

# Effects of landscape segregation on livelihood vulnerability: Moving from extensive shifting cultivation to rotational agriculture and natural forests in northern Laos

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## Abstract

This study investigates four decades of socio-economic and environmental change in a shifting cultivation landscape in the northern uplands of Laos. Historical changes in land cover and land use were analyzed using a chronological series of remote sensing data. Impacts of landscape change on local livelihoods were investigated in seven villages through interviews with various stakeholders. The study reveals that the complex mosaics of agriculture and forest patches observed in the study area have long constituted key assets for the resilience of local livelihood systems in the face of environmental and socio-economic risks. However, over the past twenty years, a process of segregating agricultural and forest spaces has increased the vulnerability of local land users. This process is a direct outcome of policies aimed at increasing national forest cover, eradicating shifting cultivation and fostering the emergence of more intensive and commercial agricultural practices. We argue that agriculture-forest segregation should be buffered in such a way that a diversity of livelihood opportunities and economic development pathways can be maintained.

**Keywords:** shifting cultivation; land sparing; multifunctional landscapes; ecosystem services; livelihood vulnerability; Southeast Asia

## 1 Introduction

In Laos, forests and forest resources play an important role in ensuring food security for the rural population (World Bank, 2001; UNDP, 2002). Of particular importance are the non-timber forest products (NTFPs), which not only serve as traditional safety nets for coping with unpredictable events (e.g. wars, droughts, floods) and losses of agricultural production but also allow rural communities to adapt to changes in their socio-economic environment (Delang 2006; Kusters *et al.* 2006; Rigg 2006; Rerkasem *et al.* 2009). However, since the late 1980s, government policies have consistently aimed at re-arranging land uses and landscapes by demarcating land for agricultural purposes and land for forest preservation and regeneration. For that purpose, village resettlement, land zoning and land allocation programs have been implemented countrywide (Evrard and Goudineau 2004; Baird and Shoemaker 2007; Fujita and Phanvilay 2008; Lestrelin *et al.* 2012). A shift from extensive subsistence-oriented shifting cultivation to intensive commercial agriculture has also been supported by government agencies. The rationale for these initiatives is that enhanced land use planning and integration of marginal lands into the global market economy would contribute to the alleviation of rural poverty and lead to the demise of shifting cultivation – a practice the government considers backwards and environmentally destructive (Vandergeest 2003; Rigg 2005; 2009; Lestrelin 2010). These initiatives also assist governmental efforts to reclaim natural landscapes through the regeneration of the forest cover in shifting cultivation areas.

The Lao government considers segregation of land uses from a complex multifunctional landscape into on the one hand, land for economic development and on the other hand, land for environmental preservation, as being in line with the sustainable development paradigm. Importantly, policies combining land use segregation with agricultural intensification are expected to lift local populations out of poverty while leaving more space for conservation. Thus, alongside village resettlement, land zoning and land allocation, agribusiness, contract farming and plantation concessions have, in recent years, been promoted as key instruments for increasing the land rent and turning traditional shifting cultivators into farm entrepreneurs.

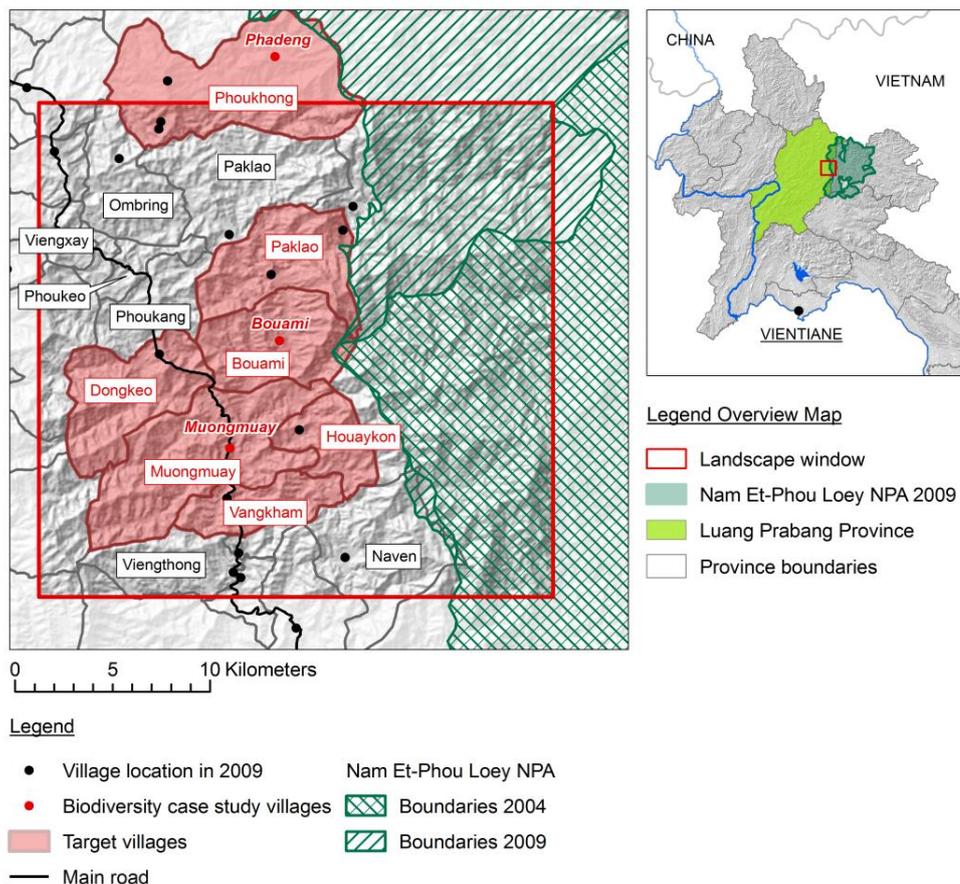
In this paper, we argue that government policies for a segregated landscape can have critical and largely unintended consequences for the provision of key ecosystem services, for food security and, more generally, for the vulnerability of rural livelihoods. Echoing the ongoing international debate about land sharing (i.e. integrating both ecological and economic objectives on the same multifunctional landscape) versus land sparing (i.e. segregating lands dedicated to protected natural habitats and intensive agriculture) (Perfecto and Vandermeer 2010; Phalan *et al.* 2011), we show that the ‘segregate’ or ‘integrate’ options play out not only at multiple spatial scales, from farm to landscape, but also across time, making their impact on ecosystems services highly unpredictable or at best speculative. On the one hand, the complexity of shifting cultivation landscapes prevents a full understanding of their functioning and evolutionary pathways under alternative land policies. On the other hand, these landscapes often exhibit higher levels of resilience to external shocks than segregated systems (Garrity 2004; Sayer and Campbell 2004; Larsen 2009; Selman 2009). By maintaining complex land use and forest mosaics, one can build on both the multi-functionality of landscapes and the diversity of livelihoods to enhance rural community resilience (Wilson 2010).

This study analyses four decades of livelihood and land use change in an upland landscape of northern Laos. First, through the use of a chronological series of remote sensing data, we describe the history of land use. We relate land use changes to changing political and economic conditions in the study area and, in particular, to the implementation of various land policies. Second, we study the impacts of landscape changes on local livelihoods through quantitative and qualitative surveys. Finally, we highlight some key cause-and-effect linkages between national land policies, land use change and ecosystem goods and services provision and discuss their implications for livelihood vulnerability.

## 2 Methodology

The case study site in Viengkham District of Luang Prabang Province covers an area of 676 km<sup>2</sup> and includes 14 villages located in the western part of the Nam Et–Phou Loei National Protected Area (NPA), see Fig. 1 and Table 1. The site is characterized by important variations in accessibility, with highly market-integrated areas along the main road and more remote, poorly integrated areas. The field work was conducted at complementary scales. Land cover was assessed at the landscape level by means of satellite image analysis, household surveys were conducted in seven target villages of the study area (Fig. 1), and forest and biodiversity inventories were conducted on plots established in three villages.

Figure 1: Case study sites in northern Laos



### 2.1 Spatial analysis of land use change

Four decades of land cover were mapped using a chronological series of remote sensing data. Landsat images from the years 1973, 1979, 1988, 2003, 2007 and 2009 were analyzed using a combination of supervised classification and visual interpretation in order to produce land cover maps for each year (Kongay *et al.* 2010). The accuracy of the 2009 land cover classification was assessed by comparing a stratified random sample of points from the Landsat image with ALOS AVNIR-2 imagery of 2009 (ground resolution 10m) and ground truth data from a field survey conducted in the same year (Kongay *et al.* 2010). As the other land cover maps were produced using a similar technique an explicit validation for them was not deemed necessary.

This land cover data was used to delineate shifting cultivation and natural forests areas for each of the years using a landscape mosaics approach (Hett *et al.* 2012). Using a moving window approach, the share of each land cover class in the neighborhood of each pixel was computed as a first step. Then, the patterns in which the land covers co-exist made it possible to distinguish between natural and agricultural areas. The percentages of upland crops, young fallow and shrubs were used to assess the intensity of land use in the areas under shifting cultivation (Hett *et al.* 2012). This approach made it possible to spatially delineate shifting cultivation, which cannot be done when conventional land cover data is used. It allowed for broad land-use types and provided insights into the management of complex landscapes rather than simply addressing changes at the pixel level and thus disregarding spatial context information. Statistics for land cover and the composition of landscape mosaics were computed for all target villages for each of the six years and compared with the statistics of the overall study landscape.

Table 1: Main characteristics of target villages

Village	Accessibility	Population density Inhabitants/sq.km	Number of households in 2008	Ethnicity % of families
Bouami	30 minute motorcycle drive to main road	10	70	Tai 85% Khmu 15%
Dongkeo	On main road	11	66	Khmu 100%
Houaykon	1.5 hour walk to main road	15	44	Khmu 100%
Muongmuay	On main road	35	172	Khmu 82% Tai 18%
Paklao	30 minute motorcycle drive to main road	10	67	Tai 3% Khmu 97%
Phadeng*	4 hour walk to main road	7	40	Hmong 100%
Vangkham	On main road	14	45	Khmu 100%

\* Merged with Phoukhong Village in 2009

## 2.2 Field surveys and data collection

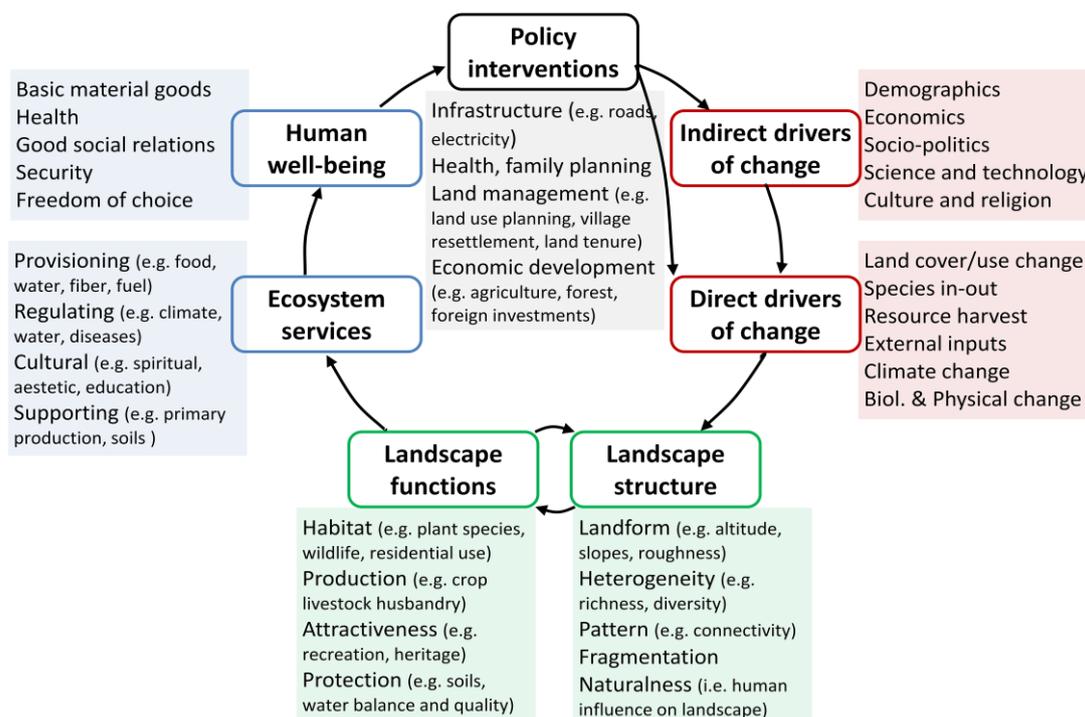
Household surveys and focus group discussions were conducted from 2008 to 2011 in the seven villages of the study site (Fig. 1). A comprehensive database was developed. This included data at the household and village levels collected from various sources (i.e. primary data from direct surveys and secondary data from district administrations and the 2005 Population and Housing Census). The data could thus be cross-checked for consistency. Household surveys investigated household composition, education, health status, settlement history and income generating activities (e.g. farm size, land use systems, production, income, consumption, livestock, use of forest products, off-farm activities). A selection of these variables is presented in Table 1. This data was used to develop a household typology comprised of four main household categories relevant to the whole study area (Fitriana, 2008). Village differentiation patterns were interpreted according to the relative incidence of the four household types. A participatory wealth-livelihood ranking of villages in Viengkham District was conducted with the relevant officials and village representatives to validate the household typology over the whole district.

In addition, biodiversity inventories were conducted in 20 plots selected in each of the three villages of Phadeng, Bouami and Muongmuay (giving a total of 60 plots) across a gradient of forest quality (Morin 2010). In 2009 - 2010 a market chain analysis was also conducted to better understand the marketing system for agricultural and forest products, its evolution over time and how stakeholders' strategies had adapted to increased market integration. The survey consisted of interviews with key stakeholders in the market chain for local products, i.e. collectors, village middlemen, district traders and local administrations of Viengkham District. The survey investigated business arrangements, trade volumes and communication networks (Mouaxengcha *et al.* 2010).

### 2.3 Assessing the impact of landscape segregation on ecosystem service provision and livelihood vulnerability: an analytical framework

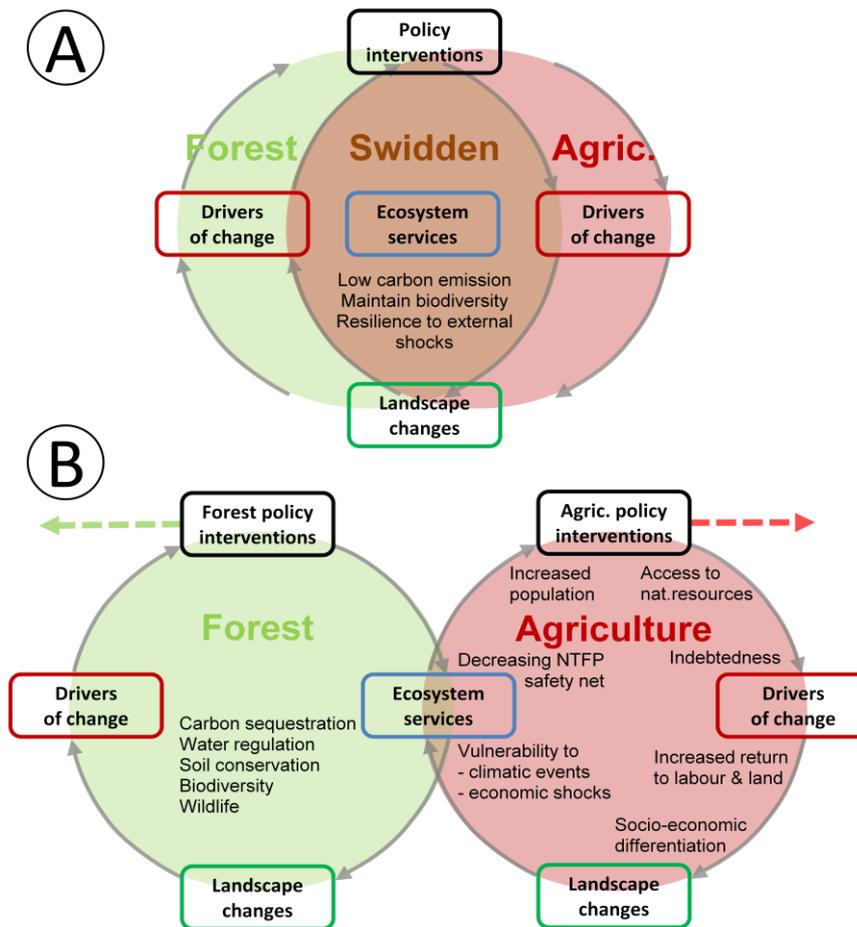
Building on the “Policy - Drivers - Landscape - Ecosystems - Human Well-being” cycle (Fig. 2) used in the Millennium Ecosystem Assessment (2005), an analytical framework was developed and applied to our study site to assess the potential impacts of agriculture-forest segregation and landscape simplification on rural livelihoods (Fig. 3). Landscape function is defined as the capacity of a landscape to provide goods and services to society. Depending on its structure, including the level of interconnections between agriculture and forest, a landscape can be more or less efficient in providing goods, like harvested crops and timber, and services, aesthetics, habitat, soil conservation and water regulation. Wilson (2010) provides a valuable conceptual model for understanding rural pathways of change based on the multifunctional quality of a landscape. As the cause-and-effect relations between the multiple factors influencing the provision of ecosystem services are almost impossible to fully disentangle, he argues that increasing the multifunctional quality of a complex landscape is the most promising strategy to increase community resilience. Therefore, among the many pathways of possible landscape changes he suggests giving priority to the ones that strike the right balance between economic, social and environmental capital.

Figure 2: Diagram linking policy landscape changes and provision of ecosystem services.



In this paper, we do not intend to fully characterize provisioning, regulating, and supporting services, including non-material benefits associated with cultural services. Rather, we aim at demonstrating how the concept of multifunctional quality can support landscape planning and inform policy (Selman 2009; Wilson 2010). The results are presented following the analytical framework presented in Fig. 3. The impacts of landscape level segregation between agriculture and forest on the ecological and socioeconomic vulnerability of local livelihoods are then investigated at the interface between policy decisions and drivers, ecosystems and human well-being (Fig. 3).

Figure 3: Analytical framework including the ecosystem services provided by swidden landscapes (A) and how they would be impacted by agriculture-forest segregation (B)



### 3 Results

The chronological series of landscape mosaics in Fig. 4 shows recent landscape transformations and their main drivers. The first row displays the time series of six land cover maps. The second row displays the corresponding land use maps, i.e. landscape mosaics derived from the analysis of the land cover maps. The shifting cultivation system is categorized into five types (Swidden 1 to 5), corresponding to decreasing levels of land use intensity or increasing fallow period; from mosaic Swidden 1, which corresponds to the most intensive land use form with a minimum of two fallow fields and one cultivated field at all times, to the mosaic Swidden 5, with the least intensive land use and a crop-fallow cycle longer than 15 years. The village locations in the most recent years (i.e. 2003, 2007, and 2009) are indicated by the grey dots.

### 3.1 Impact of government policies on landscape changes

During the Second Indochina War (1962–1975), many villagers fled the bombings and armed conflicts to hide in the remote forested areas. As a result, agricultural activities became concentrated along the forest margins, impinging on the forestlands (Fig. 4). Large tracts of natural vegetation were cleared for collective farming. A whole village or village unit would open up a large plot to cultivate upland rice alongside or in association with other subsistence crops (e.g. pumpkin or cotton for household consumption). This grouped cropping system facilitated the exchange of labor, made arduous work more congenial (e.g. weeding), spread the risk of pest damages over large fields and prevented insecurity at a time of political trouble. After the war, once villagers were able to return to their former settlements, agricultural activity became concentrated along the roads and rivers in smaller plots, creating a mosaic typical of shifting cultivation with long fallow periods.

As shown in Fig. 4, during the 1980s, the entire western region was under extensive shifting cultivation systems. The mosaics ‘Swidden 5’ and ‘Forest fallows’, with fallow periods longer than 10 years, dominated the landscape, while some pioneering shifting cultivators had begun opening up the dense forest of the Phou Loey mountain chain to the east. The agricultural systems and landscape mosaics remained almost unchanged throughout the 1990s, with a gradual expansion of agriculture towards the eastern forested areas (Fig. 4). By the end of the 1990s, long fallow systems covered the whole area suitable for shifting cultivation (i.e. only remote and sharp relief areas were still covered with dense forest). In the early 2000s, the percentage of young fallow increased in the landscape and more upland plots were visible in a given year. Finally, the end of the 2000s was marked by significant forest re-growth in the vicinity of the Nam Et – Phou Loey NPA.

These historical processes of agricultural expansion and intensification and later, of forest regeneration have been shaped by three government policies: (1) Land Use Planning and Land Allocation, (2) resettlements and the creation of focal development areas and (3) the demarcation of the Nam Et–Phou Loey NPA. The history and local impacts of these policies are detailed below.

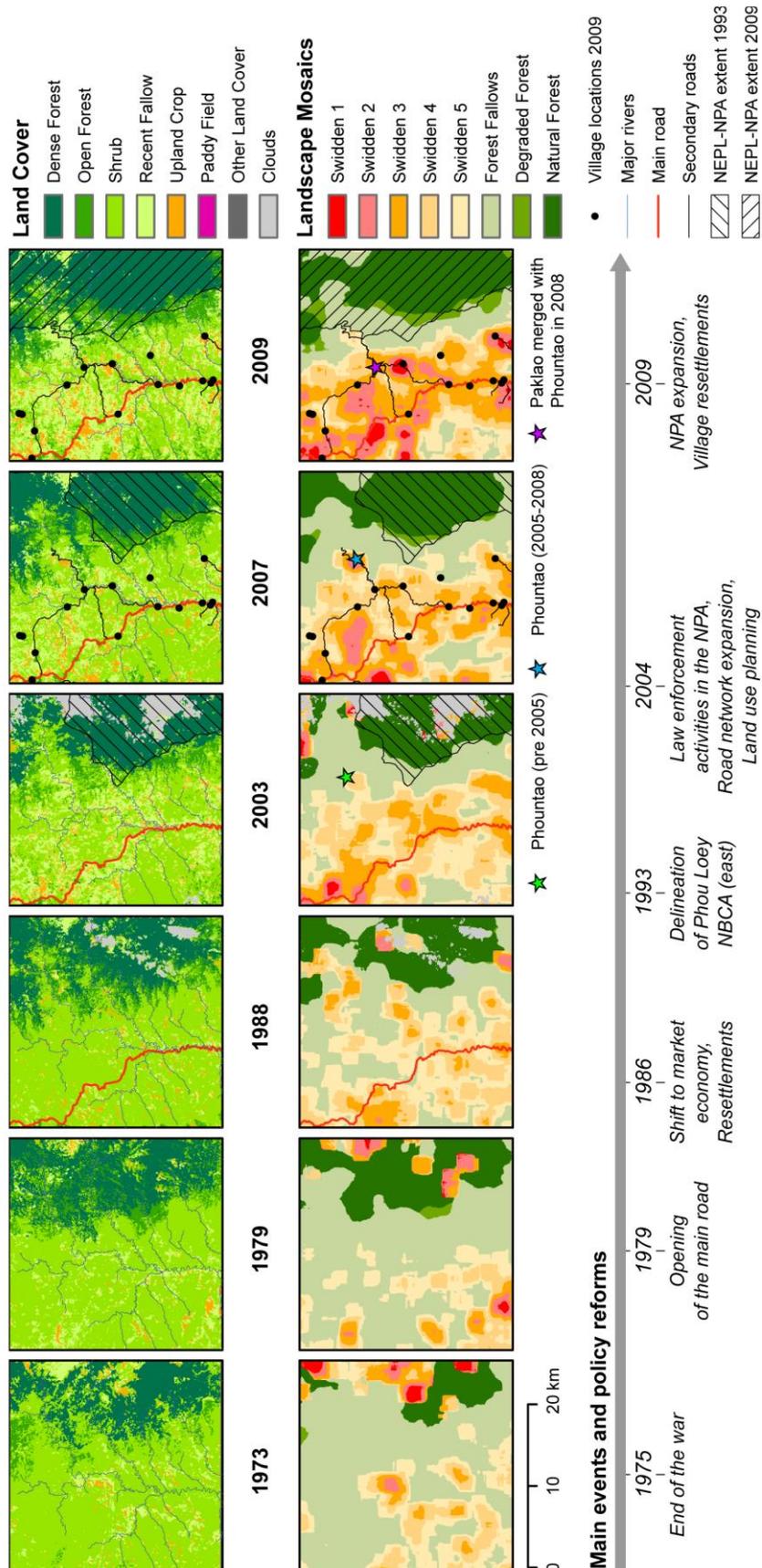
#### *Land use planning and land allocation (LUPLA)*

LUPLA was first tested in Luang Prabang Province in the late 1980s and was then extended to the whole country in the following years (Lestrelin *et al.* 2012). The process was meant to establish boundaries between forest and agricultural land. Three of our study villages (Bouami, Dongkeo and Paklao) underwent LUPLA during the 2000s. The land zoning process was conservation-oriented, leading to ratios of ‘agricultural land/total land’ that varied between 38% in Bouami, 44% in Dongkeo and 46% in Paklao. LUPLA also aimed at substituting individual land certificates for customary land tenure arrangements (i.e. right of clearance or ‘axe rights’). Each household was allocated three upland plots, which meant that the maximum fallow period possible was limited to two years. The aim was to eradicate shifting cultivation. Securing land tenure was expected to support the development of permanent and commercial agriculture. The problem was that, in the absence of alternative cropping systems and technical/financial support to farmers, the strict application of this policy in areas easily reached by government officers resulted in fallows with poor vegetation re-growth and land degradation due to rapid crop rotations. In turn, this forced land use intensification had important consequences for food security and, more generally, local livelihoods. It engendered important decreases in crop yields and a rarefaction of NTFPs in the vicinity of the settlements.

#### *Focal development areas and resettlements*

The trend in forest degradation within village territories was further aggravated by the focal site development policy – the objective of which was to move remote villages closer to the roads in order to provide better access to infrastructure and state services. In the context of the limited public resources available, it was considered more realistic to move the villagers to the roads than to extend the roads to remote areas. However, resettlements were not always accompanied by proper

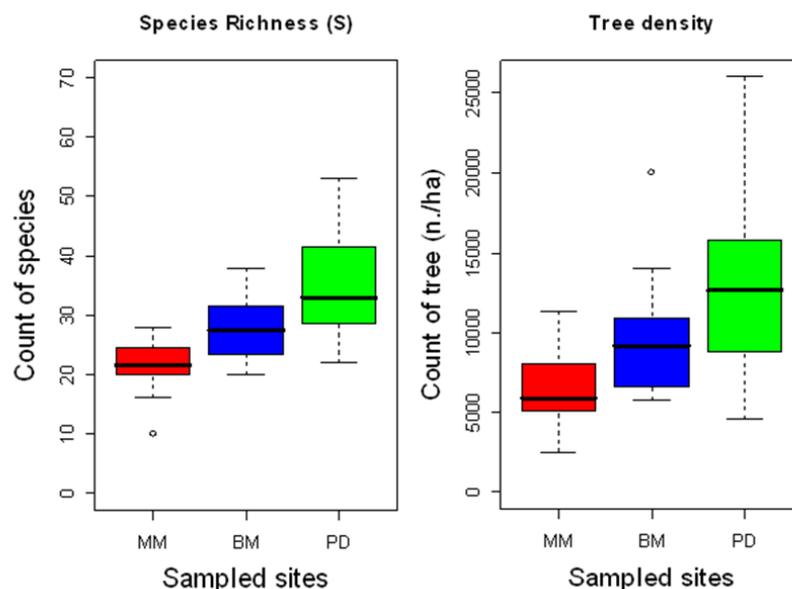
Figure 4: Land cover maps (top row) and landscape mosaics (middle row) over the study area based on a time series of Landsat images and on-the-ground surveys.



development activities and newly displaced villagers were often left to their own devices, leading to the pursuit of shifting cultivation with shortened fallow periods along the roads and increased land degradation. Combined with natural population growth, increased population pressure resulting from government policies (i.e. LUPLA and resettlement) led to a rapid intensification of agriculture with a shift from more than 10-year fallows to only two- or three-year fallows. This land use intensification – clearly visible along the road in Fig. 4 – resulted in the almost complete disappearance of secondary forests in the west of the landscape while reduced population pressure in the eastern part led to significant forest regeneration (Fig. 4).

Morin (2010) highlighted important variations in forest composition along a gradient of distance from the main road by inventorying tree diversity in Muongmuay (MM - along the road), Bouami (BM - 30 minute motorcycle drive to main road) and Phadeng (PD – four hour walk) villages (Fig. 1, Table 1). On the basis of the analysis of life traits tree communities (i.e. Primary/Secondary forest species, Evergreen/Deciduous tree species, Animal-/Wind-dispersed seed species), he identified a gradient in forest composition from dominant pioneer species (life traits = secondary forest – deciduous trees – wind-dispersed seeds) to dominant climax species (life traits = primary forest – evergreen tree – animal-dispersed seeds). The gradient was found at both village (across 20 plots at different stages of forest regeneration) and landscape (across the village accessibility gradient) levels. Land use intensification in the most accessible villages was associated with low variation of species richness, decrease of climax species and increase of pioneer species (Fig. 5). Similar variations in the ecological value of forests were described by villagers. Participatory assessments of the abundance and use of NTFPs associated with the different forest types in the three surveyed villages showed that climax forests were considered dense and healthy while pioneer forests were seen as degraded, with low wildlife diversity and density. Decreasing species diversity associated with land use intensification was considered by local populations as the most important loss in forest ecosystem services (Thephavanh *et al.*, 2011).

Figure 5: Trees density and species richness in 20 plots (20m x 100m size) selected across a gradient of land use intensity in each of the three target villages. (Source: Morin 2010)



### *The delineation of the National Protected Area of Nam Et–Phou Loey for forest conservation*

The zoning of the eastern part of the study area as a National Biodiversity Conservation Area (NBCA) in 1993 had no visible effect on the landscape. For many years, the conservation area remained a ‘park-on-paper’ as land regulations were not enforced. In 2000, the NBCA gained the status of a National Protected Area (NPA). A forest and wildlife conservation program supported by the International Union for the Conservation of Nature (IUCN) was developed to enforce the Forestry Law and Regulations both inside and outside the National Park. In 2004, the World Conservation Society (WCS) took over the support for park management activities (e.g. firearm confiscation, patrolling to prevent intrusions and poaching in the park, community outreach activities) (Johnson 2012). In 2009, the boundaries were expanded so as to almost double the existing NPA area (Fig. 1). As a result, some villages like Phadeng and Punthao were now too close to the new park area and the villagers were displaced, scattered or merged into other villages (Fig. 4). These interventions finally reinforced the general trend in land cover change as described above, i.e. a regeneration of the forest cover in the eastern part of the landscape (both within and in the vicinity of the NPA) while the western part underwent a significant degradation of the natural vegetation.

When analyzed at the landscape level (Fig. 6), forest cover changes appear to follow a curve typical of a forest transition (Mather 2007). Yet, when land use changes are investigated at the village level, the forest transition is no longer visible (Fig. 7). The intensification of agricultural land use is clearly stronger in the western villages than in the eastern ones. The share of fallow areas tends to decrease over time in all village territories, as shown by the time series of landscape mosaics in Fig. 4 and in the graphs in Fig. 7. Stagnating levels of forest fallow between 2003 and 2009 and the recovery of a small patch of degraded forest in the eastern villages can be interpreted as a positive impact of the NPA outreach activities on forest regeneration in the villages included in its buffer zone. The broader trend of agricultural intensification in all the study villages can be explained by the resettlement of villages located in the vicinity of the NPA and the re-delineation of their boundaries in order to avoid encroachment on the extended NPA territory.

Figure 6: Evolution of the area of the land cover classes: forest, recent fallow and upland crops, in the study landscape (see landscape window in Fig.1)

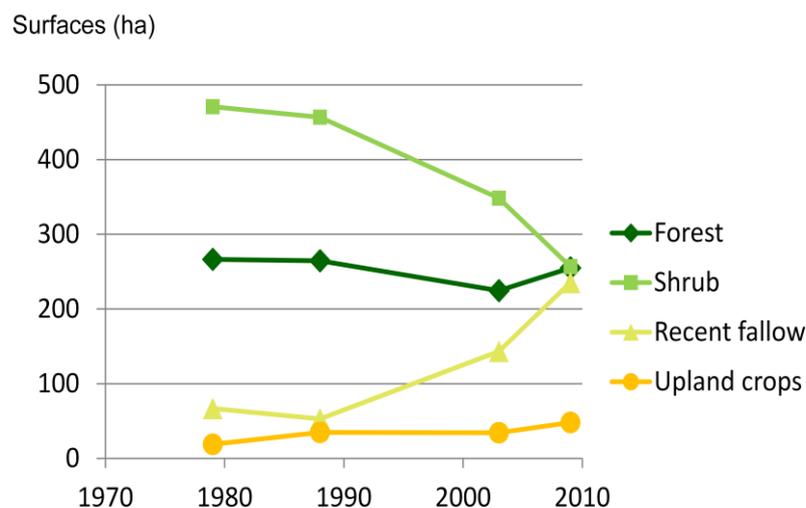
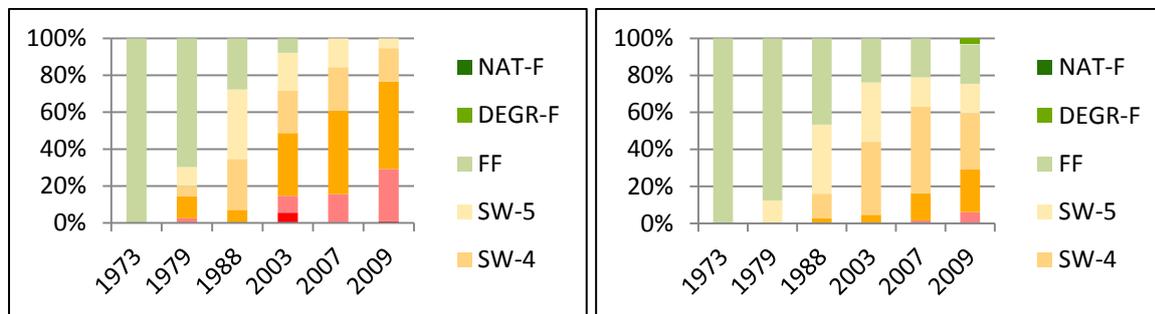


Figure 7: Changes in landscape mosaics at village level in villages located in the western side of the landscape (left) and eastern side (right). The colors in the figure refer to the landscape mosaics in the second row of Fig. 4.



As a result, all the remaining dense forest has been excluded from the village territories and management has shifted from village communities to the state. The overall trend in terms of land change patterns is a simplification of the agriculture-forest mosaics, with the western side evolving towards a dominantly agricultural landscape and the eastern side, partly covered by the NPA, evolving towards an increase in forest cover. Thus, the complex landscape (i.e. made up of cultivated plots and fallow lands at different stages of vegetative re-growth), typical of extensive shifting cultivation, is slowly transforming into a landscape where agriculture and natural vegetation are clearly segregated.

### 3.2 Importance of forest resources in local livelihood systems

#### *Ethnic determinants of resource management*

Before the 1980s, ethnicity was a key factor in explaining settlement patterns, agricultural production and forest management practices. The three main ethnic groups in the study area are the Tai Kao (6%), the Khmu (69%) and the Hmong (25%). The Tai engaged in paddy rice cultivation, supplemented by the shifting cultivation of upland rice in those areas where it was impossible to grow enough paddy rice to meet families' needs. The rough mountain relief and narrow valley bottoms were major constraints to flatland paddy rice cultivation, so relatively few Tai households settled in the area. In such regions, the two other groups (Khmu and Hmong) engaged mainly in upland rice production in shifting cultivation systems. Cultivation practices also differed in terms of the type of rice grown (i.e. glutinous rice was grown by the Tai and the Khmu and non-glutinous rice by the Hmong), agricultural tools used, areas selected for cultivation, field sizes, lengths of cultivation and fallow periods and percentage of trees retained in the agricultural landscape (Chazee 1998). All ethnic groups relied heavily on forest resources for food through hunting and gathering NTFPs (also used for medicinal purposes), and for materials for agricultural equipment, housing, etc. The forest products collected were mainly for domestic use and local exchange with neighboring communities (Chazee 1998).

#### *Capital accumulation and land use change*

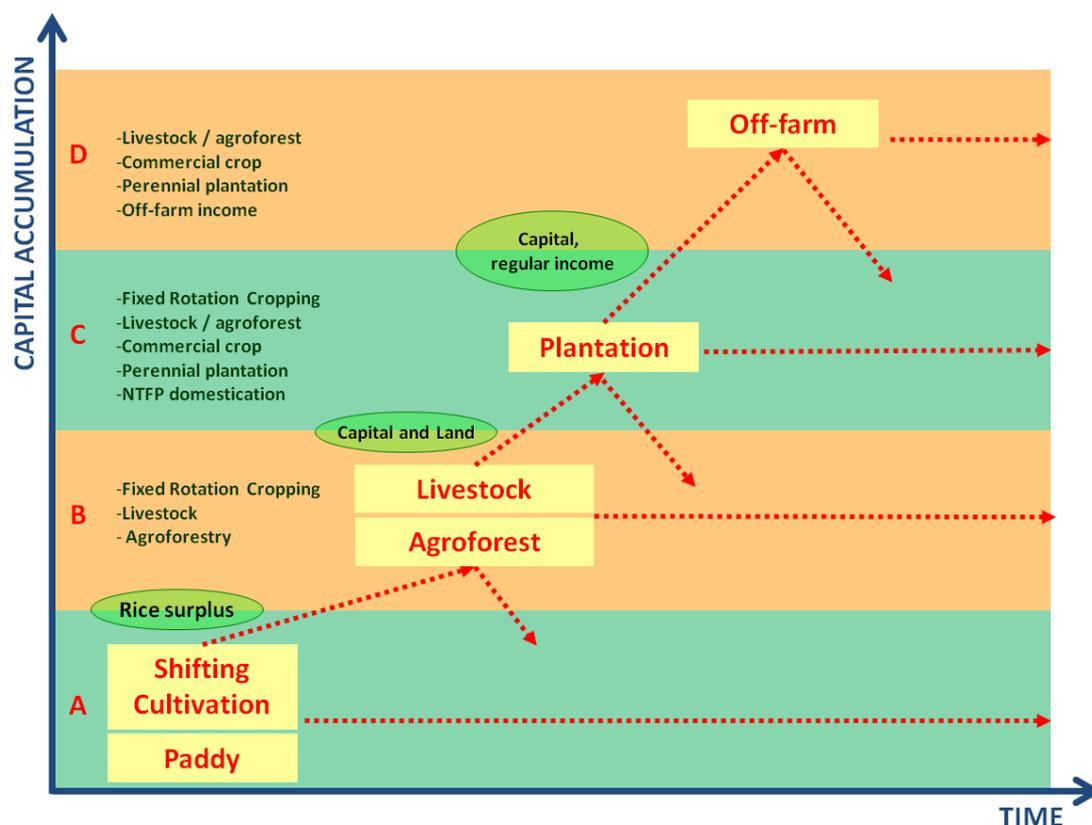
Our household surveys in the target villages reveal similar patterns of capital accumulation, despite the ethnic differences (Fitriana 2008). Before opening up to a market economy, most households were engaged in shifting cultivation. With few narrow valley bottoms suitable for paddy, even those who could grow paddy rice had to supplement their production with upland rice cultivation in order to be self-sufficient. The areas under cultivation were related to the labor force available as all agricultural

work was manual. Social and economic differentiation was therefore very limited and mainly driven by: (i) access to the most fertile fields (i.e. early settlers had privileged access to the small paddy areas available and the best upland soils), and (ii) household dependency ratio (i.e. families with a large labor force and few dependants could produce rice surpluses that could then be invested in livestock accumulation). Better-off families invested in small livestock production (i.e., pigs, goats and poultry) for domestic consumption or sale to meet the costs of religious or family related events. Large ruminants, i.e. buffalo and cattle, were considered living savings. A household could mobilize these savings by selling livestock to cope with critical shocks in life (e.g. disease or death of family members). Farmers faced with a household crisis due to human or livestock disease or poor harvests relied on forest products and, in some cases, agro-forestry products (e.g. cardamom) and NTFPs collected in fallow lands as a safety net.

### *A regional household typology*

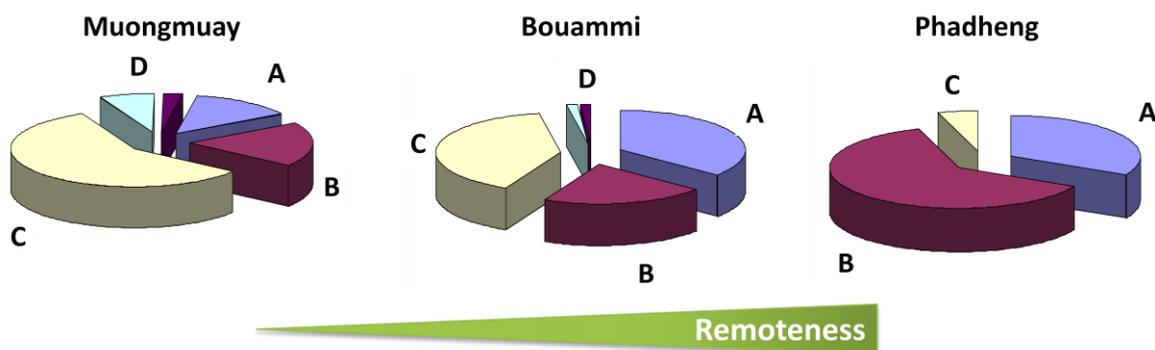
The capital accumulation process described above is largely responsible for the socio-economic differentiation among households and villages of the study area. Four types of households and livelihood strategies were identified (Fig. 8). *Type A households* are those engaged in rice production – through shifting cultivation and/or paddy – for subsistence purposes. *Type B households* comprise rice growing farmers who have accumulated capital through livestock or agro-forestry systems as living savings once rice sufficiency has been achieved. *Type C households* are those able to seize income diversification opportunities with limited financial risk, for example, by cultivating annual (e.g. Job’s tears, maize) or perennial (e.g. teak, rubber) cash crops. In addition *Type C* farmers, through commercial tree plantation, generate sufficient regular income to invest in more risky off-farm businesses.

Figure 8: Household differentiation process and typology



In *Type D households* a large percentage of the income comes from off-farm activities. This capital accumulation pathway has an important temporal dimension as indicated by the horizontal time axis in Fig. 8. For a given village, livelihood systems have evolved over time from a majority of *Type A* households to a larger percentage of the three other household types. This historical pathway also has a spatial dimension. Depending on village accessibility and market integration, opportunities for and constraints on livelihood change are different. Remote villages tend to lag behind the more accessible villages in the evolutionary pathway, as indicated in Fig. 9. For instance, the remote village of Phadeng has a higher percentage of *Type A* and *Type B* households than of the other two types.

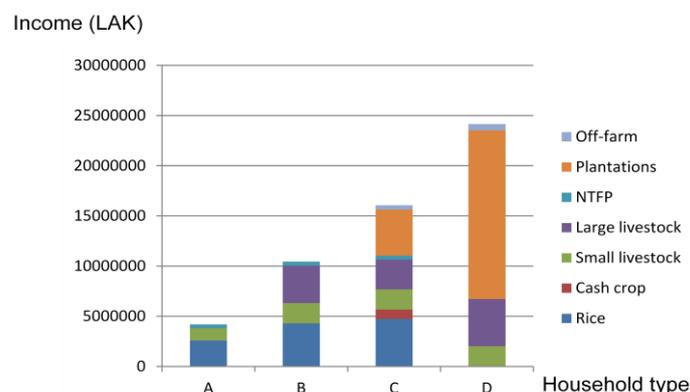
Figure 9: Distribution of household in villages in relation to their remoteness



- A. Rice-based shifting cultivation system
- B. Rice-based shifting cultivation system with capital accumulation through livestock and/or agroforestry
- C. Agricultural diversification towards cash crop production and tree plantations
- D. Increased share of off-farm income

Furthermore, as observed in our study site, the proposed evolutionary pathway is generally associated with a degradation of natural forest cover. As the density of *Type A - shifting cultivator - households* decreases, *Type C - investor - households* expand the agricultural area under cash crops and plantations to cover the remaining forest patches. The latest stages along the capital accumulation pathway are also characterized by a decreasing dependence on forest products. Not only because there is less natural forest and fewer NTFPs available in the landscape, but also because the *Type D* households no longer depend on forest products for food security or income generation (Fig. 10).

Figure 10: Income composition of four household types in Viengkham District



### 3.3 Evolving role of agriculture and forest products in a market economy

#### *From collection to domestication of NTFPs*

Under traditional shifting cultivation systems farmers rely to a great extent on forest products, including wildlife hunting and fishing, to supplement a diet based essentially on rice and a few intercrops such as pumpkin, cucumber or chilli. NTFPs are an essential part of the livelihood system as they are used for food, medicine, housing, tools, etc. (Pfund *et al.* 2011). A large variety is collected daily for consumption or collected on a more seasonal basis for other purposes. Forest dependent communities have a high level of local ecological knowledge. But with increasing access to markets and demand for NTFPs, forest product collection patterns change towards the more intensive collection of the fewer species of economic value (Nanthavong *et al.* 2011). Since most of the NTFPs are sold, the intensity of their collection depends on price fluctuations. Unsustainable gathering practices combined with forest degradation (as described in the previous sections) often lead to a scarcity of NTFPs in the most accessible areas. Villagers have to walk increasing distances to collect the same products (Thephavanh *et al.* 2011). This NTFP boom and bust process has been observed throughout the world (Kusters *et al.* 2006; Belcher *et al.* 2005). The ultimate result, as observed in the most accessible villages, is the domestication of a few NTFPs of high value - e.g. broom grass (*Thysanolaena latifolia*), paper mulberry, peuak meuak (*Boehmeria malabarica*, a vine bark use to produce incense) or bamboo - and the loss of interest in other products of less value. Through this process of domestication, NTFP production has now become a village activity, resulting in the possible erosion of indigenous ecological knowledge and the need to acquire new knowledge on the domestication of NTFPs (e.g. propagation and management techniques).

NTFP domestication also emerges in conjunction with a major change in land tenure. In traditional shifting agriculture the fallow land is open to any villager for NTFP collection or for free livestock grazing. This practice prevents the development of improved fallow management systems and NTFP domestication. But the increasing pressure on agricultural land and conflicts linked to livestock damage to upland crops trigger institutional changes. A first stage is the privatization of the fallow vegetation (i.e. the use is restricted to the household that cultivates the plot). A second stage is field fencing and the privatization of the land. Pressure on the agricultural land therefore pushes NTFP domestication to dedicated plots (e.g. broom grass, bamboo) or under an improved fallow system (e.g. peuak meuak, paper mulberry, cardamom). Another incentive for NTFP domestication is the tax paid by traders to the District Agriculture and Forestry Office (DAFO 2010) for the preservation of natural resources and re-plantation. For example, a 5% fee is collected for cardamom and 3% for peuak meuak and broom grass, which are considered natural resources. But the DAFO fee does not apply to paper mulberry and galangal, which are considered agricultural products.

#### *Market integration reduces the interdependency between agricultural and forestry products*

The value chain analysis conducted in 2009 showed that the same actors are involved in the marketing of both agricultural and forest products. Instead of specializing in one product and attempting a vertical business integration to control production, collection, processing, domestic trade and export, most actors focus on a single level (e.g. village, district, province) and a single activity or group of actors (e.g. industrial transformation, producers, collectors, traders) across a large range of agricultural and forest products. Stakeholders in the value chain justify such strategies as risk management aimed at coping with market uncertainty, fluctuations in product quantity and quality and the absence of binding contracts between actors. They have to be very responsive to the market demand and price fluctuations to avoid losing money. The volume sold is highly dependent on the price and all actors of the value chains have to constantly adapt. Job's tears, for example, almost completely disappeared from the landscape between 1997 and 1998 when the price dropped from 5,000 LAK/kg to 1,000 LAK/kg (1 USD = 8.000 LAK in 2012). In 2009, the paper mulberry price was only half of the 3,000 LAK/kg received by villagers in 2006.

The current situation is also the legacy of a long history of agro-forest product exchanges in the region studied in detail by Yokoyama (2010). Prior to the mid-1980s, all villages were ethnically homogeneous and the exchange of products was organized by ethnic Tai households along the rivers and tracks used for transportation to the urban areas (Chazee 1998; Evrard 2006). Strong historical commercial ties existed between the mountain people (Khmu and Hmong) as gatherers and the lowland people (Tai). With limited market access, local people essentially bartered a few “light” agricultural products (e.g. sesame, opium) and NTFPs (e.g. cardamom, benzoin, bamboo worms) for consumer goods (e.g. clothes, lamp oil, tools, medicines). Due to the poor quality of roads and transportation, light products that allow a high margin per kilogram of product were preferred to heavy ones. For example, farmers would have to transport 100 times more weight of broom grass than cardamom to generate the same benefit (the margin is 5,000 LAK/kg for cardamom and 500 LAK/kg for broom grass). For many years, most of the agricultural products (rice, maize, cassava) were consumed by the households and not commercialized. Despite government policies promoting cash crops the volumes were very limited as compared to NTFPs due to poor market accessibility.

In the early 1990s, with the improvement of the road quality, rivers were less used for transportation and the historical differentiation of ethnic groups with regard to collecting and trading activities faded. A complex trading network emerged with village level collectors or middlemen sending the products to district level traders (Yokoyama 2010). As a result, subsistence agriculture has gradually been replaced by commercial agriculture, and NTFP use has gradually shifted from consumption to trade. As market access improved, the variety of NTFPs gathered declined. When most of the NTFPs collected were consumed by the local villagers there was a much greater variety. Nowadays, villagers in upland areas focus on the few NTFPs of high economic value and tend to collect large volumes of these (Nanthavong *et al.* 2011).

#### *Land degradation drives changes in the availability of agriculture and forest products*

Depending on the level of land degradation and agricultural expansion, the range of NTFPs and the supply of agricultural products have changed over the recent years. For example, cardamom, which requires a shaded humid forest environment, is now only available in remote villages while it has disappeared from the villages closer to the road. In the latter, the reduction of fallow length to two years led to a gradual shift from cardamom to peuk meuak and broom grass as land quality declined (Neef *et al.* 2010; Thephavanh *et al.* 2011). At the end of the land degradation process, broom grass may be considered as an invasive grass (like *Imperata cylindrica*, which is used for house roof thatch) rather than an NTFP, as it is characteristic to both young fallows and degraded landscapes where savannah environments made up of broom grass and bamboo shrub become persistent and no longer regenerate as secondary forest.

Regarding agricultural products, the same type of product shift has occurred in recent years from sesame, soybean and groundnuts (i.e. relatively high value added per kg of product) towards heavier products such as maize. Local producers and traders explained this shift not by the improved road accessibility but instead by the irregular yields obtained from traditional cash crops (highly dependent on weather variability and pest damage), the lack of storage capacity for these oil products and the relative flexibility of maize regarding climatic variations and ease of handling and storage. One of the main consequences of these changes is a relative specialization of agricultural marketing channels that are gradually becoming independent from the NTFP trading system.

## 4 Discussion

### 4.1 Landscape homogenization and increased livelihood vulnerability

The forest transition observed at the landscape scale is usually valued positively in terms of enhanced landscape functions and ecosystem services due to increased tree cover. However, land use change analysis at the village scale suggests that the forest transition has had differential impacts within local communities. With market integration, agricultural and livestock products have provided important income sources for some households that have decreased their reliance on forest products and expanded and intensified the area used for agriculture to the detriment of the forest. Old fallows and secondary forests have been turned into permanent crops. At the same time, land policies aimed at establishing boundaries between agricultural and forest land and controlling access to forest resources have also put the poorest households at risk. In many instances, shifting cultivators have no readily available options other than pursuing agricultural practices that are not adapted to the high population densities created through resettlements and top-down land use planning policies (Fujita and Phanvilay 2008). In turn, their proximate role as actors causing land degradation and their perceived incapacity to manage natural resources appear to the government to justify further displacements away from forest lands and strengthened external control on forest resources (Lestrelin 2010; Lambin and Meyfroidt 2010).

In our study area, land regulations have gradually simplified the landscape patterns towards the segregation of agriculture and forest. While the 're-forested' eastern part of the landscape may be considered more resilient to shocks in the absence of swidden intrusions, the livelihoods are more specialized and concentrated in a small village territory, which limits the capacity to cope with unexpected events (Jackson *et al.* 2012). Complex interactions in space and time allowed traditional agroforestry systems to cope with climatic risks, pest damage and disease (Chazee 1998; Rerkasem *et al.* 2009) and with the uncertainty of market demand (Cramb *et al.* 2009; Yokoyama 2010). Over time however, the ecological goods and services provided by the fallow, in terms of e.g. regeneration of the land fertility and provision of NTFPs, have gradually decreased. Reduced to two or three years, the fallows no longer constitute a significant source of plant nutrients for agriculture or a carbon sink (Watanabe *et al.* 2004; Bruun *et al.* 2009). Similarly, if seasonality and price fluctuations reflecting market demand have long been the main drivers of the volume of NTFPs collected, changes in land use and conversion of forest cover are modifying the patterns of NTFP distribution in the landscape. In our study area, products like cardamom or benzoin are disappearing. The Lao authorities' answer to the relative scarcity of some NTFPs consists of incentives to preserve forest resources through taxes (for replanting) or in the promotion of domestication through tax exemption. While taxes on NTFPs for natural resource preservation and replanting are potentially a win-win initiative (i.e. providing income opportunities for poor households while preserving forest resources), there is little evidence from our field surveys that the taxes leveraged by the agriculture and forestry officers are actually reinvested in preserving forest resources. In the absence of transparent and equitable mechanisms for reinvestment of benefits into concrete actions, this instrument appears in fact to be more an expression of good intentions.

### 4.2 Enhancing landscape multi-functionality through participatory land use planning

Public policies and interventions pertaining to resource management are generally sector based in Laos while in reality all sectors are interconnected and any action in one sector impacts on the whole system. Thus, by attempting to define clear-cut boundaries between agriculture and forest areas, land use planning interventions have had significant impacts on the adaptability of rural communities to future changes (Jackson *et al.* 2012). New institutions and governance mechanisms are required to

integrate resource management policies across sectors towards enhanced landscape multi-functionality (Selman 2009; Wilson 2010).

Participatory Land Use Planning (PLUP) may constitute one such mechanism and, to some extent, may also contribute to buffering the negative socio-economic consequences of previous LUP programs in Laos. Instead of reproducing or increasing socio-economic inequalities through livelihood-blind interventions, community participation in LUP can ensure that existing trade-offs between conservation and development are negotiated at the local level. It can also allow for a collective exploration of the impacts of landscape changes on ecosystem services and local livelihoods.

Bourgoin *et al.* (2012) have engaged local communities in negotiating their own development pathways by using a large range of landscape visualization and learning tools. Residents of several villages in the study area (Fig. 1) were involved in scenario explorations and landscape design experiments that allowed them to assess the impacts of different landscape patterns on the livelihoods of different household types. On this background, they investigated landscape values in terms of economic development and ecosystem services before building consensual plans with other stakeholder groups and establishing priorities for local action and external intervention (van Noordwijk *et al.* 2001; Selman 2009; Bourgoin *et al.* 2012). In our study site, priority was given to maintaining a large range of livelihood options as a strategy for adaptation to unexpected changes. Bourgoin (2012) showed that this approach resulted in more diverse and multifunctional landscapes than the one produced through top-down LUP processes. In addition, agro-ecological innovations (e.g. conservation agriculture, agroforestry) were explored virtually as alternatives to shifting cultivation in densely populated areas and then tested with local communities in partnership with extension services and NGOs (Bourgoin *et al.* 2011). Payment for environmental services mechanisms were also explored to enhance smallholders' access to forest resources (e.g. located in the buffer zone of the NPA) and promote the restoration of degraded landscapes through re-forestation and/or tree protection in village territories (Hett *et al.* 2012). Overall, this experience suggests that the "land degradation trap" experienced by many rural communities across Laos could be avoided through improved landscape governance. This may be achieved by actively engaging local communities in designing their future landscape through participatory land use planning (Selman 2009; Bourgoin *et al.* 2012).

## 5 Conclusions

Our study showed that driven by land and economic policies of the government, the spatial and functional segregation between agriculture and forest is increasing rapidly in our study area. This development is typical for the rural landscapes of Laos. As a consequence, agricultural and forest products, which traditionally were intricately linked at both landscape and livelihood levels, are now found in specialized places, managed by specialized households (i.e. domestication of NTFPs) and collected by specialized traders. This trend may have negative consequences for the resilience of the overall landscape as it reduces its biological and socio-economic diversity and therefore increases vulnerability to external shocks.

Historically, village accessibility has been the main factor of economic differentiation in the uplands of northern Laos. The distance of villages from the main road coincided with a gradient of market integration and with an evolutionary pathway of farming systems moving from shifting cultivation to more off-farm-based livelihoods. The process of market integration combined with successive government policies has brought about a deep transformation in the complex and integrated landscape on which most village communities relied for their livelihoods.

Empirical evidence shows that the land sparing model promoted by the Lao government through the creation of distinct zones for agricultural intensification and for forest conservation does not necessarily lead to a better management of the simplified, intensified agro-ecological systems, and

does not necessarily benefit local populations. Various scholars have documented pathways where forest-dwellers have restrictions on their traditional access to natural resources (with important consequences for vulnerability and socio-economic differentiation) and, in some extreme cases, even have become daily laborers on their former lands (Baird 2010a; 2010b; Kenney-Lazar 2012).

Landscape governance reforms are urgently needed that would not simplify the landscape mosaics in an attempt to ease the tasks of land use planners and policy makers, but instead would engage all stakeholder groups in collectively managing “multifunctional landscapes”, which are characterized by complex patterns of land cover. More integrative planning and design processes grounded in improved multi-stakeholder negotiation mechanisms are essential to enhance landscape multi-functionality and thereby increase the capacity to respond to unforeseen change.

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