultivated for sale in markets. Farmers have to weed the plots two to four times during the rice-growing period. Upland rice is harvested in late September for early-maturity varieties and in October and early November, respectively, for medium- and late-maturity varieties (Figure 2). After rice cultivation for a year, the farmers let the field go to fallow. Many types of non-timber forest products (NTFPs) may be found in the fallow forests (Table 1), and they are important as a source of income during rice shortages. All these activities related to the swidden system support the locals' livelihoods.

The Kachet villagers faced two major problems though climate change—early and reduced rainfall. Reduced rainfall from May to June affected crop yields, mainly upland rice and NTFPs. This

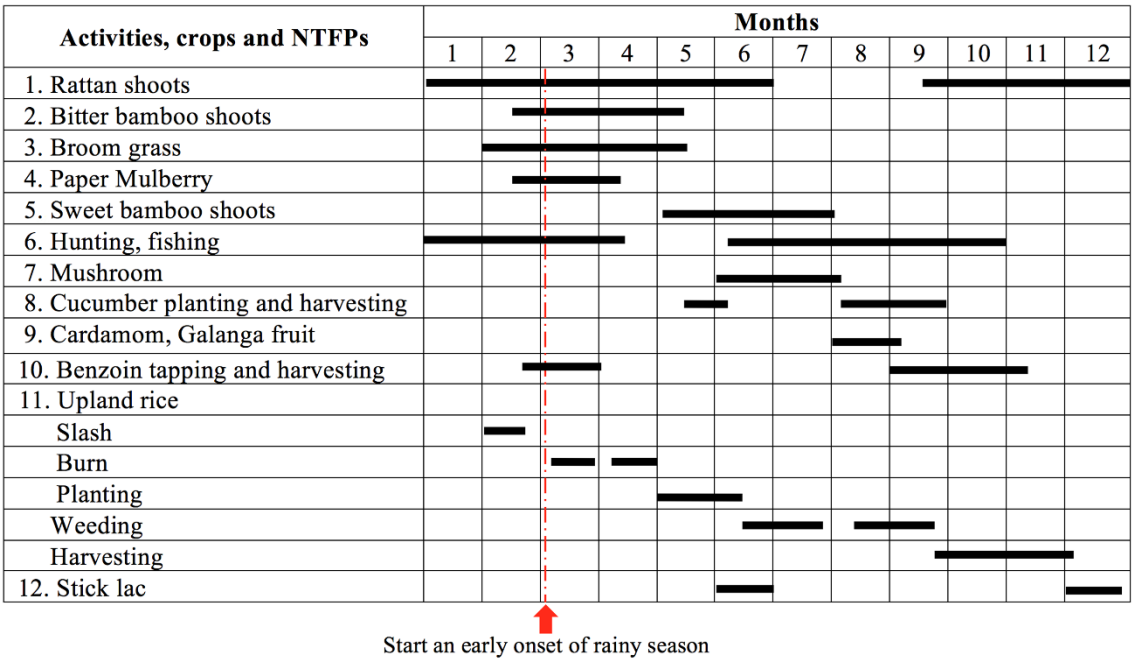

Figure 2 Seasonal calendar for Kachet village in Northern Laos (Source: Field survey in July 2011).

Table 1 Livelihood activities and NTFPs collection at the research site

For sell	For self-consumption	For sell and consumption
Cardamom (*Amomum villosum*) Peuakmeuak (*Boehmeria* spp.) Benzoin (*Styrax tonkinensis*) Broom grass (*Thysanolaena latifolia*)	Upland rice; Chili; Sesame; Taro; Sweet corn; Vegetable; Ginger; Pumpkin; Fishing; Hunting	Rattan shoots (*Calamus* spp.) Bamboo shoots (*Indosasa sinica, Dendrocalamus* spp.) Livestock Cucumber

reduced upland crop production at the research site. As noted above, upland rice cultivation is an activity that is sensitive to climate events. The early onset of the rainy season in March (Figure 3) had a great impact on swidden practices by reducing the area of upland rice cultivation in 2011. Most households were unable to burn fallow forest after having slashed it in February and therefore failed to plant any crops. In addition, some important NTFPs, such as benzoin resin, could not be collected owing to the early onset of the rainy season.

1.2 Data collection and analysis

Household data were collected via a household survey as well as semi-structured and structured interviews in addition to participatory group discussions. The household data are quantitative and qualitative. The household interview focused on the farmers' basic socioeconomic characteristics. In June 2011, the first interviews were held with the representative heads of 63 households, which were randomly selected from the 95 households in the village. Data relating to the households in 2010 were collected in the June 2011 interviews. In February 2012, a second set of interviews was conducted with the same interviewees to obtain household data for 2011. Two group discussions were held after the interviews. Separate discussions took place for participants who had sufficient rice and those who did not. The group discussions were held to hear the farmers' perceptions of climate events at the research site.

As noted above, in 2011 climate the early onset of the rainy season in March had a great impact on upland rice cultivation. Therefore, household rice sufficiency in 2011 became a more pressing issue than in other years. Despite the early onset of the rainy season, some households were successful in cultivating rice; others were not. Thus, coping with rice insufficiency largely depends on whether the locals can conduct swidden cultivation. If villagers can cultivate rice, they need only collect food for side dishes. If they cannot cultivate rice, they must earn money to buy rice through various activities, such as outside work, livestock sales, and NTFP collection.

The 63 sampled households were divided into three groups based on the impact of the 2011 climate event: group I had rice self-sufficiency and consisted of 12 households that were able to cultivate rice despite the early onset of the rainy season; group II comprised 34 households that suffered a shortage of rice of up to 3 months; group III consisted of 17 households that faced a rice shortage for over 3 months. Households in different situations adopted different livelihood strategies to cope with the impact of the climate event. In 2010, most households sampled had sufficient rice: only some households faced a rice shortage of 1–3 months. In a normal climate year, it was usual for some households to face a rice shortage of up to 3 months.

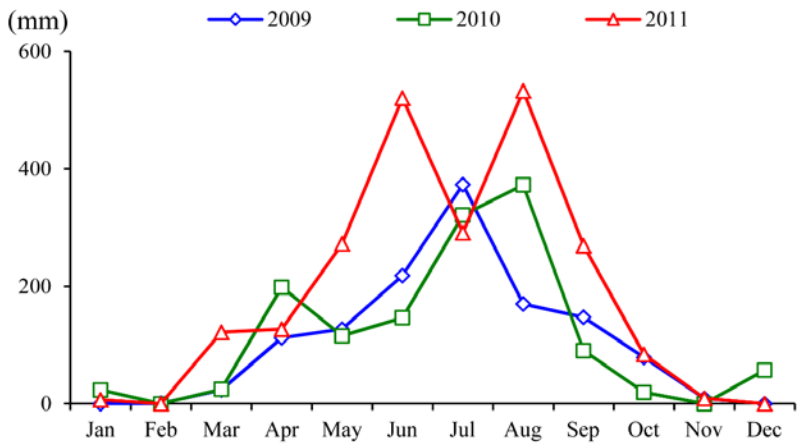

Figure 3 Average monthly rainfall in Luang Phabang Province in 2009, 2010 and 2011 (Source: Department of Meteorology and Hydrology (DMH) of Laos, 2012).

We used the Statistical Package for the Social Sciences (SPSS, Chicago, IL, USA) to perform two statistical analyses. First, we conducted a paired sample *t* test to examine the significance of the differences between a normal (2010) and the climate event (2011) year, sorted by groups I, II and III, and compared household income sources. Second, we performed a one-way ANOVA to examine the significance of the differences in the livelihood strategies among the three household groups. We also examined the factors that enhanced villagers' ability to cultivate rice successfully despite the early onset of the rainy season.

2 Results

2.1 Socioeconomic characteristics of sampled households in 2011

In the 63 households sampled, the average age was 48 years (range, 28–80). Over half (57.1%) the respondents had received only primary school education; 38.1% had no education; and 4.8% has received secondary school education. The average number of members in each household was 5.68 (range, 2–11). The average agricultural land area was 5.43 ha (range 0–22.50; Table 2). All the households cultivated upland crops (including rice) as a major activity. They consumed rice as a staple food and earned their income from upland crops and livestock. As mentioned above, the labor force in each household was important for activities related to rice production. An average of 3.11 people in each household were engaged in labor. In 2011, villagers who were unable to cultivate rice owing to the climate event had to engage in other work and activities. The average number of people in a household who undertook outside work in 2011 was 0.95. In addition to rice cultivation, the villagers generally raise cattle and water buffalo: on average, there were 1.65 cattle and 0.27 water buffalo per household in 2011.

Table 2 Basic socioeconomic characteristics of sample groups in 2011

Independent variable		Group I	Group II	Group III
Household members (person)	Max.	10	11	8
	Min.	4	3	2
	Mean	6.50	5.76	4.94
Age (year old)	Max.	65	70	80
	Min.	33	32	28
	Mean	50.42	46.68	47.82
Education (person)	Non-educated	2	14	8
	Primary 1	1	2	1
	Primary 2	2	6	3
	Primary 3	3	2	3
	Primary 4	1	1	
	Primary 5	3	7	1
	Secondary 1		1	1
	Secondary 2		1	
Agricultural plots	Max.	8	10	9
	Min.	2	0	0
	Mean	4.33	3.44	3.35
Total agricultural land area (ha)	Max.	13.88	22.50	15.25
	Min.	2.25	0	0
	Mean	6.88	5.09	5.12
Nos. of outside workers (person)	Max.	2	4	4
	Min.	0	0	0
	Mean	1.00	1.09	0.65
Labor in household (person)	Max.	7	4	6
	Min.	3	1	1
	Mean	4.67	2.71	2.82
Nos. of animals (cattle and buffalos)	Max.	18	8	5
	Min.	0	0	0
	Mean	4.75	1.03	1.18

Notes: "Primary 1" and "Secondary 1" refer to "Grade 1 primary school" and "Grade 1 secondary school", respectively. The others are the same.

2.2 Impact of climate event on livelihoods

2.2.1 Rice shortage

The villagers had clear memories of 2011, which was marked by an unexpected, significant disturbance in village food production. According to the interviews in 2011, 19 of the 63 households successfully cultivated rice despite the early onset of the rainy season. However, 44 households stated that the March onset of the rainy season badly affected their swidden cultivation: they were unable to not burn fallow forest after slashing to create upland fields. Compared with 2010, the cash crop production areas of rice, maize, taro, pumpkins, and cucumbers decreased by 92% (142 ha) in 2011. In 2011, among the 19 households that successfully cultivated rice, 12 households had sufficient rice from their own production (Table 3); seven households were unable to produce sufficient rice. The respondents indicated that the average rice yield was about 1.4 tons/ha in 2010; that

compared with about 0.9 tons/ha in 2011. The latter amount would be sufficient for 7–8 months for households with four to five members. The respondents stated that a major reason for the low rice yield was lack of labor for weeding.

In 2011, 51 households faced a rice shortage; the range was 1–9 months. This was the reverse situation to the normal year of 2010, when 50 of the 63 households had sufficient rice (Table 3); then, only 13 households had insufficient rice, and the range was 1–3 months. In 2010, respondents explained their low rice yield as being due to a shortage of labor for weeding. Another reason was a lack of land for cultivation. Such households normally obtained rice from relatives and repaid them by providing their own labor.

Table 3 Rice insufficiency at the research site for different household groups

Groups	The 2010 normal		The 2011 climate event	
	Shortage month	Households	Shortage month	Households
Group I	None	12	None	12≈
Group II	None	29	None	-
	1	4	1	17
	2	-	2	6(1*)
	3	1	3	11(2*)
Group III	None	9	None	-
	1	4	1	-
	2	3	2	-
	3	1	3	-
	4	-	4	7(2*)
	5	-	5	5(1*)
	6	-	6	2(1*)
	7	-	7	1
	8	-	8	-
	9	-	9	2

Notes: * households could cultivate rice, but not sufficient rice in the 2011 climate event; ≈households could cultivate rice and had sufficient rice in the 2011 climate event.

The rice shortage continued until September 2012—especially among households that were unable to cultivate rice in 2011. In 2011, the villagers still had rice left over from 2010. In 2012, 12 households had rice because they had been able to cultivate it in 2011. However, other households faced a rice shortage from September 2011 to September 2012.

2.2.2 Livestock production

In the study area, livestock production is an important activity for Khamu male heads of households and the household economy. Villagers generally raise cattle, water buffalo, pigs, chickens, and ducks. Cattle and water buffalo are raised in traditional fashion, particularly in fallow forest and forest areas after the harvest, and villagers go to care for them two or three times a week. In all, 42% of the households raised cattle, 10% water buffalo, 59% poultry, and 59% pigs. The respondents reported that in addition to the early start of the rainy season, particularly heavy rain fell from March to June 2011. This resulted in outbreaks of foot-and-mouth disease for livestock and other various deaths: about 415 of the 619 poultry, 43 of the 96 cattle, 20 of the 99 pigs, and 4 of the 17 water buffalo died. Temperature and rainfall have a statistically significant correlation with foot-and-mouth disease (Hii et al. 2011). The villagers have access to veterinary medicine but do not use it owing to the expense; they also lack knowledge of animal health maintenance.

2.2.3 NTFP collection

In addition to the rice shortage and animal health problems, the early onset of the rainy season in March 2011 reduced income from NTFP collection, which represents an important part of household income. NTFPs accounted for 40% of total household income in 2011 compared with 44% in 2010. The most important NTFPs—benzoin resin and broom grass—could not be harvested owing to the early rain. Benzoin trees are tapped from August to September, and the resin is harvested from March to April (sometimes as late as May) in the following year. Almost 60% of respondents stated that they owned benzoin forest land, but only five households were able to harvest benzoin resin before the onset of the rainy season. Broom grass is a fallow plant rather than a typical NTFP, but it is important as a source of income during rice shortages. In Kachet, cardamom (*Amomum villosum)*, peuakmeuak (local name) (*Boehmeria* spp.), benzoin (*Styrax tonkinensis*), and broom grass (*Thysanolaena latifolia*) are harvested for sale in local markets, whereas

bamboo and rattan shoots are collected for both consumption and sale.

Group discussions with the respondents and village authorities revealed that the locals had a very clear memory of years dominated by an early onset of the rainy season, which occurred a long time earlier. The villagers said that such years were associated with shorter cold periods for about 1 or 2 months, in case of 3 to 4 months is normal climate at the research site. The group discussions suggested that the main concern among the villagers was about crop production rather than climate change. That was because many other villages around Kachet had adopted hybrid maize production through the introduction of outside investors. Such villages were able to generate income mainly from agriculture, whereas the Kachet villagers earned money mainly through NTFP collection.

2.3 Changes in labor force and outside workers

The average household labor force was largest in group I: it was 3.42 people in 2010 and 4.67 in 2011 in group I; group III had 2.53 people in 2010 and 2.82 in 2011; and group II had 2.41 people in 2010 and 2.71 in 2011. Thus, the labor force per household showed no significant difference between 2010 and 2011 for groups I and III. The average household labor force in group II showed a significant difference at the 0.05 level during the same period. However, the results of statistical analyses showed that the average number in the labor force was significantly different among the three household groups at <0.001 for both 2010 and 2011 (Table 4). Labor exchange is commonly practiced in northern Laos in rice production activities such as slashing, planting, weeding, and harvesting. In 2011, that system was not applied owing to the shortage of labor and lack of villagers to conduct swidden farming. Another reason for the shortage of labor in Kachet was outside work in urban areas.

The average numbers of outside workers in group I households showed a significant difference at 0.01 between 2010 and 2011: there were 0.58 workers per household in 2010 and 1.00 worker in 2011. Those figures for group II also displayed a significant difference between the years at the 0.05 level: 0.68 workers per household in 2010 and 1.09 in 2011. However, the average number of outside workers did show a significant difference in group III households: 0.47 workers in 2010 and 0.65 in 2011. There was no significant difference among the three household groups for the average number of outside workers in both 2010 and 2011. Normally, the villagers start outside work after planting rice from May to June. However, in 2011, the early start of the rainy season in March resulted in a failure to burn forest, and so the villagers had to start outside work earlier. As noted above, 44 of the households were unable to cultivate rice in 2011, and so household labor was available to earn additional income outside the village; the other households devoted their labor to rice cultivation. In 2011, the daily income outside Kachet was about 50,000 kip (6.2 USD), whereas in the village it was about 30,000 kip (3.7 USD). The income outside the village was thus higher than in the village. In addition, interviews indicated that the villagers began working outside Kachet in 2005, when the daily price of labor increased slightly to 15,000 kip (0.7 USD); that figure increased to about 50,000 kip (6.2 USD) in 2011 along with commodity prices.

2.4 Changes in household income

In a normal climate year, Kachet villagers frequently made use of their natural environment for such materials as NTFPs, mainly for local markets and household consumption. As noted, rice cultivation was the main household activity, and achieving rice sufficiency based on swidden agriculture was the principal livelihood strategy in Kachet. The villagers also raised livestock to support household income. Livestock are considered a means of short-term saving, and they are sold when the owners need money. The heads of households commonly undertake off-farm activities, such as carpentry, tree planting, and roadside trading, after the rice harvest in September. Outside work is also important for generating income. The villagers work in such places as construction sites, factories, and restaurants in urban areas. Most children in Kachet drop out of school to work outside the village: the main reasons are that households lack the financial resources to support their children's education and that those children don't want to work in agricultural

Table 4 Comparison of livelihood strategies among group I, II, and III in 2010 and 2011

Livelihood strategies	Year	Group I			Group II			Group III			One-way ANOVA
		Mean	SD	T-Test	Mean	SD	T-Test	Mean	SD	T-Test	
Total NTFPs income (kip)	2010	3,498,446	1,072,254	4.125**	2,757,368	1,076,265	1.562	3,089,794	1,357,878	2.879*	1.908
	2011	2,846,529	685,951		2,572,265	760,138		2,521,412	978,421		0.64
Total crop production income (kip)	2010	950,000	889,842	1.925	1,079,412	997,810	6.255***	1,123,529	2,064,743	2.165*	0.61
	2011	625,000	864,581		8,824	51,450		88,235	196,476		11.592***
Total animals income (kip)	2010	1,295,000	1,525,048	1.915	1,543,529	2,050,444	2.777*	873,529	1,707,714	1.512	0.724
	2011	739,167	968,527		859,412	1,037,511		511,765	945,140		0.683
Total off-farm income (kip)	2010	691,667	955,804	1.798	1,791,765	2,565,760	1.729	2,119,118	2,622,581	-0.027	1.371
	2011	208,333	320,393		1,529,412	2,121,692		2,124,471	2,409,624		2.602
Total outside work income (kip)	2010	895,833	1,388,665	-1.598	1,335,882	2,573,081	-1.341	894,118	1,417,070	0.594	0.336
	2011	1,800,000	2,242,158		2,008,824	2,522,429		641,176	1,090,332		2.300
Total household income (kip)	2010	7,330,946	3,506,178	1.418	8,507,956	4,166,211	2.517*	8,100,088	4,904,955	2.832*	0.341
	2011	6,219,029	2,757,273		6,978,735	3,007,893		5,671,118	2,458,826		1.278
Number of household labors (person)	2010	3.42	1.16	-2.159	2.41	0.70	-2.693*	2.53	1.01	-0.677	5.834***
	2011	4.67	1.50		2.71	0.80		2.82	1.42		13.821***
Number of outside workers (person)	2010	0.58	0.79	-4.486**	0.68	1.15	2.963*	0.47	0.62	-1.319	0.774
	2011	1.00	0.95		1.09	1.06		0.65	1.11		1.009
Number of livestock (cattle and buffalos)	2010	6.42	9.63	1.530	2.15	3.23	3.753**	1.53	2.40	1.461	6.885**
	2011	4.75	6.15		1.03	1.78		1.18	1.78		4.094*

Notes: * Mean significant difference at 0.05 level, ** at 0.01 level, and *** at 0.001 level; 2010 had normal climate condition, and 2011 early onset of rainy season; One U. S. Dollar (USD) was equivalent to 8029 kip on average in 2011, and 8269 kip in 2010.

sector in the village. In 2010, the greatest contribution to the total household income was NTFPs. In group I, NTFPs accounted on average for approximately 48% of that income followed by livestock production at 18%, crop production at 13%, outside work at 12%, and off-farm activities at 9% (Figure 4). In group II households, NTFPs assumed the greatest proportion of total income at about 32%; this was followed by off-farm activities at 21%, livestock production at 18%, outside work at 16%, and crop production at 13%. Group III households showed the highest proportion of income from NTFPs at about 38%; that was followed by off-farm activities at 26%, crop production at 14%, and livestock and outside work at 11% each.

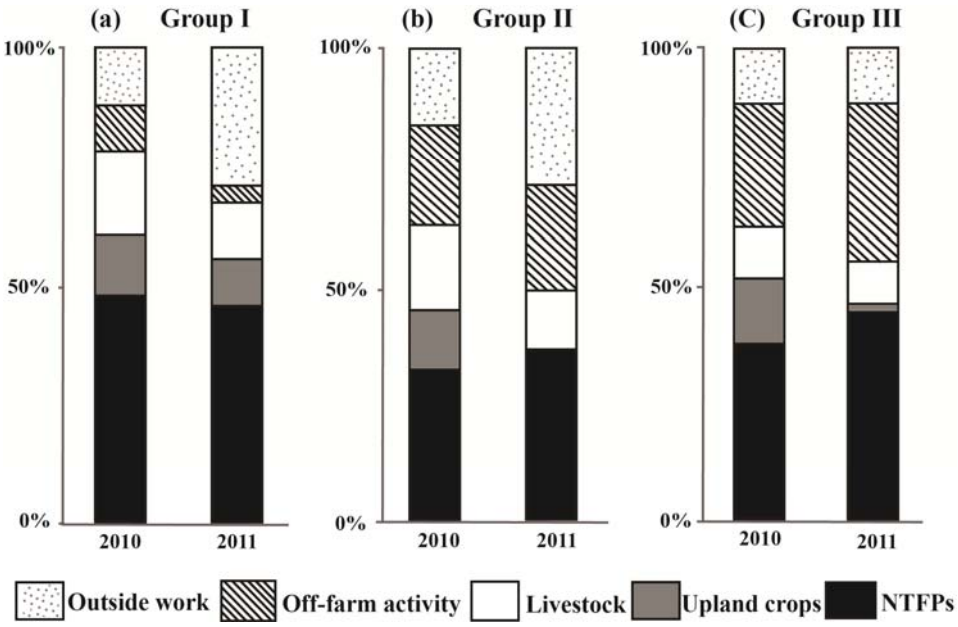

Figure 4 Proportion of incomes by economic activity in 2010 and 2011.

Following the early start of the rainy season, households with different livelihood conditions adopted varying livelihood strategies to cope with the unexpected circumstances. The villagers modified their livelihood activities in response to climate event; some households combined two or three activities. The climate event affected the sources of income in each household group. In group I households, NTFPs again assumed the greatest proportion of total income—at about 46%; that was followed by outside work at 29%, livestock production at 12%, crop production at 10%, and off-farm activities at 3%. In group II, the leading source of income was also NTFPs—about 37% of the total; that was followed by outside work at about 29%, off-farm activities at 22%, and livestock production at 12% (Figure 4). Crop production was absent in this group as an income source. In group III, there was little change in the income proportions: NTFP income remained the highest component at about 44%; off-farm activities accounted for 34%, outside work 11%, livestock production 9%, and crop production 2%.

In 2010, there were differences in the size of the labor force among the three household groups, though there were no differences in the sources of income. In 2011, however, each household group showed differences in both the size of the labor force and in income sources. Despite the early onset of the rainy season, there were no changes in the source of household income in group I between 2010 and 2011. In group II, time and labor were devoted to NTFP collection, outside work, and off-farm activities, but not on upland crop production. Accordingly, income from crop production vanished in group II, and it almost disappeared in group III. This result indicates that the climate event exerted a direct change on livelihood activities in households with a lower labor force; however, households with a greater labor force were unaffected. Thus, the number of household activities declined in groups II and III, though it was the same in group I. However, the proportion of activities in each household group changed.

2.5 Changes in livelihood strategies

Modifications in household livelihood strategies offer a means of analyzing how the villagers responded to the early onset of the rainy season. This section examines the livelihood strategies of the three household groups following the unexpected climate event in 2011.

2.5.1 Group I changes

The paired sample *t* test showed a significant difference in the average income from NTFPs between 2010 and 2011 at <0.01; however, there were no significant differences in crop and livestock production, off-farm activities, and outside work between 2010 and 2011 (Table 4). Income from NTFPs, crop and livestock production, and off-farm activities displayed a slight decline from 2010 to 2011. Income from outside work showed no significant difference between 2010 and 2011; however, remittance amounts were high in 2011—approximately 1,800,000 kip (224 USD)—compared with 895,833 kip (111 USD) in 2010 (Figure 5). More villagers left Kachet to earn money by working in urban areas or other provinces in 2011 than in 2010. Income from NTFPs decreased from 3,498,446 kip (435 USD) in 2010 to 2,846,529 (355 USD) in 2011. This was because the group I respondents put more labor into rice cultivation activities, especially on farmland preparation: in 2011, it required on average 100 person-days/ha to prepare farmland by hand rather than by burning. The group I respondents also devoted time to crop production and engaged in outside work. The reason for the lower income from NTFPs was that the early start of the rainy season in March prevented the harvesting of important NTFPs, such as benzoin and broom grass, from March to April. Accordingly, the household income from NTFPs declined slightly in each group from 2010 to 2011; however, the proportion of such income showed an increase in groups II and III. Group I households—with rice self-sufficiency—had greater access to NTFPs and more opportunities to earn income from outside work. They still tended to work on agricultural activities, including crop and livestock production, following the climate event. NTFP collection and livestock production were the principal means for group I households to cope with non-climatic factors such as food consumption.

2.5.2 Group II changes

In group II households, which suffered a rice shortage of up to 3 months, there were no significant differences in income from NTFPs, off-farm activities, and outside work between 2010 and 2011. During that period, however, there were significant differences in crop production at <0.001 and livestock production at 0.05. As noted above, such upland crops as rice, taro, large gourds, chilies, pumpkins, cassava, and cucumbers are commonly produced in the same plots. In Kachet, only cucumbers are cultivated for sale in markets. In 2011, group II households were unable to cultivate rice or plant any other crops for their own consumption or market sale. Income from livestock also showed a significant change following the 2011 climate event. After the climate event, foot-and-mouth disease killed almost 50% of cattle, which were more widely raised in Kachet than buffalo. Some owners were still able to sell their cattle at market, but at a reduced price because of the disease. Income from livestock production therefore decreased slightly in each household group. Group II households combined many activities to achieve their livelihood objectives by responding to economic changes in the normal climate year and coping with the rice insufficiency in 2011. Those households showed a greater likelihood to work outside the village and engage in

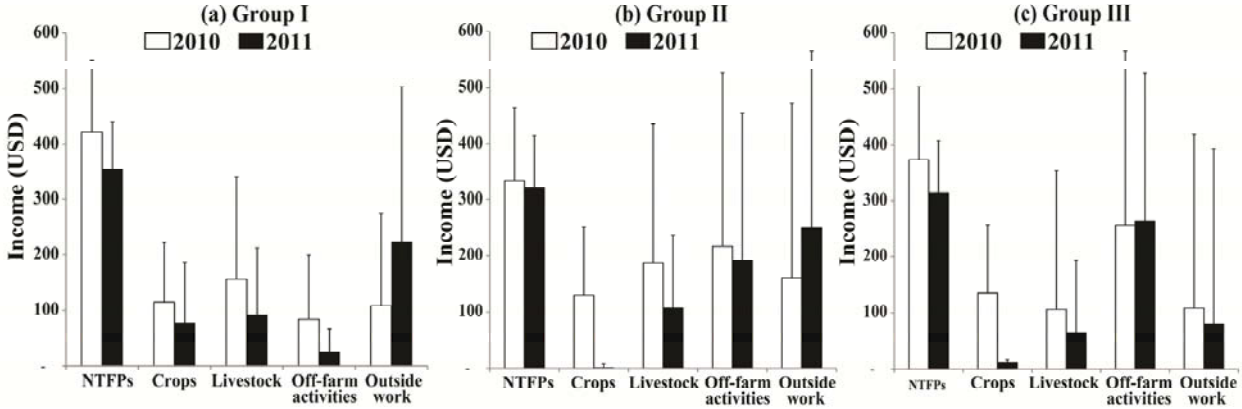

Figure 5 Average household incomes by economic activity in 2010 and 2011. One U. S. Dollar (USD) was equivalent to 8029 kip on average in 2011, and 8269 kip in 2010 (NSC 2012).

off-farm activities to generate income as well as gaining some income from livestock production to cope with the climate event.

2.5.3 Group III changes

In group III households, there was a significant difference in income from NTFPs and crop production between 2010 and 2011 at the 0.05 level, whereas income from livestock, off-farm activities, and outside work did not show a significant difference. There was a slight decrease in the income from NTFPs—from 3,089,794 kip (385 USD) in 2010 to 2,521,412 kip (314 USD) in 2011. Kachet villagers normally collect bamboo and rattan shoots for their own consumption and for market sale. In 2011, the villagers sold those shoots rather than consumed them. During a rice shortage, the villagers usually eat maize or cassava instead of those shoots and rice. In both 2011 and 2010, off-farm activities were more important in group III households than in the other groups. Such activities included tree sawing, carpentry, and NTFP trading and were a common means of generating household income in Kachet. The average income from off-farm activities in group III showed no statistically significant difference from 2010—2,119,118 kip (264 USD)—to 2011—2,124,471 kip (265 USD). Other sources of household income also declined slightly. Group III households tended to engage in off-farm activities such as tree planting, carpentry, and unskilled work. However, this group had greater access to NTFPs. This group used a combination of activities to cope with unexpected events. They did not undertake different livelihood activities in the normal climate year compared with 2011, but the proportion of each activity differed.

In 2010, there was no significant difference in the sources of income among the three household groups. In 2011, the income from crop production showed a significant deference at <0.001, though there were no significant differences in other sources of income among the three households groups. The average income from crop production was highest in group I, followed by groups III and II (Table 4). Total household income was highest in group II, though group II had a smaller labor force than the other groups. This indicates that households with a smaller labor force tended to engage in more intensive activities rather than favored livelihood activities following the climate event.

3 Discussion

There was a clear reduction in upland rice cultivation as a result of the climate event in northern Laos. The present study on upland livelihoods examined the immediate impacts of the early start of the rainy season and the response of local people using short-term coping strategies. The findings raise important issues related to short-term coping strategies, which are as important as long-term adaptation strategies. We identified the factors that enhanced the villagers' ability to cope with short-term impacts, particularly rice insufficiency, and the factors that may also be useful with respect to long-term changes. Our findings suggest that diversity of local activities is a fundamental characteristic for coping with short-term impacts, especially for rural households whose livelihoods are heavily dependent on swidden agriculture.

Many case studies have dealt with climate change and rural livelihoods. They include sustainable livelihoods and inhabitants' vulnerability in the face of coastal hazards in Borongan, Philippines (Gaillard et al. 2009), multipurpose agroforestry as an option for farmers to adapt to climate change in Ha Tinh Province, Vietnam (Nguyen et al. 2013), and adaptation to environmental risks in the coastal northern Vietnam (Adger 2000a). These provide options for responding to climate event and other impacts. In the coastal area of Borongan, skills and knowledge were important factors that enable local household to generate other livelihood activities rather than fishing during bad weather. Rigg (1997) found that nonfarm income facilitated farmers being able to change their practices to cope with environmental degradation.

The present study found the household labor force (internal household factor) to be a more important factor than land (external factor) following the early onset of the rainy season. However, land is one important factor for swidden cultivators facing population pressure, urbanization, and limited land availability. This study found that the most important factor that

enhanced the ability of Kachet villagers to produce sufficient rice after the rainy season's early start was the household labor force (human capital). Table 2 shows that the average household labor force was highest in group I. The household labor force was the most important factor, especially in sloping or upland areas. The villagers were unable to prepare land by burning under the wet conditions of 2011: to plant rice, they had to clear the area by hand. Because group I had greater labor resources than the other groups, group I households could plant sufficient rice even in bad weather conditions. In 2011, some group II and III households could also cultivate rice, but the amount was insufficient. Group I had sufficient rice because that group had the greatest labor resources and could cultivate the largest rice fields in 2011 as in 2010. Roder (2001) found that total labor in a normal year requires about 300 person-days/ha/year; the labor required to burn dry biomass in swidden cultivation is 20 person-days/ha/year. In 2011, land preparation takes 100 person-days/ha/year by hand. In 2011, labor therefore became more important in Kachet than in the normal year of 2010.

Labor exchange has an important effect on cultivation practices in Kachet. In 2010, many labor exchange groups were formed among the households to cultivate rice efficiently. In 2011, however, only a few such groups were organized because many households were unable to plant rice. The lack of labor exchange increased the burden of farm work, such as planting, weeding, and harvesting. If the villagers wanted a labor force, they had to pay for it. The price of daily labor in Kachet was low—about 30,000 kip (3.7 USD), compared with 50,000 kip (6.2 USD) outside the village. The role of labor exchange became less important and outside work more important in 2011 than in 2010.

Interestingly, land was not found to be a major factor in Kachet after the early onset of the rainy season. Households with different numbers of plots and sizes of land were not differentially impacted by the climate event. Thus, land was not a factor that significantly enhanced villagers' ability to cope with rice insufficiency following the rainy season's early onset. The interviews in 2010 indicated that land was important for the villagers when increased upland product volume was required: a larger farm size could yield greater produce. This finding corresponds with that of Roder (1997), who demonstrated that in northern Laos, a short fallow period reduces organic matter and decreases product yield; so increasing farm size is commonly prioritized over boosting yield per unit of land. This result is similar with to that of a case study of maize production in Bokeo Province, Laos (Southavilay et al. 2013). These findings are in partial agreement with those of a study in which land was identified as the single most important asset for local people in Ban Non Sao-e village, Thailand (Ozturk 2009). Our findings in Kachet for 2010 are in line with these, though they differ in the climate event year of 2011.

The climate event in the present study had a direct impact on component proportions of household income—from NTFPs, agriculture, livestock, off-farm activities, and outside work—for each household group. Our statistical analysis showed that the climate event resulted in an increase in the number of outside workers in each household group in both 2010 and 2011. However, outside work had begun before the early onset of the rainy season in March 2011. The villagers started working outside Kachet in 2005, when the price of labor increased slightly to 15,000 kip (0.7 USD); this increased to about 50,000 kip (6.2 USD) per day in 2011, along with commodity prices. This study found that local livelihoods gradually changed under the influence of socioeconomic and political conditions. These changes gave the villagers alternative options for earning additional income in urban areas other than from NTFP collection, agriculture, and off-farm activities. This concurs with Morton (2007), who stated that socioeconomic factors such as "non-market relations in production and marketing increase the complexity of both impacts and subsequent adaptations, relative to commercial farms with more restricted crop ranges". Lestrelin and Giordano (2007) concluded that economic change provides significant incentives and opportunities for farmers to change their areas of employment, such as to small-scale roadside trading and off-farm work in urban areas. In addition to the influence of socioeconomic change, political change affects the livelihoods of upland people, who are heavily dependent on swidden practices. Lao government policies aim to discourage swidden

agriculture and increase forest cover (Thongmanivong and Fujita 2006). These policies negatively affect local inhabitants by limiting access to land for cultivation. A short fallow period restrains the restoration of soil fertility and reduction of weed pressure, resulting in low rice yields (Roder 1997); the locals also have limited access to NTFPs. The main source of income for upland inhabitants is from collecting NTFPs (Yokoyama 2010).

The change and reduction in livelihood activities in 2011 were coping strategies for climate change: in response, the villagers modified such strategies related to agriculture, livestock production, off-farm activities, and outside work. These practices are similar to ones adopted in Vietnam (Adger 2000a, Nguyen et al. 2013, Bastakoti et al. 2014), Thailand (Lebel et al. 2009), and the Philippines (Gaillard et al. 2009). Those studies also found that the local environment was important for inhabitants in coping with short-term events. For example, the people of Ha Tinh Province, central Vietnam, undertook home gardening as a strategy to cope with strong climate variability and frequent weather hazards causing food shortages. The fishermen of Borongan, Philippines, combined fishing and farming in response to cyclones and storm surges. We found that households faced different levels of impacts from the climate event and adopted different coping strategies. Households with rice self-sufficiency had greater access to NTFPs and more opportunities to obtain remittances as the economic crisis forced them to find alternative source of income, including factory employment in urban areas. Such household engaged in many activities, such as NTFP collection, crop and livestock production, off-farm activities, and outside work, in response to non-climate stressors more related to economic growth than to climate factors. Thus, households with a substantial labor force engaged more easily in many activities to meet subsistence needs and augment income levels. Ellis noted that "the causes and consequences of diversification are differentiated in practice by location, assets, income, opportunity, and social relations" (Ellis 1998).

Livestock production was another important factor that helped the Kachet villagers overcome the climate event. This finding conflicts with that of Kazianga and Udry (2006), who found that livestock production is not an effective buffer of households in rural Burkina Faso during a drought. Conversely, Nganga et al. (2011) observed that activities dominated by livestock production were important for livelihood welfare in Gaza province of Mozambique. Household income and asset shocks influence livestock sales in northern Kenya (McPeak 2004). Livestock markets play an important economic and ecological role during droughts in dryland Africa even though livestock prices are low in local markets (Turner and Williams 2002).

In the case of Kachet, we found that livestock production was related to outside work: if household members wanted to work outside the village, almost all the household's animals had to be sold. This is because raising livestock there follows a traditional system based on free-grazing conditions. Animals were left in forests after the harvest season, and villagers would go to care for them two or three times a week. Group II households, which had a lower labor force, chose to sell all their animals immediately in response to their rice insufficiency. Therefore, the average number of livestock differed significantly between 2011 and 2010. Group II households engaged in off-farm activities to generate income. Outside work was a long-term strategy for group II households to cope with non-climate factors such as education, health service, equipment, and clothing. Conversely, group III households chose to undertake off-farm activities around Kachet and sell one or two animals if they lacked money. This group suffered a heavy impact from the climate event—particularly the rice shortage of over 3 months. Thus, group III tended to support their livelihoods in the form of off-farm activities, particularly unskilled jobs.

Off-farm activities include carpentry in the area around Kachet, tree planting, and roadside trading. They are commonly practiced by the household head and young household members lacking experience and education. This is because off-farm activities result in high income despite a lower labor input and demand less time than other activities. Outside work was a strategy for groups I and II to achieve their livelihood goals under economic change. Engaging in outside work is possible for educated adult household members

with work experience. However, 38% of our respondents lacked education. Thus, those individuals had limited access to work in urban areas. Lack of skills and education results in limited access to coping options with climate stressors (Eriksen et al. 2005). In general, people create new coping strategies for climate variability. However, our findings do not indicate new livelihood activities for coping with the climate event in Kachet. The villagers did not adopt new livelihood strategies to deal with the rice shortage. They engaged in various activities, including NTFP collection, agriculture, livestock production, off-farm activities, and outside work, but the proportion of households undertaking each activity differed. The important finding here is that households undertaking a limited number of activities were less vulnerable than households engaged to a lesser degree in many activities.

In Kachet, NTFP collection constituted the largest component of household income. With a normal climate, upland crop production was important for household consumption and created a small surplus for market sale. NTFP collection was the principle livelihood strategy in each household group. However, the most important NTFPs are found during long fallow periods of 4 years or more (Yokoyama 2004). This implies a negative effect on villager livelihoods when population pressure and forest policy in the near future will dictate shorter fallow periods.

In northern Laos, the government, development agencies, and other sectors, such as non-government organizations, currently promote long-term development strategies; they include commercial forestry, long-term investment in rubber plantations, and upland agriculture programs (Alexander et al. 2009). Although these activities can improve economic conditions in rural areas, they are not intended to assist coping with short-term climate events. The present study suggests that agricultural policy should promote economic development that permits farmer access to a range of options—not only for adaptation to long-term vulnerability but also for coping strategies in dealing with the short-term impact of climate events. Such a policy is in contrast to one that promotes certain crop varieties for drought and specific climates as well as other planting techniques and short fallow improvement strategies. These schemes are not suitable for livelihoods from swidden farming in response to climate events.

4 Conclusions

This study evaluated the livelihoods of upland people in northern Laos following an unexpected climate event—early onset of the rainy season. The study helps explain the effects of that event and indicates the relative importance of variables that are significant in supporting farmers' capacity to respond to and cope with such events. We also examined local livelihood strategies in dealing with the effects of the climate event. Our findings show that the rainy season's early onset in March 2011 greatly impacted agricultural households that practiced swidden cultivation of rice and other crops for their own consumption. The findings also indicate that the labor force variable was the most important factor in enhancing the villagers' ability to deal with rice insufficiency following the climate event. Households with a large labor force had greater options for coping strategies: households with a substantial labor force tended to manage better after the climate event than those with a small labor force. Therefore, to improve household coping capacity in dealing with climate events, internal household factors such as labor, skills and education (human capital) should be considered rather than external factors such as farmland.

The Kachet villagers have lived with significant climate change in the past and tends to frequently increased in the future. Coping strategies were shaped by the level of impact of the climate event and households' needs toward achieving their livelihood objectives. NTFP collection was the most important coping strategy in both the climate event year of 2011 and the normal climate year of 2010. The villagers were highly dependent on natural resources, which were reflected by their weak coping capacity. Intensive activities were also important in helping the villagers overcome the rice insufficiency after the climate event. A lack of additional income activities for sustainable livelihoods is likely to result in limited capital assets, which is the case for most farmers in poor rural areas of northern Laos. However, we believe that the Kachet villagers can achieve their

livelihood objectives under extreme climate conditions by embracing a range of adaptive options. We identified changes in household strategies in response to the climate event, but research into adaptation to socioeconomic and political change was limited in this study. We suggest that this issue be investigated further because the livelihood strategies of the Kachet villagers could become more complex in the future.

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