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Opportunity costs associated with land use transitions

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Opportunity costs associated with land use transitions:

a nested "Land use – Landscape – Livelihoods" (3 Ls) approach for REDD+ impact assessment

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Executive summary

Opportunity costs associated with past land use transitions are usually calculated at the sub-national level based on parameters characteristic of each land use type such as economic profits and estimated carbon stocks. In this report, we extend the analysis of opportunity costs to the landscape level so as to account for ecosystem goods and services associated with land use patterns and their implications in the broader context of livelihood systems. The costs and benefits of land use and REDD+ transitions for short and long term livelihood perspectives and food security may indeed be very different depending on the scale of analysis (e.g. mosaic landscape vs. land use patch) and the variables included in the analysis, especially those with no monetary value (e.g. culture and traditions) that are often important factors of household/individual decision making with respect to land use conversion.

Based on participatory land use mapping, household surveys and focus group discussion about the perceived impact of land use transitions to livelihoods and ecosystem services, we assessed REDD+ feasibility in eight villages located in four study sites in China, Indonesia, Laos and Vietnam. Despite the limited number of research sites that may prevent a straightforward generalization of our results, the approach to opportunity costs analysis developed and experimented within the framework of the I-REDD+ project provides valuable insights into the impacts of recent land use transitions in rural Southeast Asia. In particular, by looking beyond the economics of land use at the plot level, we were able to highlight important linkages between current dynamics of land use change and trajectories of socioeconomic differentiation, economic and ecological vulnerability, inequalities and risks of social conflicts, etc.

The results raise serious questions as to whether there is a real potential for REDD+ in rural Southeast Asia. Despite an apparent good potential for REDD+ projects in several of the study villages, technical problems are plentiful. Documented additionality may be difficult to achieve in cases where environmental regulations were already in place before the REDD+ era with a strong impact on reducing deforestation despite the small compensations received by local communities (e.g. Vietnam and, to a lesser extent, Laos). Moreover, forest degradation potentially accounts for much larger emissions in many of these areas than deforestation and as long as measurement of degradation is still too complex for national measurement, reporting and verification systems, REDD+ projects may not be relevant. Other difficulties need to be considered in China and Indonesia where the opportunity costs of rubber and oil palm will be extremely difficult for REDD+ to compete with on economic terms. In other areas, where the forest is managed by the state (e.g. Laos, Vietnam sites), there is little prospect for communities to receive a fair share of REDD+ benefits.

It is thus essential to identify windows of opportunity – both in the temporal and spatial sense – where the REDD+ potential is high, for example in areas with low opportunity costs of current land uses, dense forests and low population, but high risk of future deforestation and forest degradation. Such areas are rapidly disappearing in Southeast Asia and the window of opportunity is therefore closing fast.

Finally, if such opportunities are identified, there is a need for flexible local REDD+ architectures that adapt to highly variable local contexts and a mix of market incentives and command and control (law-regulation enforcement) will be needed alongside local participation.

1. Introduction: A conceptual and operational framework for opportunity cost analysis

> *"The opportunity cost is a concept which definition involves two core notions: (i) the notion of a foregone opportunity, meaning that an investment, activity, or use of a resource, all prevent an alternative investment, activity or use of the resource; and (ii) the notion of a cost, meaning that the foregone opportunity would have provided benefits"* (Pirard 2008, 513-514).

An opportunity cost analysis is a 'boundary object' that not only facilitates communication between science and policy but also requires discussion and agreement between scientists – from different disciplines – and policymakers (Cash et al. 2003; World Bank 2011). In the context of REDD+, opportunity costs analysis aims at assessing whether the rent on forest carbon sequestration that would reach the actors of deforestation and forest degradation can offset the foregone land use and livelihood opportunities due to conserving forest areas or enriching carbon stocks of degraded forests. The accurate estimation of the economic losses and foregone livelihood assets due to forest conservation is a very strategic issue for at least two main reasons: to identify low cost strategies for reducing deforestation and forest degradation, and to provide fair compensation to forest users and managers (Pirard 2008). Various approaches are being used and developed for estimating opportunity costs in relation to carbon sequestration and REDD+ (Richards and Stokes 2004; Pirard 2008; World Bank 2011).

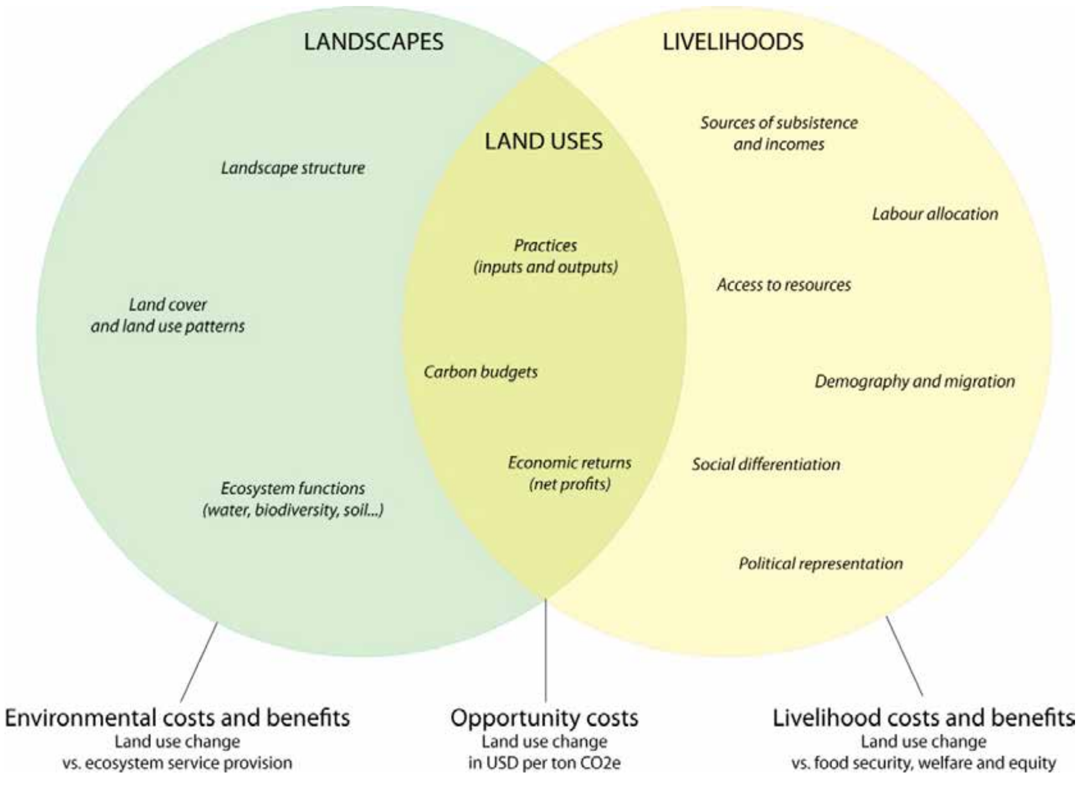
These approaches can be gathered into two main categories according to their scale of significance and their potential contribution to actual REDD+ implementation.

- **Large scale aggregative approaches**: A first type of large scale approaches was presented in the Stern Review of the Economics of Climate Change (Grieg-Gran 2006; Stern 2006). This approach combines average national returns per hectare of different land uses (e.g. annual food crops, oil palm and rubber, cattle pasture) with estimates of the areal extent of each land use at the national and international levels. From there, it assesses REDD+ opportunity costs as the net value of returns from land uses that would be prevented as a result of avoiding all deforestation and forest degradation. A second type of approach uses global estimates of forest extent, carbon densities and/or deforestation rates as well as aggregate economic variables (e.g. distribution of land values, profits generated from timber production, agriculture and pasture). Based on these, it assesses the global potential for REDD+ in percent of reduced deforestation and emission reductions at different carbon prices (Kindermann et al. 2008). While both approaches can be useful for producing large scale estimates of forest conservation / carbon emission reductions at specific costs to the global economy, they provide limited information on the potential and challenges for REDD+ implementation at the national level, for example, sub-national variability in agro-ecological potential, land rent and drivers of deforestation and forest degradation.

- **Sub-national empirical approaches**: At the national and sub-national levels, a generic approach has been developed integrating the real extent of different land use types (including forests) with the estimated carbon stocks, economic profits and co-benefits (e.g. water provision, biodiversity) associated with each land use type (Swallow et al., et al 2007; Pagiola and Bosquet 2009; World Bank 2011). On this basis, projections of opportunity costs, carbon emission reductions and benefit distribution are made under different scenarios of land use change (e.g. 'business as usual', agrarian reform, shifting returns per hectare). In turn, these projections can provide guidance for managing trade-offs (e.g. food production vs. carbon sequestration vs. biodiversity) and targeting REDD+ initiatives at the sub-national level (Börner and Wunder 2008; Börner et al. 2010).

The latter empirical approach serves as a starting point for our opportunity costs analysis in four study sites in China, Indonesia, Laos and Vietnam. However, echoing the call of various researchers for more comprehensive assessments (see Ghazoul et al. 2010; Gregersen et al. 2010; Thompson et al. 2011; Wegner and Pascual 2011), we take the approach a step further by integrating two additional levels of analysis: the landscape and the livelihood system. The costs and benefits of land use and REDD+ transitions for short and long term livelihood perspectives and food security may indeed be very different depending on the scale (e.g. mosaic landscape vs. land use patch) of analysis. In some instances (e.g. smallholder agriculture contexts), the costs and benefits of land conversion may also be strongly related to variables like household labour availability, access to land and water, and cultural or traditional standards, most of which have no direct monetary value – only qualitative or scarcity values that vary from one household/individual to another. A multi-level approach at the interface between landscapes and livelihoods (see Figure 1) allows us to assess, at different scales, such a wide range of potential ecological and socio-political costs and benefits of land use transitions.

Figure 1: Conceptual framework for a nested approach to the opportunity costs of land use transitions



Land uses: A generic local–empirical approach is employed to estimate the opportunity costs associated with potential land use change (e.g. annual food crop to secondary forest, tree monoculture to agro-forestry) in the four research sites. This approach is implemented in three steps:

1) Development of a typology of land uses and associated practices, inputs and outputs in each research site,
2) Assessment of the economic returns per land use type (i.e. expenses, revenues and net profits in US$ per ha and per year – including historical perspective),
3) Definition of appropriate time horizons and discount rates, estimation of the Net Present Value (NPV) of the different land use types, and quantitative assessment of the opportunity costs for possible land use changes in US$ per ton of CO_2e (CO_2 equivalents).

The time-averaged carbon densities (in ton of CO_2e per ha) under the different land use types are estimated from the literature or provided by other work packages.

Landscapes: The above information on land uses is then contextualised at the landscape scale (i.e. village level). The landscape-level approach is implemented in three steps:

1) Landscape analysis and cartography of land cover and land use patterns in each research site at two points in time: 2000 and 2012,
2) Participatory and expert-based assessment of the ecosystem services provided at the land use and landscape levels (ordinal variables representing the value of land uses and landscapes for e.g. water regulation, soil erosion control, and biodiversity conservation),
3) Valuation of the environmental costs and benefits of different land use trajectories (matrix of ordinal values per land use change).

On the basis of previous work on land uses and carbon stocks, landscape level carbon sequestration is assessed by extrapolating carbon densities, in ton of CO_2e per ha, from land uses to the landscape level.

Livelihoods: The above work on land uses and landscapes provides inputs to a livelihood impact analysis. The analysis is undertaken in three steps:

1) Surveys on current livelihood systems in each research site (village and household level information on e.g. livelihood activities, time and labour allocation, access to resources and land regulation, demographic trends and migration, socioeconomic and gender differentiation, political organisation and representation, education, and access to information),
2) Participatory assessment of the contribution of the different land use types to local livelihoods (ordinal variables representing the values of different land uses for, e.g., household subsistence, food security and cultural activities) – “pebble scoring method” (e.g. Sheil and Liswanti 2006) or other participatory method,
3) Valuation of the livelihood costs and benefits of different land use trajectories (matrix of ordinal values per land use change).

Finally, alongside a more comprehensive cost-benefit analysis, we analyse land use transitions not only on the basis of expert knowledge but also through participatory exercises involving various stakeholders. The rationale for this hybrid approach is that to engage village communities in the design of local REDD+ architectures from the outset of the feasibility study. REDD+ feasibility is then further assessed against the “3E+ criteria”: i.e. climate effectiveness, cost efficiency, equity outcomes, and co-benefits generated in terms of biodiversity and other ecosystem services, poverty reduction and sustainable livelihoods, governance and rights, and climate change adaptation (Angelsen 2009).

2. Methods

2.1. Data collection

Data collection took place from November 2011 to June 2012 in two target villages in each of the following four countries: China, Indonesia, Laos, and Vietnam. The location and main characteristics of the eight villages are described in detail in the four country reports in Appendixes 1-4. Two rounds of field activities were organized in each village, about one week each time with four months between the two rounds. Interviews of key village or district informants were conducted to obtain historical changes in land use in the target villages in partnership with WP7. A list of all household heads present in each village at the time of the survey was established from the village census and a random sample of fifty households was selected for questionnaire survey. Local enumerators were trained to conduct household surveys. The questionnaire was revised based on the results of the testing phase, so as to adapt it to the local context. The questionnaire covered many aspects of the household structure and economics, including family composition, labour force available, productive and non productive assets, land tenure, plot location and land use history, crop and livestock production and other sources of income.

Focus groups were organized with about 5-10 men and 5-10 women in separate groups. Three types of group discussions were organized: (i) developing participatory household typologies and poverty indicators, (ii) assessing opportunity costs of land use (data collected for all land use types on cropping calendar, labour force, production costs and income), and (iii) characterizing local perceptions – using pebble distribution exercises – of livelihood (consumption, income, medicine, culture, aesthetics) and ecosystem (water regulation, soil conservation, biodiversity, air quality and climate) services provided by the main land use types. After the first field visit, data from the different sources (i.e. questionnaire survey, local informants, focus groups and literature) were cross-checked. Household survey data were entered in a database and computed to generate descriptive data about the target villages (cf. country reports in Appendixes 1-4) as well as a household typology.

During the second round of fieldwork in the target villages, local communities were engaged in participatory mapping of current and past (year 2000) land uses on a 3D model of the village (Rambaldi, 2010) in order to characterize recent land use transitions and investigate their impacts on livelihoods and ecosystem service provision. The village maps were adjusted with high resolution satellite images (e.g. RapidEye or Google Earth images from different years) so that areas of the different land uses could be assessed at the village/landscape level (Appendixes 1 to 4).

Data related to the opportunity costs of the different land use types identified during the first field trip were reviewed and carefully cross-checked with village participants in the eight target villages. Net Present Values were calculated for each land use type. The household typology derived from focus group discussions and household data collected during the first round (50 HH per village) was also tested and validated with villagers.

2.2. Data processing and comparative analysis across study sites

Data derived from the different sources, sites and scales were combined so as to link land use transitions with carbon stock variations (using carbon stock estimates, as available in the literature specific to the target sites) and livelihood/ecosystem services, i.e. reliance of the household types on different land uses and perception of landscape changes. Beside simple graphs describing the relations between couples of variables, we used three comparative approaches:

1. The REDD Abacus software (Harja et al., 2011; www.worldagroforestry.org/sea/abacus) was used to analyze the opportunity costs of land use change in our target village landscapes from 2000 to 2012 and generate abatement cost curves. Abatement cost curves indicate how much emission reduction would have been feasible at what price. They are generated using (i) the differences in economic value (i.e. calculated as Net Present Value) ($/ha) and (ii) the time averaged C stock (t C/ha) of any type of (iii) land use change (i.e. matrix of land use transitions derived from participatory mapping 2000 and 2012). For each of the 8 study sites, REDD Abacus files were created to (i) convert differences in carbon stocks into estimated emissions, (ii) generate tables of opportunity costs for every type of land use change from the differences in NPV and C stocks, (iii) determine the actual emissions for each cell in the matrix from the area involved and the emissions per unit area and finally (iv) compute the cumulative emission total after sorting by opportunity cost. This classical approach to opportunity costs analysis is deemed useful to assess the local feasibility of REDD+ (World Bank, 2011). If the economic value of emission reduction (i.e. carbon market price) is higher than the opportunity costs of avoiding emissions, it may be financially attractive to develop a REDD+ scheme, otherwise there would be little prospect for voluntary emission reduction through carbon payment.

2. Differentiated impacts of land use changes on the different household types were investigated by looking at: (i) how the different household types identified in each study village rely on land resources, (ii) to what extent these household types have been shaped by past land use transitions, and (iii) how they may evolve in the future. The percentage of village area under each land use type that is managed by the different household types is used as an indicator of the impact of land use transitions on the local economy.

3. Perceived values of landscape changes were computed by combining land-use transitions from participatory mapping (2000-2012) with the data on perceived livelihood and environmental values of the different land use types (i.e. results from the "pebble distribution exercise"). Villagers assigned values to the relative contribution of land use types to different livelihood functions/environmental services. Men and women's perceptions were aggregated and weighted by the relative importance attributed by the villagers to the different landscape functions/services. Building on this and the land use distributions of 2000 and 2012, "landscape scores" were calculated for 2000 and 2012 in each study village. Despite the approximations in the values associated with each land use type, the differences between the 2012 and 2000 landscape scores for different functions/services can be used as an indicator of the livelihood and environmental impacts of the land use transitions observed at the landscape level.

3. Land use transitions in the study sites

In this section we provide the empirical data necessary for our comparative approach. Additional information about the individual study sites is available in Appendixes 1-4.

3.1. Shifting cultivation at the outset of the transition

Historically, the main land use in all study villages was shifting cultivation, practiced by subsistence farmers using similar resources and agroecological knowledge. Upland rice combined with cassava, taro and vegetables for family consumption have been grown for centuries as part of long rotations which included 12 to 15-year fallows. In China's Xishuangbanna region, like in Laos and Vietnam, villagers also engaged in animal husbandry, including cattle, pig and poultry, for subsistence. Wherever alluvial land could be terraced to grow lowland rice, farmers would intensify their rice production in their paddies. While lowland rice and livestock production were less developed in East Kalimantan, villagers engaged in complex rubber-based or rattan-based agroforestry systems in combination with mixed fruit gardens. Agriculture was practiced within complex landscape mosaics characterized by a decreasing intensity with the distance to the settlement areas. The villages were embedded in a forest matrix and their boundaries were not clearly defined. Villagers relied to a large extent on non timber forest products for their livelihoods and food security in case of bad harvests. The customary land tenure system (i.e. right of clearance or 'axe rights') temporarily allocated the land use right to the family who first opened the forest, while forest resources were open access.

3.2. A decade of rapid and radical changes in land use and livelihoods

In all study landscapes, land use changes that occurred during the last decade (2000-2010) had a larger amplitude and impact than any event that happened in previous decades, with the noticeable exception of the Indochina war (e.g. Laos and Vietnam sites). These changes, described for each country in more detail below, have been driven by two main forces: (i) land policies and tenure reforms in the 1990s and (ii) fast increase in market economy integration in the 2000s. These drivers led to a rapid expansion of commercial agriculture, a competition with former subsistence agriculture and a gradual reduction, intensification or abandonment of traditional shifting cultivation practices (see also Sun et al., 2012). The process of land use intensification, i.e. shortening of fallow periods and/or lengthening of cropping periods up to annual or permanent cropping has generally resulted in higher return to land and/or labour.

<u>Manlin and Mansai villages in Xishuangbanna, China</u>

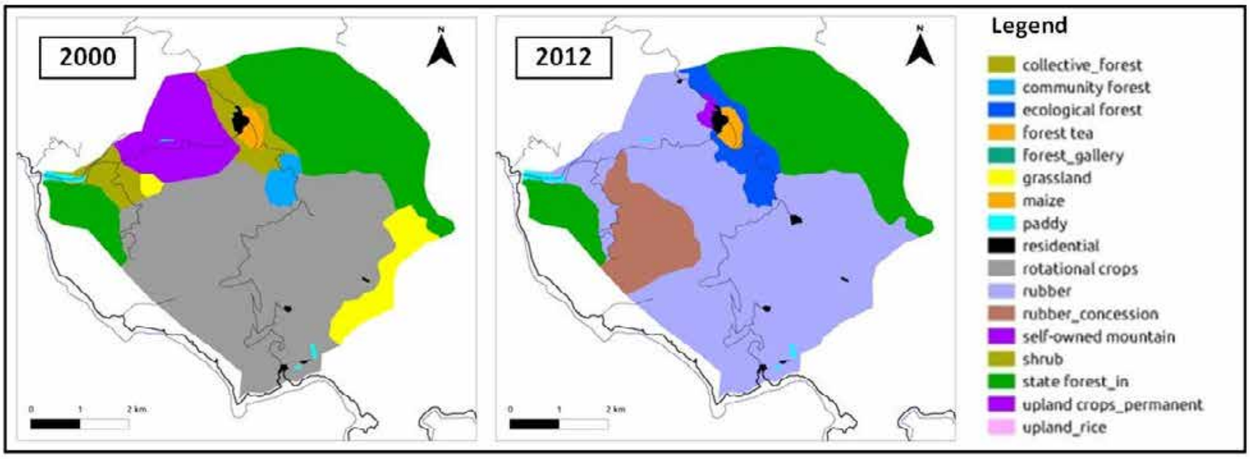
During the 1990s, villagers were practising shifting cultivation of upland rice (1 year cropping/7 to 8-year fallow) and maize (2 to 3-year cropping/3 to 4-year fallow), raising livestock (about 1500 heads of cattle and buffaloes in Manlin, 210 heads in Mansai) in the grasslands and collecting firewood and NTFPs in community forests. One cycle of paddy rice per year was grown in both villages but the area was not sufficient to cover the rice consumption of the whole village. Ancient tea was grown in the high altitude forests but the market prices were so low that farmers used it mainly for their own consumption. Maize was used to feed the pigs, 50 heads per household on average. Horses were used to carry goods for sale outside of the village.

Road construction in 1997 in Mansai village and in 2000 in Manlin village opened the area to the market and triggered major changes in the local land use systems (Figure 2). This coincided with the first rubber plantations entering into production in the area and providing substantial benefit to the early adopters who were initially supported by a government project. In the following years, almost all villagers, attracted by the increasing prices (from 1.2USD/kg in 1998 to 4.5USD/kg in 2011) and perspectives of high economic return, planted rubber. Maize was grown the first three years as intercrop in the rubber plantations, but it gradually disappeared from the landscape as the plantations got older and saturated the whole landscape. As a consequence pigs have also almost completely disappeared, households raising 2 or 3 pigs only for consumption. As large livestock were damaging the young rubber plantations, villagers decided to sell their herds in the mid 2000s. In 2008 all large livestock had been sold. Grassland and shifting cultivation areas had been replaced by rubber plantations. The sudden increase in tea prices boosted the renewal and expansion of forest tea in high altitude areas that were not suitable to rubber. Most of the so-called 'self-owned mountain', allocated to individual households in 1983, and collective forests were turned into forest tea. And more recently, tea is also grown in forests designated as 'Ecological Forest', which is a government programme that pays a small compensation for forest conservation to the villagers. Today, most villagers consider that ancient forest tea, ecological forests and self-owned mountain do not need to be considered differently. They are used the same way for tea production and firewood collection. The only difference for ecological forests is that timber extraction requires an official permission from the Forestry Department.

The rapid economic development of the area attracted outside investors (so-called 'big-bosses'). In 2003, the investors started to contact local authorities and villagers to rent land for planting rubber. Their plots are managed by migrant workers, often ethnic Hani people, who have little relations with the local population. Social relations have been transformed by this increasing reliance on hired labour to manage intensive cultivation systems. The influx of off-farm wage labourer from neighbouring provinces is expected to increase in the coming years when most of the currently young rubber plantations will become productive. Local villagers have no idea of the total area rented to outsiders as the contracts are signed between individuals. In 2009-10, investors also started to rent lowland paddy fields to grow banana in Mansai village. About 27 ha of paddy land were rented out by Mansai villagers. Following the example of the investors, in 2010, some villagers started to plant banana on their own paddy land. They were supported by investors who provided technical training as a reward mechanism for people who facilitated their establishment there. Paddy land is now also rented out to investors to grow winter crops such as sweet corn, beans, water melon, pumpkins, etc (Figure 2).

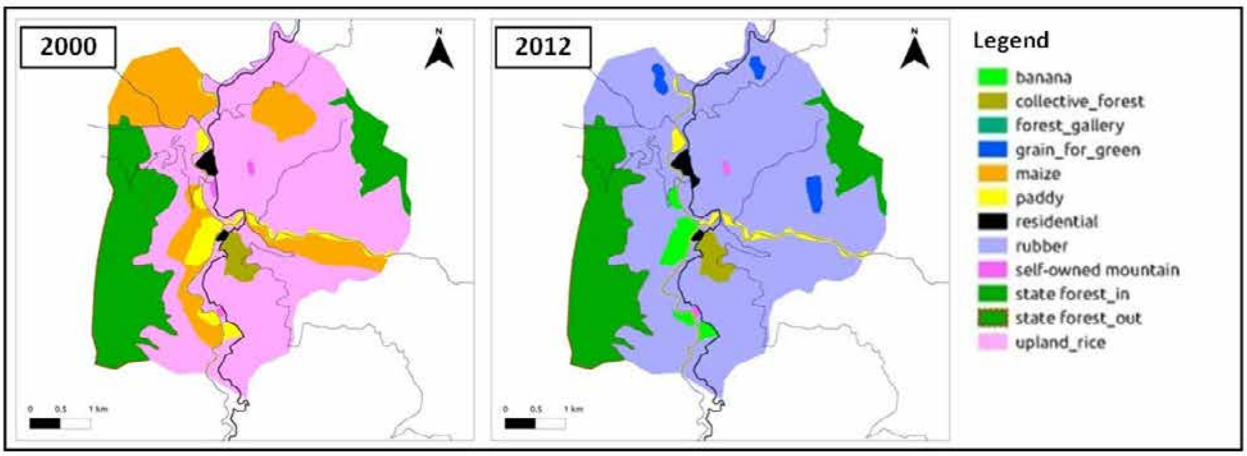
<u>Figure 2</u>: Participatory land use maps 2000 and 2012 and land use transition matrix (ha) - China

A. Manlin village



Manlin	community f	ecological fo	forest tea	grassland	paddy	residential	rotational cro	rubber	rubber_conc	self-owned r	shrub	state forest_	upland crops	Total
community f	-	57												57
ecological forest		-												-
forest tea			29											29
grassland				-				155	13			11		180
paddy					17									17
residential						19								19
rotational crops						4	-	1 423	286					1 714
rubber								-						-
rubber_concession									-					-
self-owned mountain										-				-
shrub		106				0		96	20	17	-			239
state forest_in												914		914
upland crops_permanent						1		331	11				-	343
Total	**-**	**163**	**29**	**-**	**17**	**24**	**-**	**2 005**	**330**	**17**	**-**	**925**	**-**	**3 511**

B. Mansai village



Mansai	banana	collective_fore:	grain_for_gree	maize	paddy	residential	rubber	self-owned mounta	state forest_i	state forest_ou	upland_rice	Total
banana	-											-
collective_forest		32										32
grain_for_green			-									-
maize			8	-			356					364
paddy	44				54							98
residential						13						13
rubber							-					-
self-owned mountain						0	2	4				7
state forest_in							22		91			112
state forest_out										346		346
upland_rice			21			3	1 196				-	1 219
Total	**44**	**32**	**29**	**-**	**54**	**15**	**1 576**	**4**	**91**	**346**	**-**	**2 191**

Sakok and Samsoom villages in Laos

The study villages in Laos represent two stages in a process of agricultural intensification from traditional collective shifting cultivation in Samsoom to shortening of the fallow period due to relative land scarcity in Sakok (Figure 3). In Sakok, cropping systems are highly constrained by their location in the core zone of the Nam Et – Phou Loey National Protected Area (NEPL-NPA). Before land use planning and land allocation (LUPLA) in 2000, villagers in Sakok practiced shifting cultivation with 10-year fallows or more. Village population was low because of insecurity in the area (counter-revolutionary activities) that pushed many families to out-migrate from 1988 to 1998. The land allocation program implemented in 2000 considerably reduced the agricultural area of the village so as to increase forest protection in the core zone of the NPA. This led to a shortening of the crop rotation cycle from 10 years to 3 years, which was not enough to maintain upland rice productivity. Villagers developed alternative strategies to secure their livelihood, such as using chemical inputs to maintain soil fertility on the slopes, intensifying their land use in the lowland by expanding terraced paddy areas, diversifying crop production by growing hybrid maize, diversifying income generating activities through NTFP collection for the market or off-farm activities.

People in Samsoom village rely on upland rice cultivation for their livelihoods as there is no paddy area in their village. Since the enforcement of the boundary of the Nam Et-Phou Loey NPA in 2005, villagers have shortened their fallows from 10-15 years to 7-8 years. The swidden intensification process is delayed in Samsoom as compared to Sakok but it follows the same pattern. This trend has been actively promoted by the Lao government in an attempt to convert subsistence based agriculture to commercial agriculture.

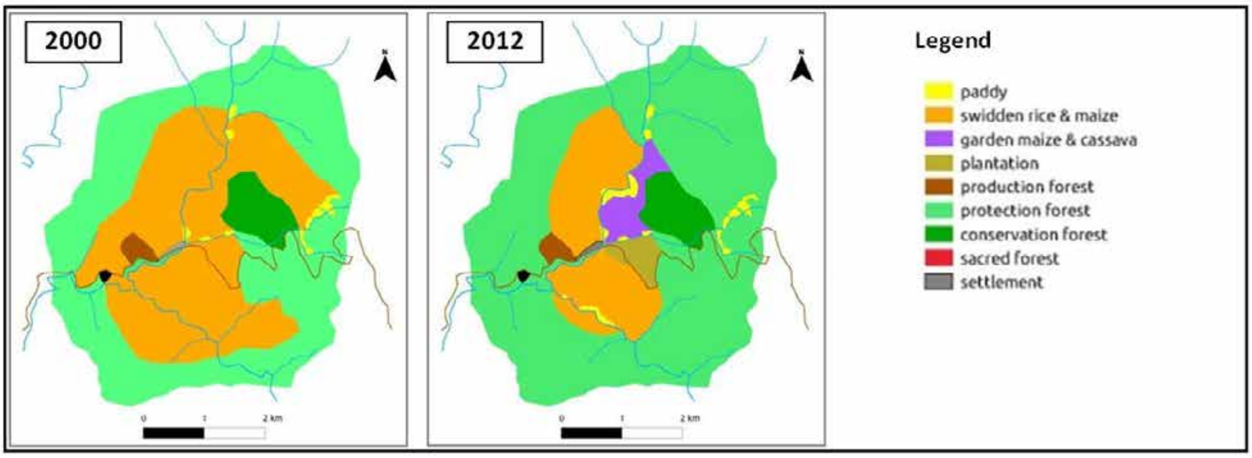
Beside upland and lowland rice, which are traditionally grown to cover rice sufficiency, villagers raise large livestock through extensive management practices. Cattle and buffaloes are basically left roaming freely in the village territory most of the year. Their owner would just locate them once in a while (i.e. every week or two weeks) and make sure they do not get close to the swidden fields during the cropping season. But with the intensification of the shifting cultivation systems the grazing quality of the fallows has decreased and the livestock production system is under pressure. As a result, villagers in Sakok raise less livestock than they did before LUPLA. Non-timber forest products (NTFPs), which were also mainly collected in the fallows, have also gradually decreased in the recent years.

In 2007 hybrid maize was introduced in Samsoom by a middleman from Viengthong district. Since then, hybrid maize cultivation has expanded into former poppy cultivation areas (for opium), which had been the main source of cash income until it was eradicated by the government in the early 2000s. In 2009, Sakok villagers also began to convert some of their swidden to permanent hybrid maize cultivation. Households who owned less than 3 plots started growing maize on their plot the year after upland rice and then maize every year as upland rice could not be grown anymore in the absence of fallow. The rapid expansion of hybrid maize in the study area is consistent with the government's promotion of commercial agriculture. Increased production costs in turn increase the economic vulnerability of farmers and land degradation due to increased erosion in upland cropping systems without fallow also increases their ecological vulnerability. To reduce the economic risks, some household diversify their production by growing traditional maize and tobacco into the hybrid maize cultivation areas. The traditional maize is used for household consumption and for feeding pig, while tobacco is for sale.

The main drivers of recent land-use changes include the establishment of the national protected area, policies towards the reduction of shifting cultivation, the eradication of poppy, and the implementation of LUPLA. In addition, the booming hybrid maize production led to the rapid conversion of upland swidden rice fields to hybrid maize cultivation.

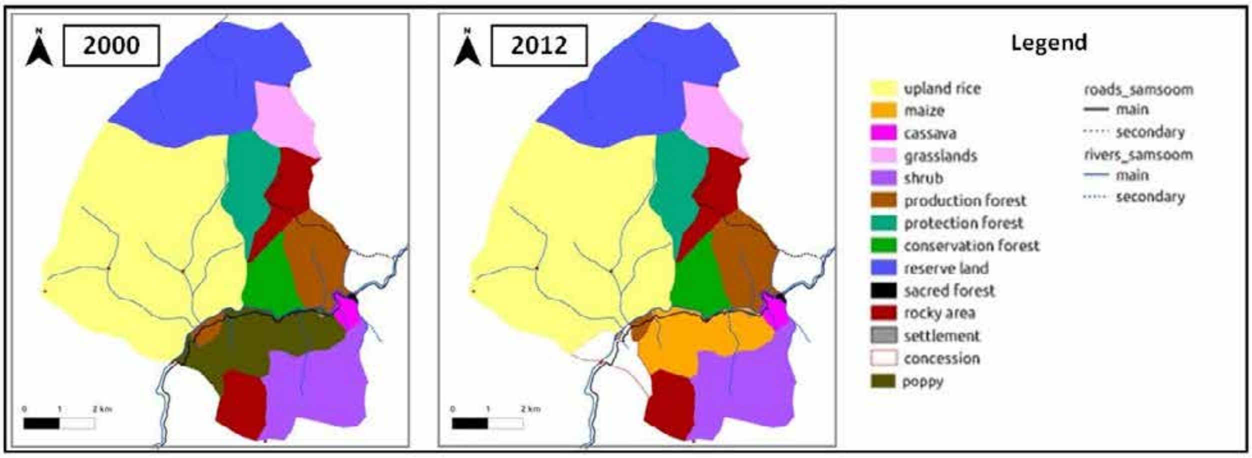
Figure 3: Participatory land use maps 2000 and 2012 and land use transition matrix (ha) - Laos

A. Sakok village



Sakok	conservatior	garden maize	paddy	plantation	production fi	protection fc	sacred forest	settlement	swidden rice	swidden rice	Total
conservation	97										97
garden maize & cassava		-									-
paddy			23								23
plantation				-							-
production forest					19	1 149					1 168
protection forest						8					8
sacred forest							3				3
settlement								4			4
swidden rice		71	18	45		416			-	398	948
swidden rice & maize										-	-
Total	**97**	**71**	**41**	**45**	**19**	**1 574**	**3,16**	**4**	**-**	**398**	**2 252**

B. Samsoom village



Samsoom	cassava	concession	conservatior	grasslands	maize	poppy	production fi	protection fc	reserve land	rocky area	sacred forest	settlement	shrub	upland rice	Total
cassava	58														58
concession		-													-
conservation forest			247												247
grasslands				250											250
maize					-										-
poppy		10			10	-						1			21
production forest		100			483		416					1			1 000
protection forest								359							359
reserve land									1 130						1 130
rocky area										481					481
sacred forest											5				5
settlement												3			3
shrub													643		643
upland rice		67												2 656	2 723
Total	**58**	**178**	**247**	**250**	**493**	**-**	**416**	**359**	**1 130**	**481**	**5**	**6**	**643**	**2 656**	**6 921**

Penarung and Batu Majang villages in Indonesia

Traditionally, livelihoods in both study villages relied mainly on upland rice production under shifting cultivation, non-timber forest product collection (vegetables, fruits, and rattans), livestock husbandry (pig and chicken for self-consumption), fishing and hunting (Figure 4).In Batu Majang, farmers usually crop one to two hectares of swidden for one to three years and then move to a new plot within their own land when productivity declines. After they abandon their plot, they often plant local fruits, cocoa, rubber and vegetables in the young fallow to mark land ownership. After about 4-7 years such plots become mixed tree crop gardens. As swiddens are usually opened in old fallows near rivers to ease transportation, tree crop gardens are also located along the rivers, with the oldest ones closest to the settlement areas. Besides tree crop gardens, three types of forest were identified by local villagers in Batu Majang: communal protected forest, customary production forest and state protected forest. In Penarung, the swidden system is similar to Batu Majang with a 5 to 10 years rotation, but long fallow periods of over 20 years are also found. Farmers also mark their fallow land by planting local fruits, vegetables, rubber and rattan vines. Penarung used to be famous for its good quality rattan production. Rattan was planted in production forests, gardens and swidden. However, the price for rattan is now very low and the rattan agroforest is gradually disappearing, replaced by other, more lucrative land uses. Since 2000, villagers have increasingly planted commercial rather than subsistence tree crops: rubber since 2005, cocoa since 2006 in Batu Majang, and agarwood since 2008 which indicates a gradual conversion of the swidden system to more permanent smallholder plantations.

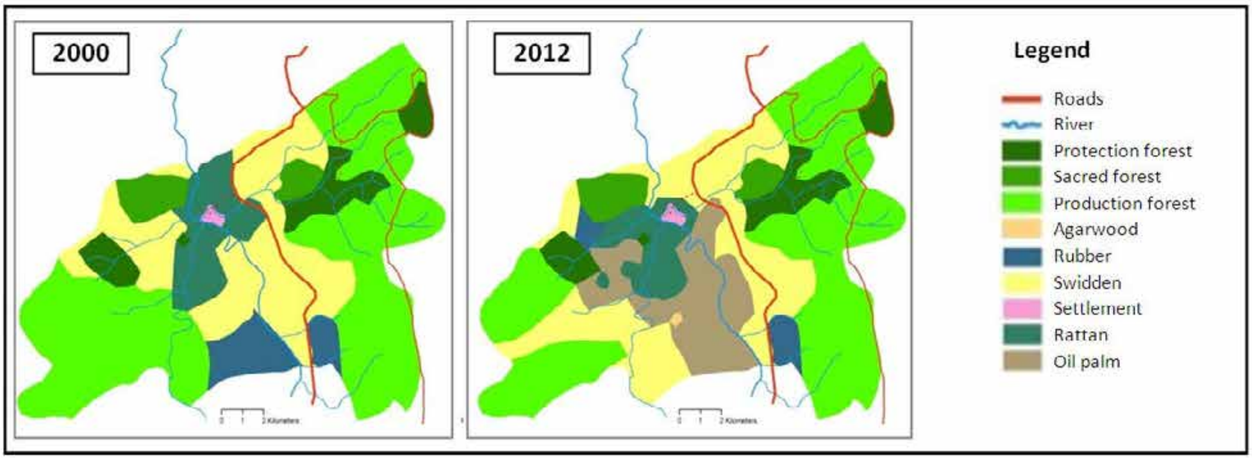
Traditional fruit garden and sacred forest have been conserved as the identity and symbol of local culture. It is also part of the family history. In Penarung, three family lineages share traditional land tenure rights over the village territory. Descendants of these families are the main decision makers about land use in accordance to land inheritance of their respective families.

Large areas of Penarung territory were included in a timber concession which operated from 1990 to 2002. Rubber was introduced by one of the 3 logging companies that operated in the village as an obligatory compensation of timber industry in Indonesia. More recently, mining and oil palm companies have obtained land concessions from the government. In Penarung, 2,000 ha are targeted land of investors for oil palm plantation, of which 1,600 ha were already released and planted in 2012. Villagers' access to oil palm benefits was not clear yet. Local villagers expected that 20% of the 2,000ha will be allocated to villagers as smallholder plantation. Coal mining is also spreading very rapidly all around the village. Two years ago, people from neighbouring villages who sold their land to a coal mining company started opening swidden in Penarung village (about 30 households). While new business investments offer income generation opportunities to many villagers, they may also face land shortage in the future if land concessions are further expanded. In 2012, only 20% of Penarung households still had active swiddens while they were 100% only ten years before.

So far, oil palm plantations are not present in the area around Batu Majang because of its remoteness and no facilities to process oil palm fruits after harvest. However, logging companies are already there. Through their operations, they may well open the road to further expansion of oil palm plantations. The main threats to deforestation and forest degradation would then be combined in the same place like in Penarung.

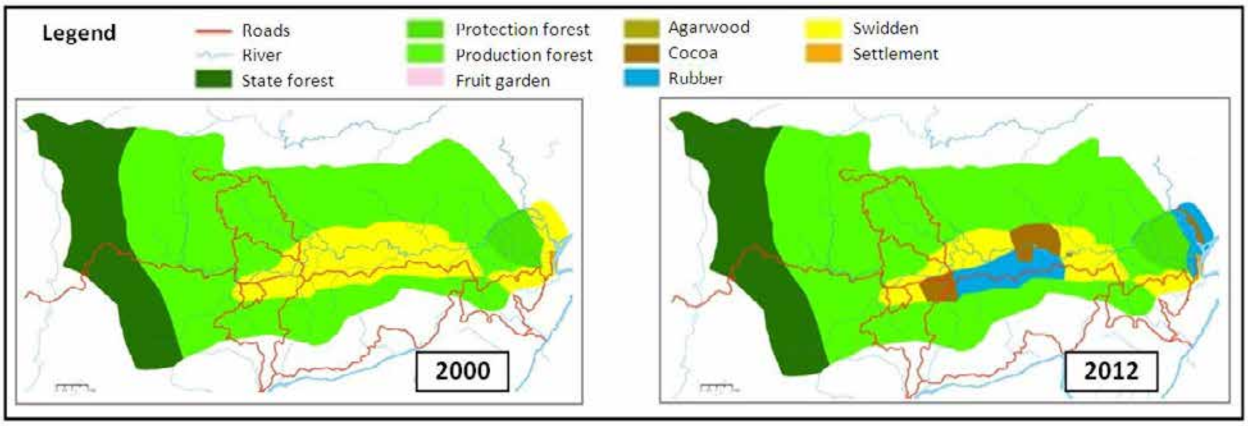
Figure 4: Participatory land use maps 2000 and 2012 and land use transition matrix (ha) - Indonesia

A. Penarung



Penarung	Agarwood (g	Customary p	Oil palm plar	Protected fo	Rattan mixe	Rubber agro	Sacred fores	Settlement	Swidden rice	Total
Agarwood (g	-									-
Customary production fore		8 198	239		0		1		1 634	10 073
Oil palm plantation			-							-
Protected forest				873	10	1			1	885
Rattan mixed garden			298	2	932				443	1 675
Rubber agroforest			710			315			134	1 159
Sacred forest		2	29		4		1 453		0	1 488
Settlement								71		71
Swidden rice	23	134	1 581	7	351	158	12		2 877	5 144
Total	**23**	**8 334**	**2 857**	**882**	**1 297**	**475**	**1 466**	**71**	**5 089**	**20 495**

B. Batu Majang



Batumajang	Agarwood (g	Cocoa agrofo	Customary p	Customary p	Fruit mixed g	Rubber agro	Settlement	State forest	Swidden rice	Total
Agarwood (g	-									-
Cocoa agroforest		-								-
Customary production forest			17 918							17 918
Customary protected forest				835						835
Fruit mixed garden					4					4
Rubber agroforest						-				-
Settlement							33			33
State forest								5 560		5 560
Swidden rice	10	887				1 482			2 648	5 026
Total	**10**	**887**	**17 918**	**835**	**4**	**1 482**	**33**	**5 560**	**2 648**	**29 378**

Diem and Moi villages in Vietnam

Diem and Moi villagers have stopped shifting cultivation after implementation of the forest land allocation (FLA) programme in 1999. Before that period, the main land use was shifting cultivation (7 to 8 years rotation) of upland rice, cassava and taros. Villagers also engaged in animal husbandry, including cattle, pig and poultry, for subsistence only. FLA was undertaken through land zoning and allocation of upland fields and secondary forestlands to villagers. By allocating land to individual households, the government hoped to restrict villagers' access to hillsides and forested areas and, thereby, put an end to shifting cultivation. Paddy land had been previously allocated to individual households. In Moi, each household received 200 square meters of paddy land in 1993. Since 2001, "green books" (temporary land use titles) are progressively replaced by "red books" (permanent land use titles) for agriculture areas in both villages, and for forest land in Moi (not yet in Diem).

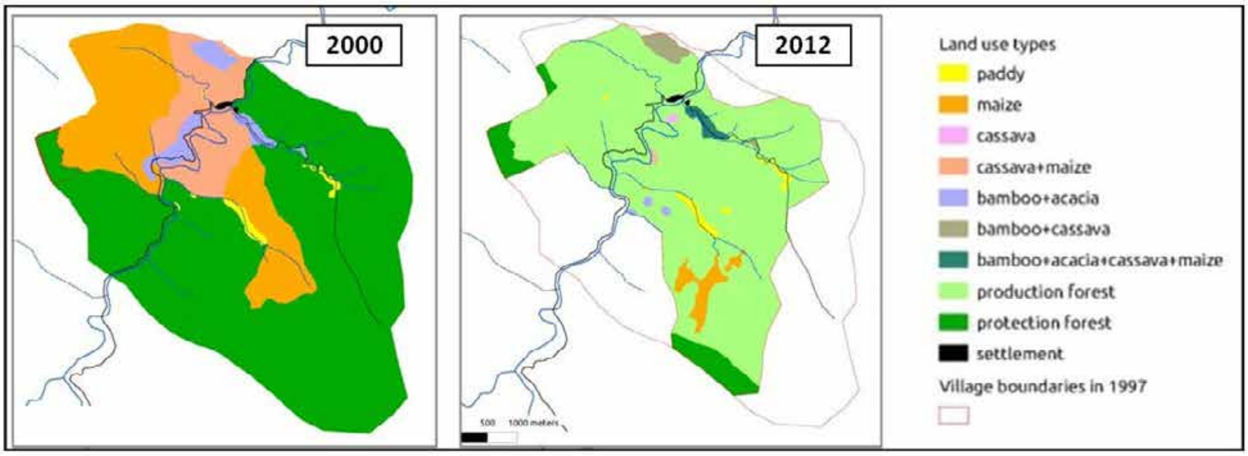
Land allocation has been accompanied by a ban on the clearing and burning of forest land. This forest protection policy deeply affected local livelihoods. In Moi, rice production does not cover the consumption needs anymore. On average, Moi households have to face 6 to 8 month rice shortages. As a result, crops like cassava and hybrid maize generally serve of substitutes for rice, not as feed for livestock. Villagers rely very strongly on government-subsidized rice (10-13 kg of rice per villager in 2012), a support that they have received since the land allocation was done in 1999. Compared to Diem, Moi has less opportunity for economic development due to poor road conditions and limited market access.

Plantations of bamboo and acacia trees have rapidly developed in Diem village since 2000s and are now mainly used for commercial purposes (Figure 5). Over the past decade, maize (hybrid variety) and cassava have become the main crops planted in rainfed areas while paddy rice is grown along to the river banks. According to the villagers, crops play a very important role for food security (mainly for consumption) and cattle (cows and buffaloes) represent the main source of cash incomes. Cattle are raised through a free roaming system in secondary forests and bush lands. Since 2006, off-farm activities have also rapidly developed. Off-farm job opportunities have in part been promoted by officials from the commune after advertising from entrepreneurs on job offers (e.g. garment, industrial plantations). Bamboo and acacia plantations have also developed in Moi village (Figure 5), but, contrary to Diem, these engage only a small share of the population (2 households for acacia and 5 households for bamboo). Limited road access and traffic result in very low incomes from bamboo and acacia plantations. Villagers do not have a lot of cattle (1 per household in average) and concentrate generally on buffaloes. Forest products (mainly bamboo shoots, medicinal plants and timber) represent an important source of income for the villagers. Off-farm activities represent also a key source of cash incomes and about 50 villagers are working off-farm outside the village.

Beside the 1999 FLA programme, the redefinition of the village boundaries has been an important driver of land use change in Diem and Moi. Large tracts of land located in peripheral areas of Diem were redistributed to neighbouring villages. In Moi, around 200 hectares of primary forest in the southern part of the village were classified as buffer zone for the Pu Mat National Park and put under the authority of the Con Cuong district forestry company (Figure 5). Thus, the village land was downsized from 1,230 to less than 1,000 hectares. The process was even more dramatic in Diem as village boundary redefinition led to a downsizing of the village territory from 2,680 to 1,550 hectares. In recent years, many villagers have engaged in bamboo and acacia plantation and have additional paddy land in order to make up for the lost agricultural opportunities.

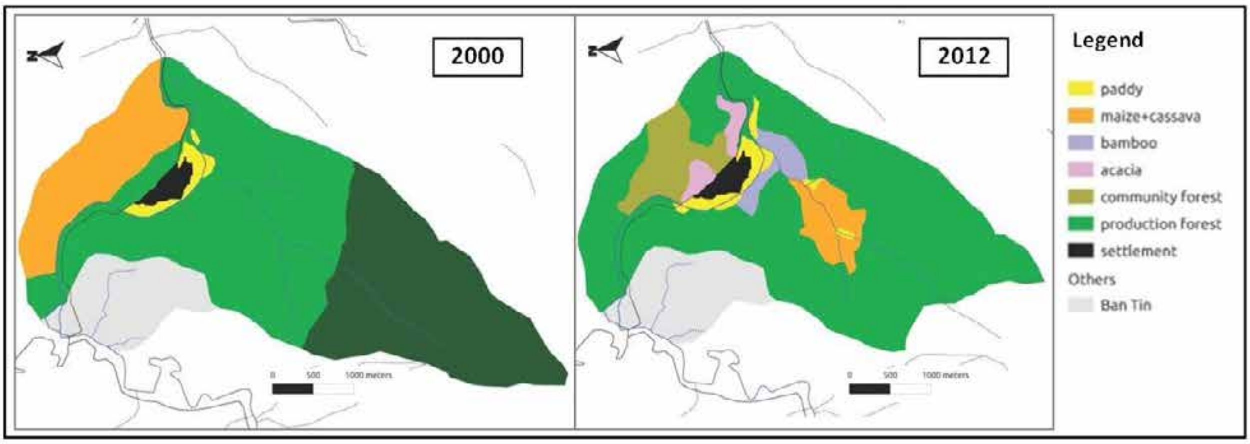
Figure 5: Participatory land use maps 2000 and 2012 and land use transition matrix (ha) - Vietnam

A. Diem



Diem	bamboo	bamboo+aca	cassava	cassava+mai:	maize	paddy	production f	protection f	settlement	state forest_	swidden	Total
bamboo	24	16					33					72
bamboo+acacia		-										-
cassava			-									-
cassava+maize		3	2	-			241			11		257
maize					-							-
paddy						22						22
production forest		5			22		634	54		1 050		1 764
protection forest								32				32
settlement									3			3
state forest_out										-		-
swidden					20	3	430	7		70	-	531
Total	**24**	**24**	**2**	**-**	**42**	**25**	**1 338**	**93**	**3**	**1 131**	**-**	**2 683**

B. Moi



Moi	acacia	bamboo	community f	maize+cassa	paddy	primary fore	production f	settlement	state forest_	swidden	Total
acacia	-										-
bamboo		-									-
community forest			-								-
maize+cassava				-							-
paddy					22						22
primary forest						-	219		196		415
production f	13	32	12	57	10		466				589
settlement								18			18
state forest_out									-		-
swidden	12		68				107			-	187
Total	**25**	**32**	**80**	**57**	**32**	**-**	**792**	**18**	**196**	**-**	**1 231**

4. Opportunity costs of the observed land use transitions (2000-2012)

4.1. Carbon vs. profitability trade-offs curves

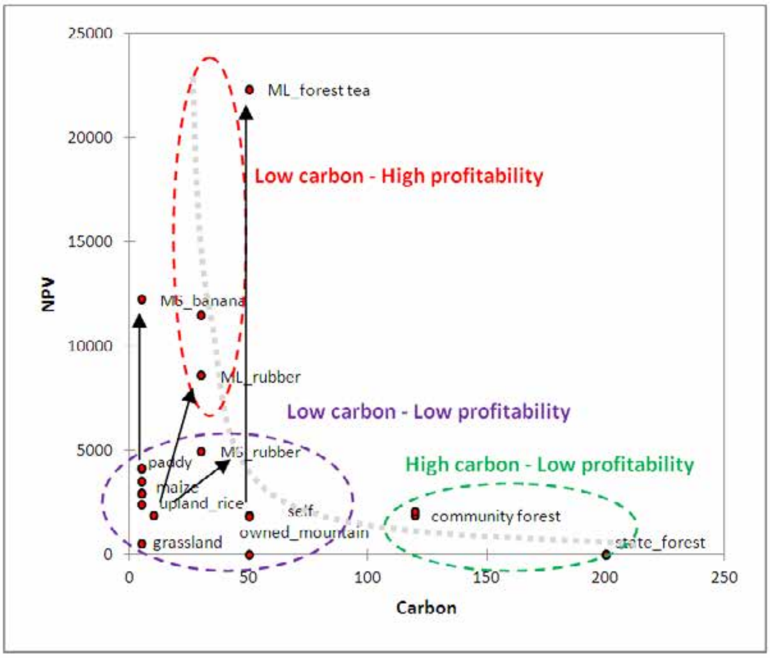
The land use transitions described in the previous section (see also Appendix 1 to 4 for a detailed description of all land use systems) were analyzed in terms of their economic impacts, i.e. return to land and return to labour, and potential for carbon sequestration. As shown by the trade-offs curves below (Figures 6 to 9), most of the existing land use systems in the study villages fall into “low carbon stock-high profits” and “low carbon stock-low profits” clusters. Protected forests, managed by the communities or the state, are the only component of a “high carbon stock-low profits” cluster. The analysis of land use changes over the 2000s decade reveals a general transition away from traditional shifting cultivation systems towards higher profitability land uses. A noticeable exception is the transition from rice swidden to acacia in Vietnam that can be explained by the ban on swidden and government incentives to develop acacia plantations in the area.

The comparison across study sites in four countries exemplifies the successive steps in a general process of agricultural intensification:

- *On the hillsides,* the intensification process first takes the form of a shortening of the shifting cultivation cycle, then a conversion to cash crops (e.g. maize) with shortened fallow periods and finally annual cropping relying on the use of chemical inputs (i.e. herbicides, insecticides, fertilisers). The last stage consists in converting land uses to tree plantations, either by incorporating tree species in the fallows towards complex agroforests (e.g. forest tea in China, agarwood, cocoa or rubber in Indonesia) or converting the fallows to monocultural tree plantations (e.g. oil palm in Indonesia, rubber in China). Only the conversion from grasslands or permanent crops to agroforests or tree plantations leads to carbon sequestration. The conversion from swidden systems to agroforests and tree plantations are associated with carbon sequestration only in the case of short rotations of the initial land use and reconstitution of biomass and carbon stocks in the final land use.

- *In the valley bottoms,* land use is also intensified through an increase in the number of crop cycles, i.e. from one rice crop to two cycles thanks to irrigation systems, or by adding one cycle of maize in the spring and winter crops such as watermelon. Then, the conversion to more intensive systems takes the form of ‘industrial’ banana plantations introduced by external investors in the case of China. All these changes are usually carbon neutral.

<u>Figure 6</u>: Trade-offs curve of different land-use systems – China (ML = Manlin, MS = Mansai)



<u>Figure 7</u>: Trade-offs curve of different land-use systems – Laos

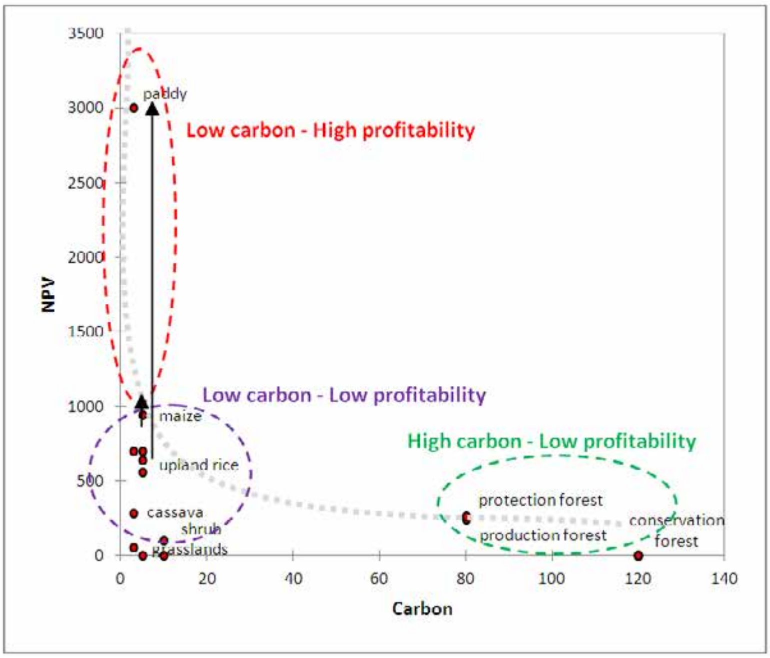


Figure 8: Trade-offs curve of different land-use systems – Indonesia (PN = Penarung, BM = Batu Majang)

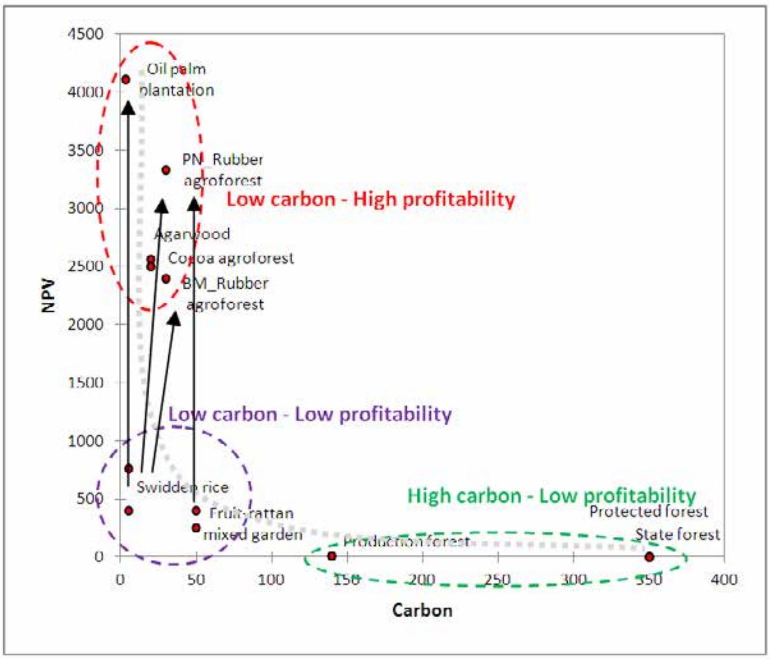
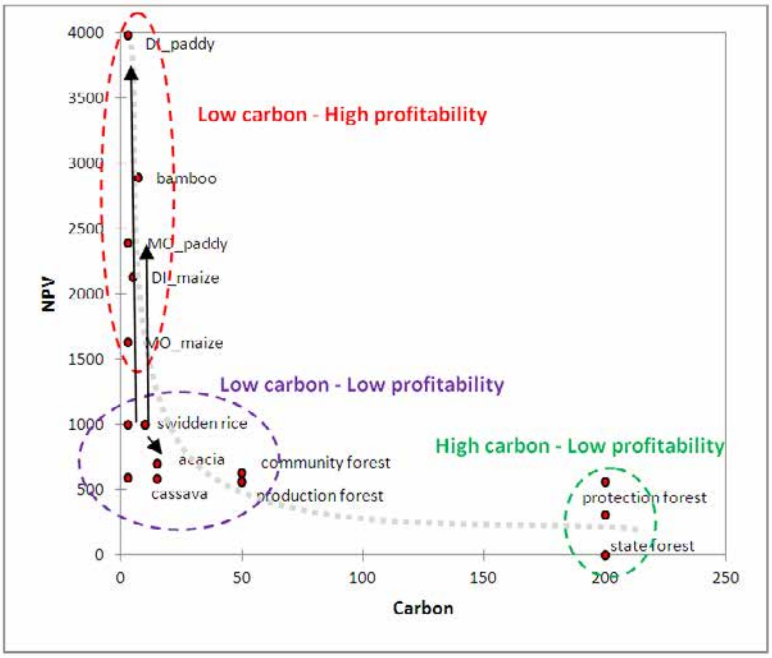


Figure 9: Trade-offs curve of different land-use systems – Vietnam (DI = Diem, MO = Moi)



4.2. Abatement cost curves

REDD Abacus software was used to analyze the opportunity costs of changing land use systems per unit emitted carbon from the land use transitions that occurred between 2000 and 2012. We calculated the forgone financial benefits for local populations if carbon emitting land use transitions would have been avoided. Such a landscape level approach provided an indication of feasible avoidable emissions if a REDD+ project would have been in place during the last decade.

Table 1 summarizes the results generated by REDD Abacus for eight villages. Village areas and population densities have been added to facilitate interpretation of the results.

<u>Table 1</u>: Outputs of the REDD Abacus software for the eight study sites over the period 2000-2012

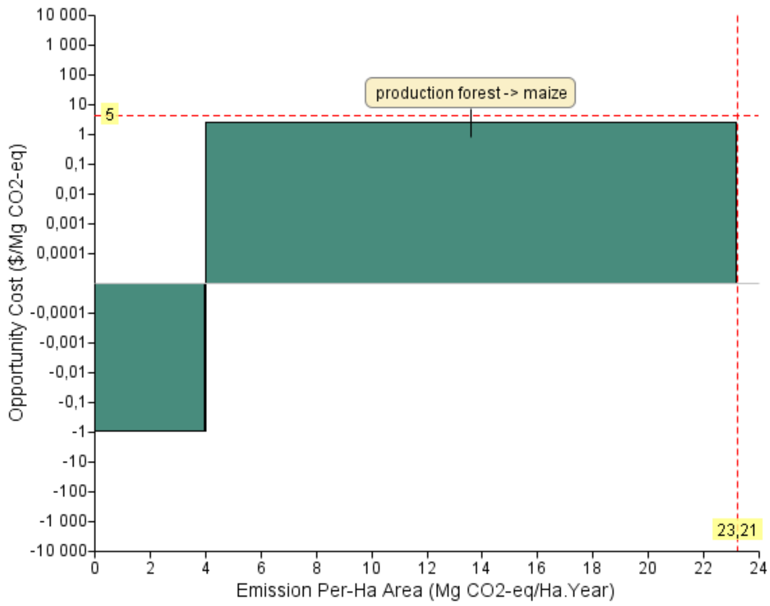
Country	Study sites	Emission per-ha area (Mg CO_2 /ha,year)	Sequestration per-ha area (Mg CO_2 / ha,year)	Cost-Benefit per-ha area ($ / ha,year)	Emission (Mg CO_2 / year)	Sequestration (Mg CO_2 / year)	Cost-Benefit ($ / year)	Village area (ha)	Population density 2011 (inhab. / sq.km)
China	Manlin	0	76	3 913	91	265 323	13 740 013	3 511	8,1
	Mansai	6	66	4 920	13 773	144 887	10 780 667	2 191	14,7
Laos	Sakok	0	153	-222	651	344 955	-500 242	2 252	14,3
	Samsoom	23	0	-143	160 615	147	-988 518	6 921	5,3
Indonesia	Batu Majang	0	6	167	0	185 159	4 900 281	29 378	3,2
	Penarung	59	8	458	1 205 525	168 030	9 377 570	20 495	1,8
Vietnam	Diem	2	290	-395	4 700	779 325	-1 058 867	2 683	25,4
	Moi	113	21	-31	138 960	25 930	-37 764	1 231	57,8

These results confirm that recent land use transitions in the two Chinese sites, Manlin and Mansai, were not associated with carbon emissions (except for limited areas of agricultural land that was converted to residential areas) and that the opportunity costs associated with massive expansion of rubber plantations (Figure 2) are so high that they could not be compensated by carbon at the current market price (USD 5 per Mg CO2-eq is used here as a conservative value to account for additional transaction costs).

As Sakok is located in the core zone of a national protected area, the village is under high pressure from the government to preserve its forests. Demarcation of the NPA combined with strict application of land policies allowed to prevent carbon emissions and to sequester approximately 153 Mg CO2 / ha.year. This remarkable result was achieved at the expense of local livelihoods as the cost of this land conversion for the village population is estimated at USD 222 per ha.year. Several projects active in the area have developed compensation mechanisms to buffer the negative impact of the forest conservation policy on villagers' livelihoods.

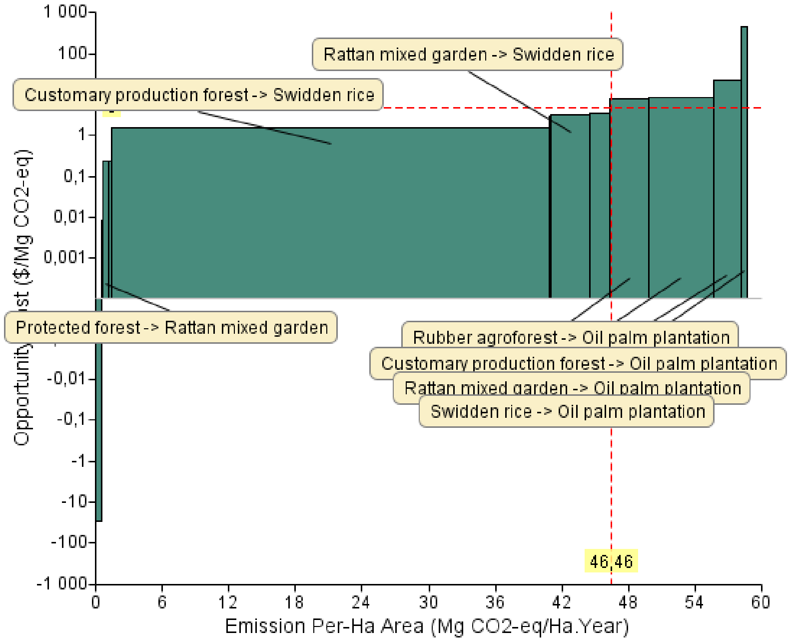
Samsoom was under less pressure during the study period. Carbon emission in the area is mainly related to the conversion of swidden to intensive maize cropping systems. The abatement curve of Figure 10 shows that this conversion could have been avoided if REDD+ compensation mechanisms would have been in place. The reduced benefit from land use conversion observed in Samsoom is related to the abandonment of opium poppy cultivation since 2000. While this income loss for the village was partly compensated by maize expansion, experience from other regions in Laos shows that poverty increase due to strict application of environmental regulations may revive poppy cultivation. Therefore, compensation mechanisms for lost income generation opportunities should be systematically explored with local communities.

<u>Figure 10</u>: Abatement cost curve for Samsoom village (2000-2012)



In Batu Majang, recent land conversions (i.e. conversion of swidden to agroforests, Figure 4) were almost carbon neutral and had a very positive impact on economic benefits (USD 167 / ha.year) for the village community, especially as the village area is very large and population density is low. Such land use conversion could be easily supported by a REDD+ project as the village maybe under threat of oil palm expansion. The opportunity cost of conversion to oil palm plantations being much higher than conversion to agroforests, compensation mechanisms that can prevent the introduction of oil palm in the village may be more efficient than avoiding expansion of oil palm once it is already in. While Batu Majang has been preserved from oil palm expansion because of its remoteness, concession deals have deprived Penarung villagers from large tracts of land. This trend is associated with high levels of carbon emission (59 Mg CO2 / ha.year) and also large economic benefits (USD 458 / ha.year). As oil palm plantations under concession are expanding at the expense of swidden, agroforests and production forests, local communities have to open new swidden land in production forests and agroforests (Figure 4). These land use conversions generate carbon emissions that may be compensated under a REDD+ project as shown in Figure 11. However, this may only delay a future conversion to oil palm plantations that REDD+ cannot prevent at current carbon prices (Figure 11).

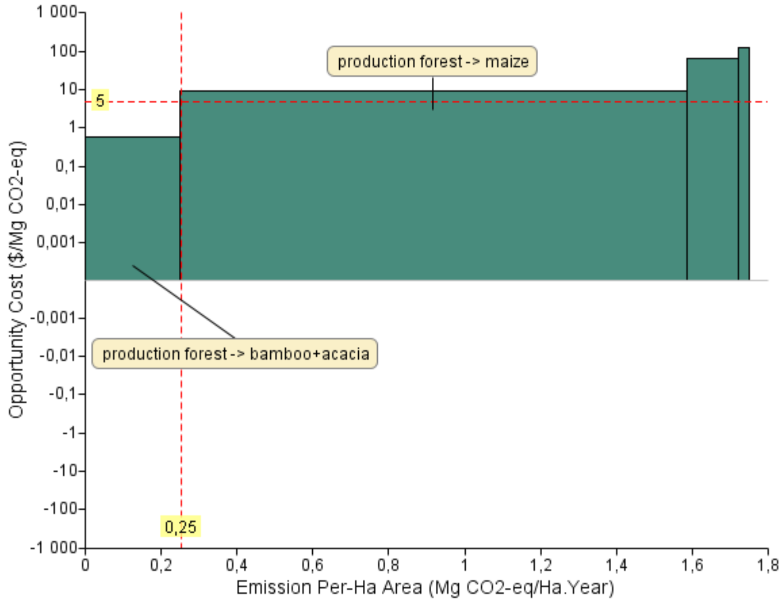
Figure 11: Abatement cost curve for Penarung village (2000-2012)



In Diem village, restriction on shifting cultivation imposed by the district authorities led to important carbon sequestration (290 Mg CO2 / ha.year) despite a high population density. This positive environmental impact is associated with negative consequences for livelihoods and high economic costs per ha (-395 USD / ha.year). At the current carbon price, only limited additional carbon emission can be offset with the conversion of production forests to bamboo and acacia plantations.

In Diem and Moi villages, the reclassification of production forest, under village management, into state forest generated carbon sequestration that may need to be actually verified as it is not sure that the level of forest protection would improve with re-centralization of forest management. Furthermore, the allocation of 200 ha of the southern part of Moi village territory to the Pu Mat national park led to a reclassification by local villagers of the remaining part of their protected dense forest into production forest (219 ha). This conversion is associated with high carbon emission values in the REDD Abacus calculations that may not fully reflect the real status of the forest cover.

Figure 12: Abatement cost curve for Diem village (2000-2012)



Finally, REDD+ may not have been an option in the Chinese sites as it could not compete with the high opportunity costs of conversion to rubber plantation. The same situation is found in parts of Indonesia with the rapid expansion of oil palm plantations. REDD+ may arrive too late to invert the mega-trends in land use changes in places where conversion to plantations is already taking place. In other contexts, like in Batu Majang, it may be possible to use REDD+ compensation mechanisms to promote the transition towards agroforests instead of industrial tree plantations. The former strategy presents the advantage to retain more biodiversity than the latter and could also contribute to reduce farmers' vulnerability to price fluctuations. In the case of Vietnam and, to a lesser extent, Laos, villagers have already been under significant pressure from the government to abandon shifting cultivation, preserve forests and intensify agriculture. Thus, the room for manoeuvre is very limited in term of additional carbon sequestration. In such contexts, REDD+ projects provide very limited additionality. They may also not be financially viable. With the high population densities encountered in Vietnam for instance, forest lands are often heavily degraded and their carbon value may not justify (i.e. cover the transaction costs) implementation of REDD+ mechanisms. Other compensation mechanisms for lost opportunities of local communities due to land and forest policies of the early 2000s may be developed to buffer adverse impacts on local livelihoods. Existing rice subsidies and direct support to poor households can be easily captured by local elites as reported in the case of Moi village. Clear and transparent benefit sharing mechanisms will be required to ensure that REDD+ projects do not harm the poorest households who rely the most on forest resources and have limited power in local actor-networks.

5. Impact of land use changes on local livelihoods

5.1. Household typology and reliance on the different land use types

Household data collected from 50 households were used to identify four household types in each of the study villages. The main objective of the typology was to identify groups of households that relied on similar land resources and/or shared similar land management strategies (e.g. shifting cultivators, livestock breeders, tree plantation manager, part-time farmers with off farm activities). The household typology was also built upon wealth ranking criteria commonly used by local villagers. These criteria were formalized during separate focus group discussions with men and women (Appendix 1 to 4). They pertained for example to the housing quality (e.g. temporary, permanent house), family labour force, social status in the village, assets (e.g. hand tractor, motorcycle), land (e.g. paddy area, total farm area), indebtedness, capacity to pay for children education, etc. These criteria were incorporated into the survey questionnaires so that household classifications would reflect local knowledge relevant to household differentiation.

The four household types: A, B, C, D are consistent for the 2 villages of each country but are different between countries, which prevent from full comparison of a given type across countries. In general, the different types correspond to a gradient of capital accumulation from *Type A* farmers who are often the poorest in the village, food insecure, with very limited land and assets to *Type D* farmers who have accumulated enough land and capital to be considered as the better-off households:

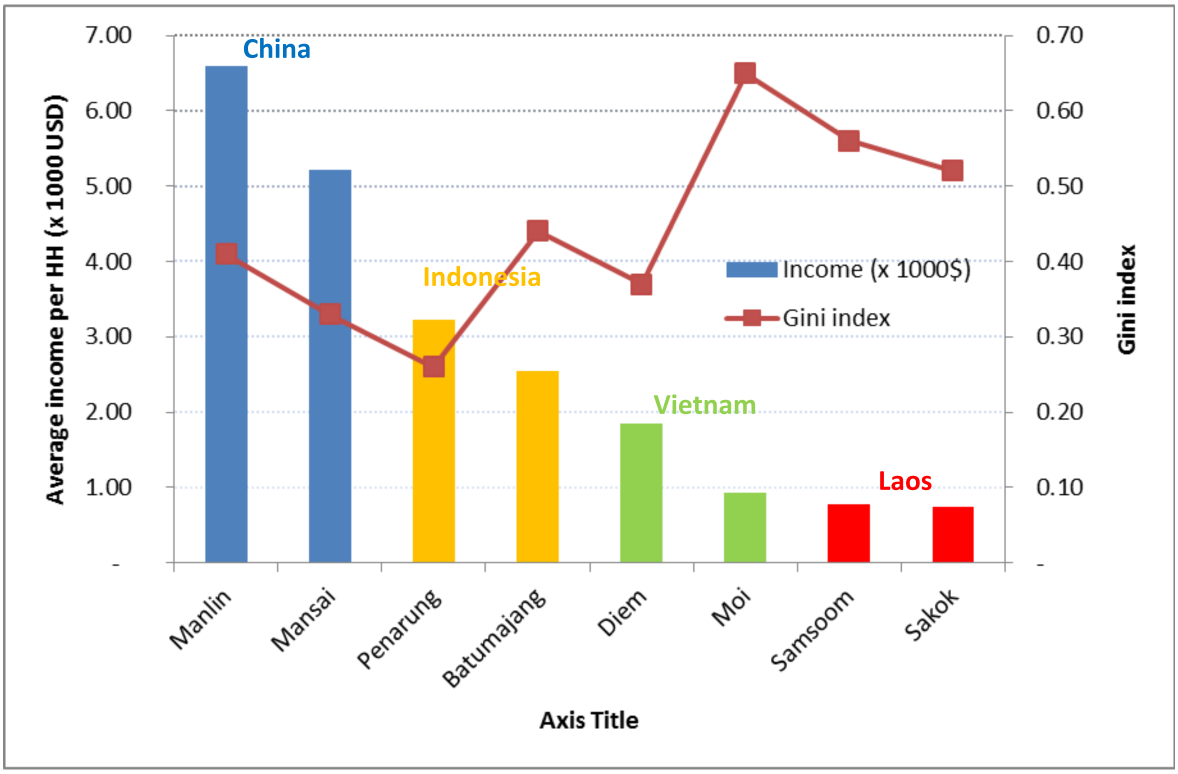
- *Type A* households were identified as the once dominant class of shifting cultivators (Indonesia, Laos, Vietnam) or, in places where shifting cultivation has disappeared, as households with limited access to land (China) who engage mainly in annual crops and seek additional income from NTFP collection or off-farm activities, i.e. daily labourer in other farmers' fields (China) or staff of the oil palm or coal mining companies (Indonesia). Young families who did not inherited land from their parents usually belong to that type.
- *Type B* households can reach food security thanks to access to paddy land, livestock breeding or other 'low investment' agricultural activity such as agroforestry.
- *Type C* households have accumulated sufficient capital to engage in tree plantations. They are usually old settlers who have access to large tracts of upland fields that they plant in rubber (China, Indonesia) or bamboo and acacia (Vietnam). Their current income level may not reflect their livelihood quality as most plantations are still young in most study villages and the benefits do not cover the large investments they have done since the early 2000s, yet. But their assets and land availability are key criteria of classification for this household type besides their investment in tree plantation.
- *Type D* households have reached a level of capital accumulation that allows them to diversity their activities outside of the agricultural sector. They may invest in local trade or become entrepreneurs. They rely less on forest land for their livelihoods and most of their income come from off-farm activities.

As indicated above, large variations have been found between countries. One of the main reasons is the existence of very different levels of integration into the market economy which in turn determines local opportunities for off-farm activities. For example more than 60% of household income is generated through off-farm activities in Penarung and Batu Majang villages in Indonesia while less than 3% of the village income is generated from off-farm activities in the study sites of Laos. Another important factor of variation across research sites relates to population density and the impacts of land regulation. The Vietnamese sites for instance present population densities that are much higher than in other sites (Table 1) with important consequences for local livelihoods. Land scarcity created by recent environmental policies is a key constraint to rural development in Vietnam. With population densities 15 times higher in Vietnam than in Indonesia and less off-farm job opportunities, environment protection measures had stronger negative impacts on livelihoods. Villagers' incomes in our study sites in Vietnam and Laos are below the international poverty line of 1 USD/day/person, while sites in Indonesia and China enjoy higher income despite development trajectories that came at the expense of the forest cover (Figure 14). Agricultural intensification is promoted in Vietnam and Laos to lift households out of poverty and farmers are eager to convert their upland fields to more lucrative tree plantations. Market access is the main constraint so far for these remote villages, close to national parks.

When analysing village level income disparities among households, we found that economic development was associated with decreasing Gini coefficients (Figure 14). As the Gini index ranges from 0% (equal distribution of income) to 100% (total concentration of income), this means that agricultural intensification combined with access to off-farm activities tend to decrease income inequalities that are found in villages that rely on extensive shifting cultivation systems (e.g. Moi village). This counterintuitive result may be explained by a gradual change in household type composition within the villages: from a majority of subsistence farmers (i.e. balanced income distribution), to a coexistence of subsistence and market-oriented farming systems (i.e. income inequalities) and finally a majority of commercial farmers (i.e. balanced income distribution). While further analysis of a larger sample of villages will be needed to confirm these preliminary results, information collected through focus group discussion in the study villages tend to corroborate the idea that most households in the villages benefit from the new income opportunities.

However, the relative homogenization of household incomes can hide increasing social and economic disparities. In the Chinese research sites, for instance, most of the officially registered landowners have benefited from the rubber boom. Yet, rubber expansion is also associated with a very significant influx of migrant workers. The latter live in miserable conditions with no status or local registration and very low income. When all plantations will enter into production they may outnumber the official villagers. Migrant households can enrol their children to the local schools but do not have access to other services provided by the local administration, which may become an important source of tension in the future.

Figure 14: Average annual household income in study sites and Gini index



These results show the importance to address the impacts of land use transitions on food security and livelihoods at the local level. A good understanding of household constraints and strategies is essential to design compensation mechanisms for lost opportunities that are adapted to the local development trajectories.

5.2. Perceived value of landscape changes

As introduced in the method section, the perceived values of landscape changes were computed by weighting each land use type according to the perceived value assigned by local villagers for five livelihood criteria:

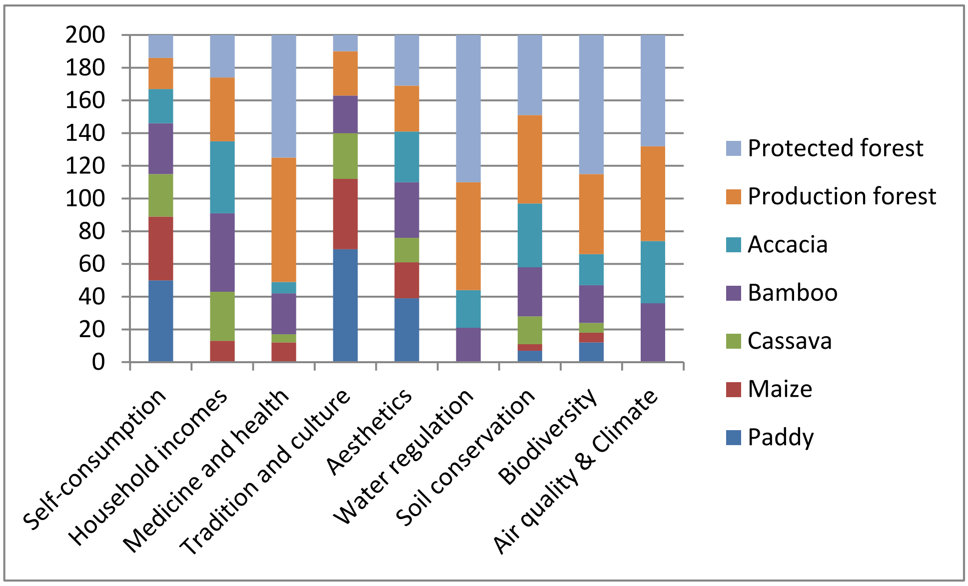
- Self-consumption: capacity of the land use type (including all products: crops, NTFPs, livestock) to cover food needs of the villagers,
- Cash income: capacity of the land use type to generate cash income through the sale of its products,
- Medicine and health: provision of medicinal or health care products used by villagers,
- Tradition and culture: importance of the land use type for local identity and cultural traditions,
- Aesthetics: aesthetic qualities of the land use type from local perspective.

and four environmental services:

- Water regulation: capacity of the land use type to contribute to water regulation: e.g. limit floods and regulate droughts,
- Soil conservation: role of the land use type in soil protection, i.e. avoids soil erosion and landslides,
- Biodiversity: contribution of the land use type to biodiversity conservation,
- Air quality and climate: contribution of the land use system to air quality and climate regulation, e.g. through carbon sequestration.

For each criterion, 5 men and 5 women distributed 20 pebbles (total 200 pebbles) according to their perceived contribution of the land use types to that criterion. Figure 15 shows for example the relative value assigned by Diem villagers to the nine criteria.

Figure 15: Perceived value of land use types for livelihood and environmental services in Diem (pebble ranking)



For each criterion, a landscape value was then computed by weighting the area of each land use by the perceive value of that land use for the criterion, and summing-up for all land use types. Each criterion was also weighted by the perceived value assigned by participants for their livelihoods, for environmental services and in general. The total livelihood value, total environmental value and total landscape value were calculated as the weighted sum of the landscape value for the criteria relevant to livelihood, to environmental services, and all 9 criteria respectively. The landscape value was then calculated for the two land use maps of 2000 and 2012.

Building on differences between the two land use maps (2000 and 2012) in each study village, landscape transition scores were calculated as percentages of change in the values of the 9 criteria investigated during pebble distribution exercises (Figure 16). The scores were then aggregated into total livelihood scores, total environmental scores and total landscape scores (Figure 17). The results in Figure 16 and 17 can be used as estimates of the perceived livelihood and environmental impacts of the land use transitions observed at the landscape level (i.e. increase or decrease of the landscape value between dates).

Figure 16: Changes in landscape scores between 2000-2012 for all criteria

	Livelihoods indicators					Environmental services indicators			
Villages	Subsistence	Household incomes	Medicine and health	Tradition and culture	Aesthetics	Water regulation	Soil conservation	Biodiversity	Air quality & Climate
Manlin	-271%	50%	-19%	-174%	-20%	-39%	-52%	-42%	-24%
Mansai	-329%	64%	-47%	-323%	40%	2%	33%	-189%	35%
Penarung	-11%	-17%	-15%	-13%	-15%	-20%	-18%	-19%	-15%
Batumajang	-28%	-31%	-9%	-8%	-3%	-1%	0%	-2%	-2%
Diem	-96%	-64%	-42%	-81%	-69%	-40%	-49%	-44%	-44%
Moi	-3%	-9%	-14%	3%	-37%	-35%	-21%	1%	-36%
Samsoom	-26%	-20%	-6%	-2%	8%	17%	7%	12%	26%
Sakok	-21%	-3%	-44%	13%	19%	44%	39%	39%	44%

Figure 17: Summary of changes in landscape scores between 2000-2012

Villages	Total livelihood value	Total environmental services	Total landscape value
Manlin	15%	-40%	-5%
Mansai	20%	10%	18%
Penarung	-14%	-19%	-16%
Batumajang	-12%	-1%	-6%
Diem	-62%	-43%	-52%
Moi	-10%	-24%	-17%
Samsoom	-17%	14%	-7%
Sakok	-9%	42%	24%

Villagers in the Chinese sites see rubber expansion as very beneficial to their livelihoods, especially to household income in a market economy that requires increasing expenditure for agricultural intensification but also for children education, etc. This major change has happened at the expense of local traditions and landscape aesthetics but more importantly at the expense of key environmental services. However, the positive and negative aspects of the recent land use transitions seem to compensate each other so that local villagers are satisfied with their situation.

In Indonesia, recent changes are valued negatively as local farmers do not benefit from recent expansion of oil palm plantations that are managed by outside investors. Besides, they clearly perceive the negative impacts of recent land use changes on their natural environment. Yet, the shift from on-farm to off-farm activities (work in oil palm plantations, mining, etc.) somehow compensates for the perceived loss in quality of life.

The worst case land use transition scenario appears to be in Vietnam where a significant reduction of the village territory, combined with strong environmental regulation, has degraded both local livelihoods and the provision of environmental services. Compensation mechanisms provided by the government were not sufficient to cover the loss opportunities.

In Laos forest conservation policies are associated with negative impacts on livelihoods but a strong increase in environmental services. However, villagers in Laos are among the poorest in Southeast Asia and forest protection may prevent local development.

6. Conclusions

The approach to opportunity costs analysis developed and experimented within the framework of the I-REDD+ project provides valuable insights into the wide ranging impacts of current land use transitions in rural Southeast Asia. In particular, by looking beyond the economics of land use at the plot level, we were able to highlight important linkages between current dynamics of land use change and trajectories of socioeconomic differentiation, economic and ecological vulnerability, inequalities and risks of social conflicts, etc.

However, the results also raise serious questions as to whether there is a real potential for REDD+ in rural Southeast Asia. Despite an apparent good potential for REDD+ projects in several of the study villages, technical problems are plentiful. Documented additionality may be difficult to achieve in cases where environmental regulations were already in place before the REDD+ era with a strong impact on reducing deforestation despite the small compensations received by local communities. Moreover, forest degradation potentially accounts for much larger emissions in many of these areas than deforestation and as long as measurement of degradation is still too complex for national measurement, reporting and verification systems (Mertz et al 2012), REDD+ projects may not be relevant.

There are also other difficulties that need to be considered: In China and Indonesia, for example, where the opportunity costs of rubber and oil palm will be extremely difficult for REDD+ to compete with on economic terms, it is doubtful that REDD+ as a financial mechanism can counter forest conversion. Strong government intervention will be necessary to prevent further deforestation here. In other areas, where the forest is managed by the state (e.g. Laos, Vietnam sites), there is little prospect for communities to benefit and participate as will probably be required if an international REDD+ mechanism is finally agreed upon.

It is thus essential to identify windows of opportunity – both in the temporal and spatial sense – where the REDD+ potential is high, for example in areas with low opportunity costs of current land uses, dense forests and low population, but high risk of future deforestation and forest degradation. Such areas are rapidly disappearing in Southeast Asia and the window of opportunity is therefore closing fast.

Finally, if such opportunities are identified, there is a need for flexible local REDD+ architectures that adapt to highly variable local contexts and a mix of market incentives and command and control (law-regulation enforcement) will be needed alongside local participation.

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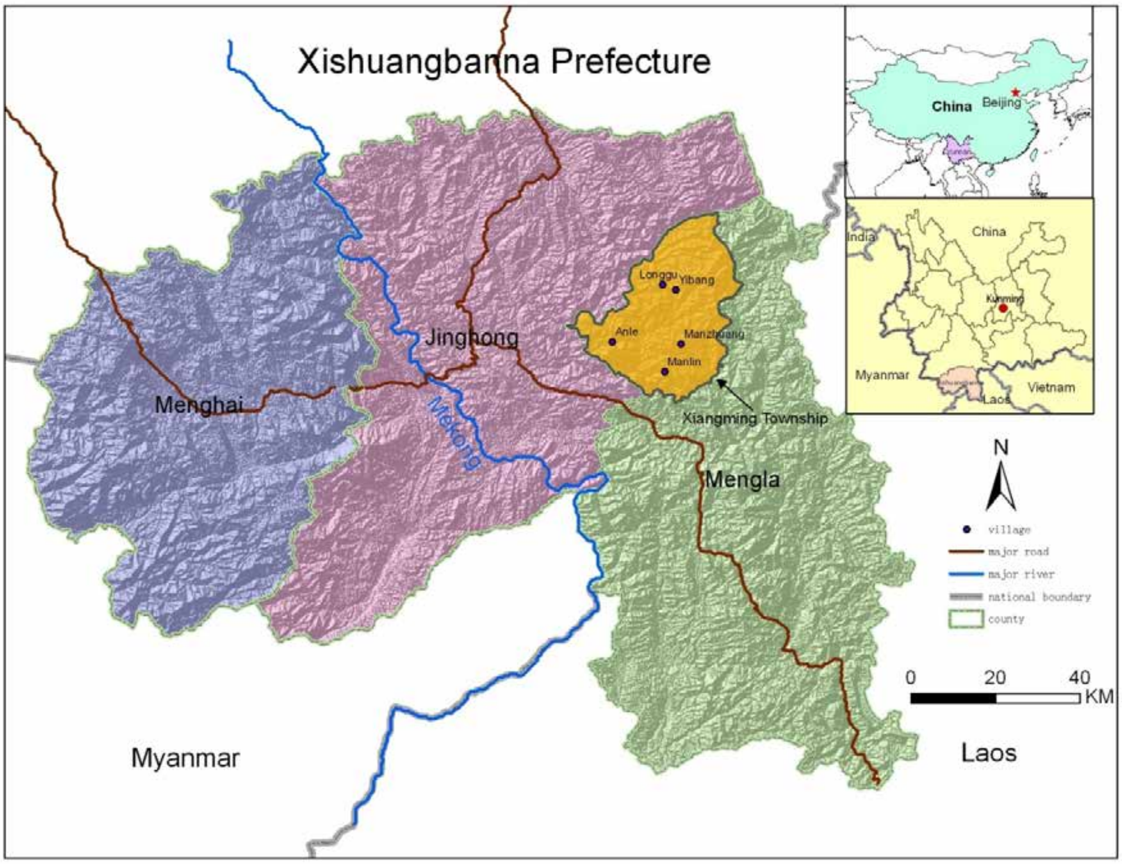
Appendix 1: I-REDD+ WP5 Country Report: China

by Qiaohong Li and Dietrich Schmidt-Vogt

1. Context: village description in the regional context

1.1. Village location

In China, the study site is Man Lin administrative village located at 1180 m.a.s.l. in Xiangming township of Xishuangbanna autonomous prefecture, Yunnan province. The climate is monsoonal with an average annual temperature of 25° C and an average annual precipitation of 1700 mm. The terrain is mountainous with slope inclinations ranging between 30° and70°, and in some areas attaining up to 90°.



1.2. Characteristics of the village compared to the other villages in the region

Manlin administrative village has 8 natural villages with a population of1800 people in 475 households. An area 10,000 mu is under ecological forest. One of the main products collected from the forest is firewood, which is obtained by villagers from private forest in the mountains that was allocated to them in 1983. The maximum area allocated to each household was 15 mu, the average was around 4 or 5 mu/HH.

Manlin natural village has 286 people and 108 registered households (we later learned that only 87 are actually living there – the others had their registration arranged by the 'big bosses' to be able to work in the area). Population growth: 130 in 1950, 236 in 1982/3, 256 in 200, and 286 in 2011. The population is expected to increase slowly in the future. The villagers are mainly Yi ethnic people. One forest guard is employed in the village.

Mansai natural village is divided into 2 hamlets, Mansai1 and Mansai 2, which are located at a distance of 1.5 km from each other. Mansai 1 has 38 Households and Mansai 2 has 84 Households. Villagers are mainly ethnic Dai people. Because of the absence of large forest stands, there are no forest guards in these villages. The two villages present very similar livelihoods largely based on rubber cultivation. The villagers of Mansai 2 moved from Mansai 1 about 50 years ago. Some HH of these villages are mainly occupied by migrant workers and elders staying at home.

The vegetation in Manlin is tropical mountain rain forest at around 900-1200 m.a.s.l. The forest is characterised by *Pometia tomentosa*, *Castanopsis* spp., *Dysoxylum gobara* and *Knema cinerea*. The canopy can be divided into 3 layers: the first layer reaches 35m in height and is dominated by *Pometia tomentosa*; the second layer reaches 25 m and is dominated by *Castanopsis* spp., and *Schima wallichii* while the third layer contains a multitude of species, such as *Machilus* spp., *Lithocarpus* spp. *Elaeocarpus* spp. *Mallotus* spp. Shrub and herbaceous layers at the edges and inside of some forest areas are rich in species.

Shifting cultivation was practiced from 1950s to1990s and then gradually given up. Forest recovered in some steep areas and is today state forest. As there is hardly any illegal cutting in the state forest, the forest is in a good condition with a profusion of lianas and epiphytes. More and more animals emerge in this area, such as wild boar, barking deer, bear (*Ursus thibetanus*), even wild ox, and many snakes and birds (Michael Køie Poulsen kept a record of birds in Manlin village and counted about 70 species in 13 days of observation). Tea seedlings are planted in the collective forest for shading of the tea trees. While this practice does not do any harm to the collective forest, private forests suffer from cutting trees for firewood to roast the tea leaves, as the area of tea plantations become larger and larger. Timber for house construction and furniture is also obtained from the private forest.

1.3. Land use trajectories and drivers

Historically, the Xishuangbanna region would have had close to 100% forest cover, dominated by tropical seasonal rain forest (21%), mountain rain forest (23%), and subtropical evergreen broad leaf forest (57%). By 1976, forest cover had been reduced to 70% and by 2003 to 50%. These forested areas have mainly been replaced by rubber plantations, shrublands, and shifting cultivation.

In Manlin village, the corn field has been gradually converted to rubber field. In the first few years of rubber plantation, corn was intercropped with rubber. The corn is expected to be phased out completely in 2013. As a result, pigs raising, mainly with corn as feed, will be also diminished after 2013. The average number of pigs per household was increased to as high as 8, around 1987/8, after the Household responsibility system, but has been decreased steadily with the corn field being converted to rubber plantation.

Rice paddy was increased from 83 mu to 140 mu in 1993-94 with promotion from the government. The converted land was previous used in the shifting cultivation. It is expected to keep the current area because there is no more suitable land to be converted to paddy field.

The ancient tea tree was expanded after 2008, mainly due to the dramatic price increase--from 2.6 yuan/Kg in 1990 to 200 yuan/kg in 2011. Again, the area will be expected to stay constant in the future because there is no land to be converted.

Rubber trees have been planted since 1987/8. The overall area growth shows as a S curve-- a typical diffusion pattern. Lack of technology, knowledge and capital, and skepticism prevented the wide spread at the beginning. Then, thanks to promotion from governments, technology brought by big bosses, higher price of rubber, easier market access with the paved road, rubber plantation replaced almost all the suitable lands in the village. Rubber price increased a lot in recent years, from 7 yuan/kg in 1998, to 13 yuan/kg in 2008, then to 28 yuan/kg in 2011. Villagers, when asked their predictions on the rubber price in the future, are not sure about the trend. But they seem not too worried even the price drops significantly.

Fallow tea was planted only after 2008, triggered by the increase of tea price. The fallow tea, 120 mu in total, was mainly planted in the self-own-mountain land. The area is expected to be kept constant in the future.

In Mansai village, originally, food crops were the main source of subsistence but rubber plantation has now become the main livelihood. Before 1997, date of the road construction, villagers were growing food crops: dry mountain rice (1 year crop/7-8 years fallow), corn (2-3 years crop/3-4 years fallow). They had livestock (cattle, buffalos, pigs) but the cattle were eating the young rubber leaves so the villagers decided to sell their herds in 1999. Villagers were collecting mushrooms, medicinal plants and bamboo shoots for consumption. Then they started to sell the NTFPs.

In 1997, the road was built (government project) allowing for commercial productions and the development of rubber as a main crop. The government also supported the establishment of rubber plantations. Rubber seedlings were distributed (costs was 4.5 Y/unit at that time) and technical training was provided by a national poverty eradication programme. At the beginning, only 40-50 households engaged in rubber production, most households were afraid of having to reimburse the seedlings (this never happened). Then in the 2000s most Households engaged in rubber production when they started to see the profits made by the early adopters. The accountant planted 10 mu of rubber in 1997 and 10 new mu in 1998. He replaced dry rice with rubber while keeping rice production in his paddy fields (enough for subsistence). Now he has around 70 mu of rubber, including 20 mu in production.

“Big bosses” started to come here around 2004 to rent land, villagers rent out a lot of land to “big bosses” for growing rubber, watermelon, beans, vegetables etc. They prefer renting out their paddy fields (900 Y/mu for 9 years) instead of cultivating them (they would get 3-400 Y/mu with a lot of labour requirements). Some villagers rent out their paddy only in winter (for 200 Y to 300Y/mu) for beans and watermelon production. This type of contract is generally not with “big bosses”, mainly with people from the region. They got contracts of 40 years for a total of 1000 mu of collective land. The bosses wanted to rent large areas so the villagers organized a meeting to discuss the rent of collective village land. Then groups of 5-6 households also started renting out their land together. Most collective land was rented in

2006-7. At that time, it was rented at 2.35 Y/mu/year for a 40-year contract. The bosses paid all in one instalment: 90,000 Y for 1000 mu for 40 years! The village community needed this money to pay for the connection to the national electric grid. Now, the villagers rent at 4000 Y/mu/40 years (without a share on the production).

Around 2009-10, “big bosses” started to rent lowland paddy fields to grow banana (there was no banana before that). The village committee organized a meeting to ask which households wanted to rent paddy. Now, around 400 mu of paddy are rented out by villagers of Mansai 1 and 2. These paddy plots were often poorly productive. The land is rented at 900 Y / mu / year for a period of 9 years, paid every year.
Some households have also started to plant banana on their own paddy land as soon as 2010, following the examples of the investors. They were supported by the big bosses (received technical training from technicians working for the big bosses). Similar to a reward mechanism for people who facilitated their establishment there, around 15 households are planting by group of 5-6 households. They sell banana to intermediates for 3.8 Y/kg (the price is 7 Y/kg in Kunming). They learned with the technicians that are hired by investors for their banana plantations. Around 100 mu of paddy is also rented in winter for beans, corn and vegetable production.

Paddy land is also rented out to big bosses who grow winter crops such as sweet corn, beans, water melon, pumpkins, etc. Seasonal rending rate is 200-300 Y/mu.

The transition from subsistence agriculture to cash-crops (i.e., bananas) and plantations (rubber and tea) in a short period makes a great story

2. Profitability of land use systems

2.1. List and description of land use types

In Manlin, the following 7 land use types are identified: maize, rubber, paddy, ancient forest tea, young tea in fallow, self-owned mountain& ecological forest and state forest.

a. Maize

Maize is planted under rubber during the first 1-3 years and occasionally in separate plots (disappearing practice). The main purpose for growing maize is for pig feed. After all young rubber plantations will have entered into production (2013) there will be no fields left to grow maize and the villagers will stop raising pigs or will have to buy maize to feed their pigs. The average production of maize is 500kg/mu/year, input is 180Yuan/mu/year, labour requirement is 8 man.day and the net present value is 2931USD/ha.

b. Rubber

The village has 10,000 mu of rubber, of which only about 1000 mu are mature. Rubber production started in 1987 in the south of the village. The crop was promoted by a government project for poverty alleviation. All households were offered to participate in the project, but while some were afraid that they would have to reimburse the input costs, others did not maintain their plots properly, especially with respect to weeding. As a result, not all households in the village were involved in the first round of establishing rubber plantations. The state farmers started planting rubber in 1996 and expanded gradually afterwards. Most of

the rubber plantations are not yet productive (3000 mu will be productive in the next 2 years and 7000 mu later on). A large influx of labour force is expected when the whole rubber area will become productive.
The average production of rubber is 55kg/mu/year, input is 257.5Yuan/mu/year, labour requirement is 8 man.day and the net present value is 8587USD/ha.

c. Paddy

In 1983 the village had 83 mu of paddy land. In 1993-1994, a government project promised subsidies to villagers for establishing new paddy fields. The villagers expanded the paddy area to 140 mu but did not receive the subsidies. The average production of paddy is 200kg/mu/year, input is 1225Yuan/mu/year, labour requirement is 10 man.day and the net present value is 4114USD/ha.

d. Ancient forest tea

The village has 600 mu of ancient forest tea, which accounts for most of the area under forest tea in the entire administrative village. Forest tea is a traditional method of producing high quality tea by letting tea trees grow to their full size, often surrounded by other tree species. This production system is also called ancient forest tree, because some trees can attain an age of several 100 years. Income from tea amounts to 2 million Chinese Yuan per year for the whole village. The average production of ancient forest tea is 4kg/mu/year, input is 0Yuan/mu/year, labour requirement is 4 man.day and the net present value is 22315USD/ha.

e. Young tea in fallow

Forest land in the mountains is owned by households since the 1980s and falls under the category of private forest. These areas were initially mostly used for collecting fuelwood. Since 2008, 120 mu of this land have been planted with ‘fallow tea’.

f. Private forest& ecological forest

Ecological forest consists of 1,700 mu of private and 300 mu of collective forest. 60 households in the natural village have an ecological forest plot. Timber for construction can be cut with permission and other NTFPs can be collected for own consumption. Hunting is not allowed, but there are very few animals left anyway. One forest guard is employed in the village on a salary of 150 Y/month. He goes to the forest 2-3 times per month but does not know exactly the size of the area that he has to survey.
The average production of firewood in the private mountain forest is 1000kg/mu/year, input is 0 Yuan/mu/year, labour requirement is 3 man.day and the net present value is 1860USD/ha. The average production in the ecological forest is 1000kg/mu/year, input is 0Yuan/mu/year, labour requirement is 3 man.day and the net present value is 2046USD/ha.

g. State forest

There is 40,000 mu of state forest from which villagers are permitted to collect NTFPs but no wood or timber. From among the 7 land use types, both men and women perceive ancient forest tea to have the highest livelihood value and state forest to have the highest environmental value.

In Mansai, the following 6 land use types are identified: rubber, paddy, paddy+winter crops, banana, self-owned mountain& ecological forest and state forest.

a. Rubber

Rubber cultivation is the main livelihood activity in Mansai. In 1997, a road was built (government project) which allowed for commercial production and the development of rubber as a main crop. The establishment of rubber plantations was supported by the government. Rubber seedlings were distributed (costs was 4.5 Y/unit at that time) and technical training was provided by a national poverty eradication programme. Farmers converted their upland rice and fallow forest to rubber plantation. At the beginning, only 40-50 HH engaged in rubber production, because most HH were afraid of having to reimburse the seedlings. This fear, however, was ungrounded then, in the 2000s, most HH engaged in rubber production when they started to see the profits made by the early adopters. Now every household has a rubber plantation. Villagers started planting rubber 16 years ago and have tapped for 8 years. The average production of rubber is 55 kg/mu/year, input is 275Yuan/mu/year, labour requirement is 8.5 man.day and the net present value is 4946USD/ha.

b. Paddy

Originally, paddy was the main source of subsistence. Paddy rice is grown in two seasons per year. Paddy fields are located near to the river for sufficient water supply. The average production of paddy is 280 kg/mu/year, input is 1225Yuan/mu/year, labour requirement is 10 man.day and the net present value is 4114USD/ha.

c. Paddy+winter crops

Paddy land is rented out to entrepreneurs who grow winter crops such as corn, beans, vegetables, potato, watermelon, pumpkins, etc. Seasonal renting rate is 200-300Y/mu. Winter crops vary from one year to the other- if last year's crop was not successful or prices too low, a different crop will be grown in the following year. This year (2011), many people plant beans and sweet corn, but in previous years they planted mostly watermelon and pumpkin. The average production of winter crops is 1300 kg/mu/year, input is 400Yuan/mu/year, labour requirement is 30 man.day and the net present value is 19813USD/ha.

d. Banana

Banana is the second most important source of income in Maisai. Around 2009-10, entrepreneurs started to rent lowland paddy fields to grow banana (there was no banana before that time, banana planting requires sufficient water supply and flat land). The village committee organized a meeting to ask which HH wanted to rent out paddy. Now, around 400 mu of paddy are rented out by villagers of Mansai 1 and 2. These were plots with low productivity in the past. The land is rented at 900 Y / mu / year for a period of 9 years, with rent to be paid every year. The average production of banana is 3750 kg/mu/year, input is 5270Yuan/mu/year, labour requirement is 17.5 man.day.

e. Private mountain& ecological forest

The only one area of private mountain forest in Maisai is located at the upper village close to residences so that people can have easy access to the mountains for cutting firewood. The two villages have also 400 mu of ecological forest, but no compensation was received yet. Previous land use was watershed forest and medicinal plants area. The ecological forest was established in 2009 during the forest reform. Since 1994 villagers received a compensation of 300-400 Y/year for the protection of the watershed forest (previously collective forest). The money was used for local administration expenses.

The villages have been engaged in the “grain for green” programme since 2005 (2003). This programme subsidizes reforestation at a level of 220 Y/mu. Around 300 mu of agricultural land converted to forest (Rubber plantations). The average production of private mountain forest is 1000 kg/mu/year, input is 0Yuan/mu/year, labour requirement is 3 man.day and the net present value is 1860USD/ha.

f. State forest

There is only one place of state forest located inside Mansai’s territory, which is located in the upstream of Houay Feuang river. State forest is protected for conserving water sources and solidifying the soil. In state forest, logging and fuelwood collection are not allowed. NTFPs collection, however, is acceptable.

From among the 6 land use types, men perceive that paddy has the highest livelihood and state forest the highest environmental value; women perceive that private mountain & ecological forest has the highest livelihood and that state forest has the highest environmental value.

3. Livelihood typology and reliance on the different land use types

3.1. Farming system and livelihoods options

Household typology-Manlin village

Four household types have been identified:

1: Rubber >60 mu with >10 mu in production
and/or Tea > 100 kg per year

2: Rubber 30-60 mu with 5-10 mu harvested
and/ or Tea 50-100kg harvested per year

3: Rubber <30 mu with <5 mu harvested
and Tea <50kg per year

4: Hired workers in rubber plantations

NB: the first 3 household types are composed of the 108 officially registered households in the village. Type 4 is estimated at about 80 households (unregistered in the village). The housing and car categories have not been included as they correspond to household expenditures.

The 4 household types can be further characterized as follows:
A: Limited access to land, very small rubber plantations (around 1ha) and small tea plantations (34% households)
B: Large area of rubber, no tea (14% households)
C: Large area of rubber with some tea in production (42% households)
D: Rubber tappers, limited access to land, no off-farm incomes (10% households)

Currently, the most important livelihoods sources in Manlin village are ancient forest tea, rubber, livestock, off-farm income and passive income. We found that agriculture is the main income source in Manlin with 89%. Off-farm income constitutes 7%, livestock accounts for only 3% and passive income accounts for 1% (Figure 1).

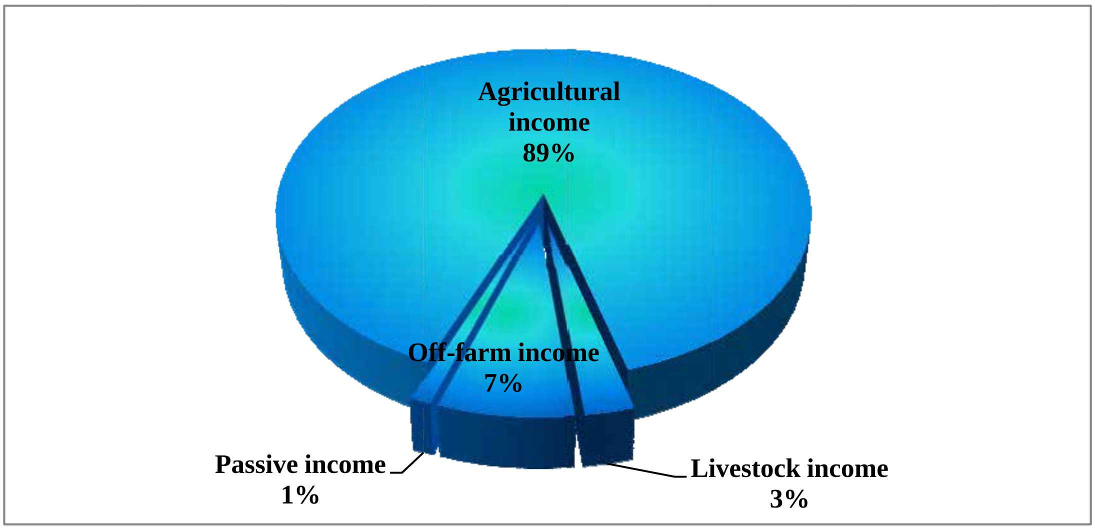


Figure 1.Components of main livelihoods strategies in Manlin village in 2011

Based on the 4 types of households mentioned above, which will be referred to as A,B,C,D, we found that in Manlin village type C has the highest toal income reachings 1,144,691Chinese Yuan. Type D has the lowest total income with only 175,800 Chinese Yuan (Figure 2).

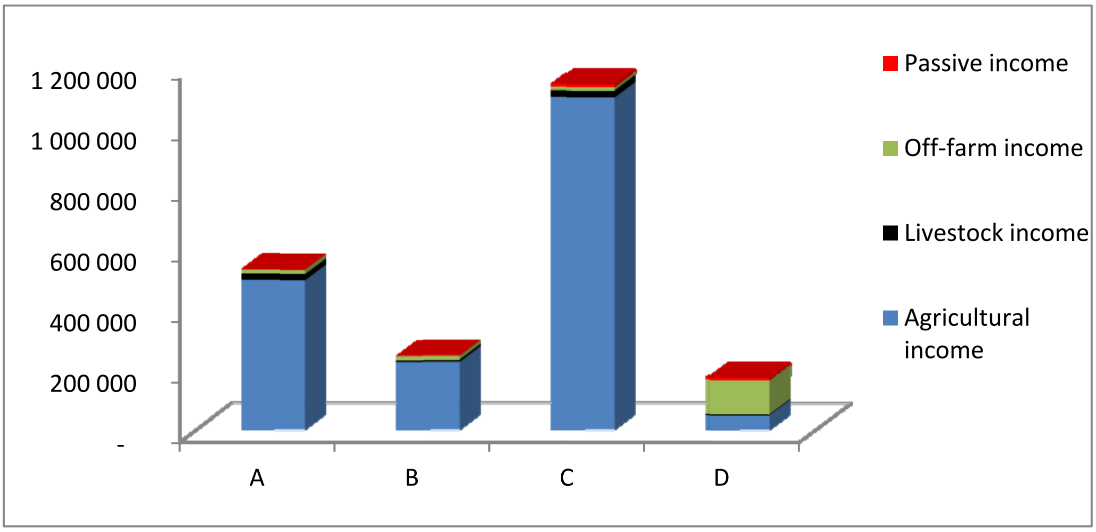


Figure 2. The total income of different household types in Manlin village

We also analyzed the total value of assets in relation with the 4 types of household , and found that type C has the highest value of assets with 505,765 Chinese Yuan and Type D has the lowest value with only 66,824 Chinese Yuan.(Figure 3)

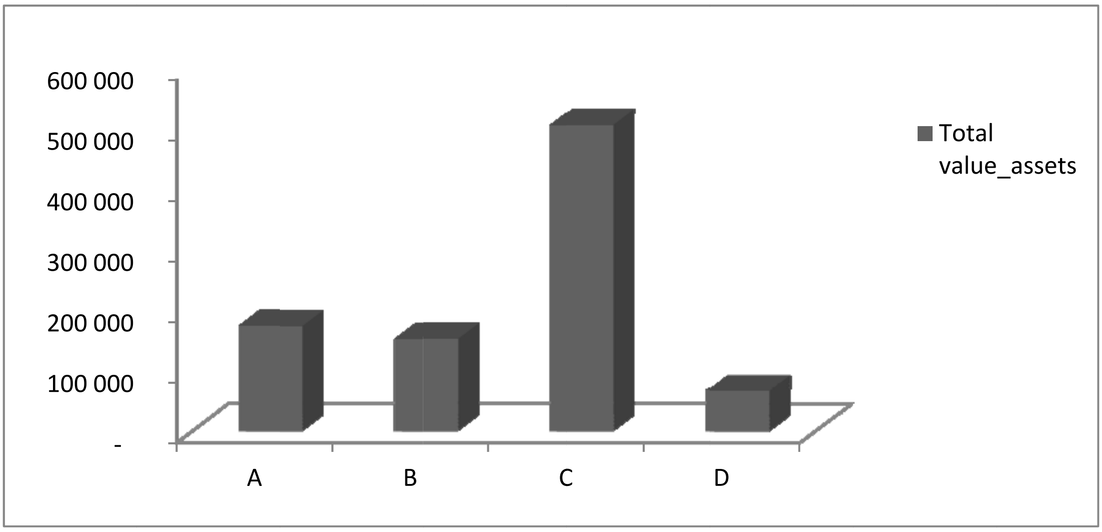


Figure 3.The total value of assets of different household types in Manlin village

The most recent change in HH livelihood strategies is that young people want to earn money from rubber only(the young people move to Xiaobanchang hamlet). In future, when more rubber is mature, villagers will hire more workers to tap rubber. In addition, more people will get involved in off-farm work since they can use the money from rubber to invest in business.

Household typology – Mansai village

Four household types have been identified:

1: Rubber: 100-120 mu + 30-40 mu in production
Paddy 8-9 mu

2: Rubber 50-60 mu + 20 mu production
Paddy 4-5 mu

3: Rubber 30-40 mu + 5-6 mu production
Paddy 2-3 mu

4: Hired labour on rubber plantations = approximately 10% of all households in the village

The big investments mentioned above (e.g. excavator) refer to the types 1 and 2. Some people from type 1 have sold land to raise money for these productive investments and now belong to type 2.

The 4 household types can be further characterized as follows:
A: Limited access to land, very small rubber plantations, small paddy areas (20% households)
B: Average rubber plantations (1-3 ha) and/or paddy areas (50% households)
C: Large area of rubber (3+ ha) +paddy land (18% households)
D: Average to large landholders, renting out paddy land (12% households)

Currently, the most important income sources in Mansai are rubber, banana, winter crops, passive income and livestock. Similar to Manlin village, agriculture is the main income source in Mansai village, reaching 85%; passive income accounts for 10% and income from livestock is 5%(Figure 4).

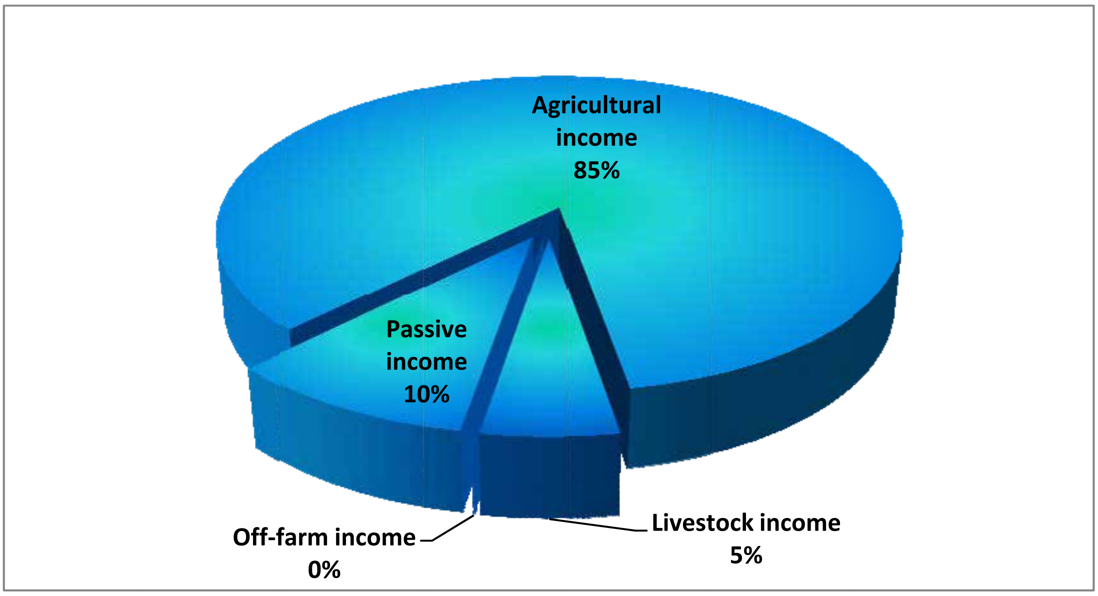


Figure 4.Components of main livelihoods strategies in Mansai village in 2011

Based on the 4 types of households mentioned above, we found that in Mansai village type B has the highest toal income with 774,230 Chinese Yuan whiletype A has the lowest total income with only 172,880 Chinese Yuan (Figure 5).

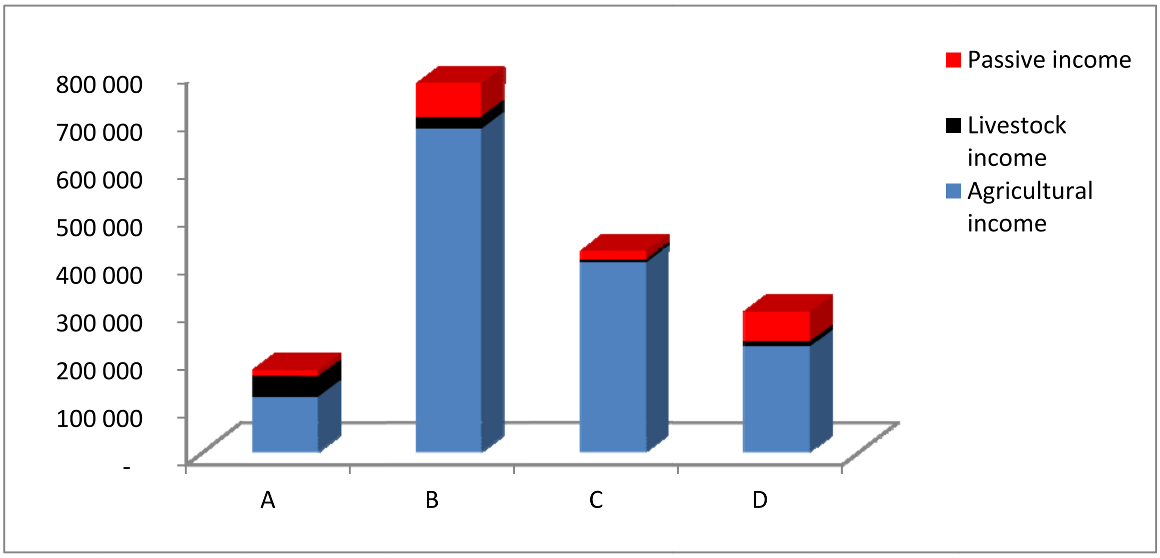


Figure 5. The total income of different household types in Mansai village

We also analyzed the total value of assets in relation with the 4 types of households and found that type B has the highest value of assets with 653128Chinese Yuan and type A has the lowest value with only 111,845 Chinese Yuan(Figure 6).

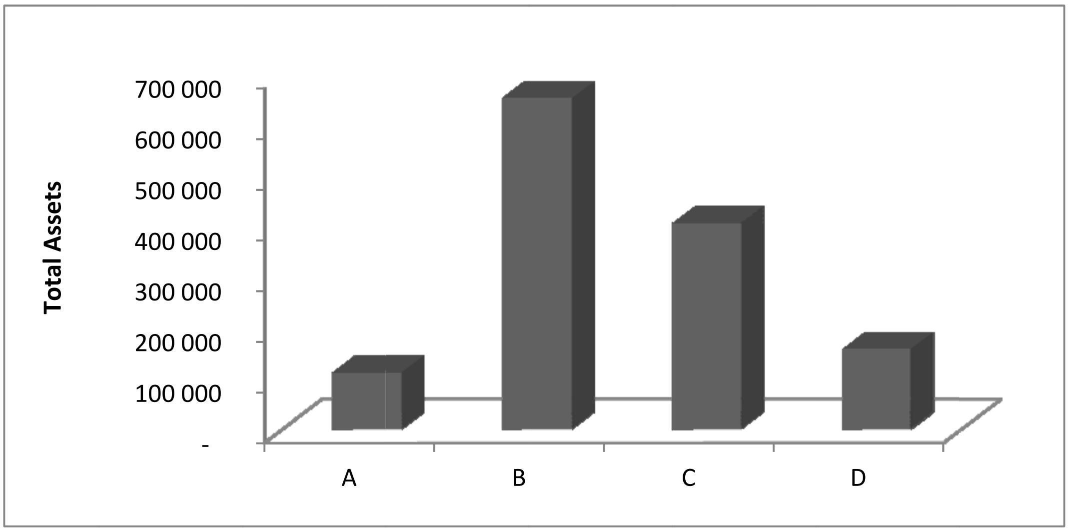


Figure 6.The total value of assets of different household types in Mansai village

Recent HH livelihood strategies changes in Mansai village are that people are trying to diversify their livelihood strategies. We observed, for instance, that two households started to cultivate medecina plants such as Demdrobium. Local government also supports people to cultivate this plant. People have to invest a lot of money at the initial stage but say that the market price is very high. In future, when more rubber is mature, villagers will hire more workers to tap rubber. In addition, more people will get involved in off-farm work since they can use the money from rubber to invest in business.

3.2. Landholdings

Based on our survey of 50 households, we found that in Manlin village the average landholding per household is 126.1mu. The total land area is 6306.7mu out of which paddy land is 104.4mu (1.7%), maize is 124mu, rubber is 6003.6mu (95.2%) and forest tea is 161.8mu (2.6%) (Figure 7).

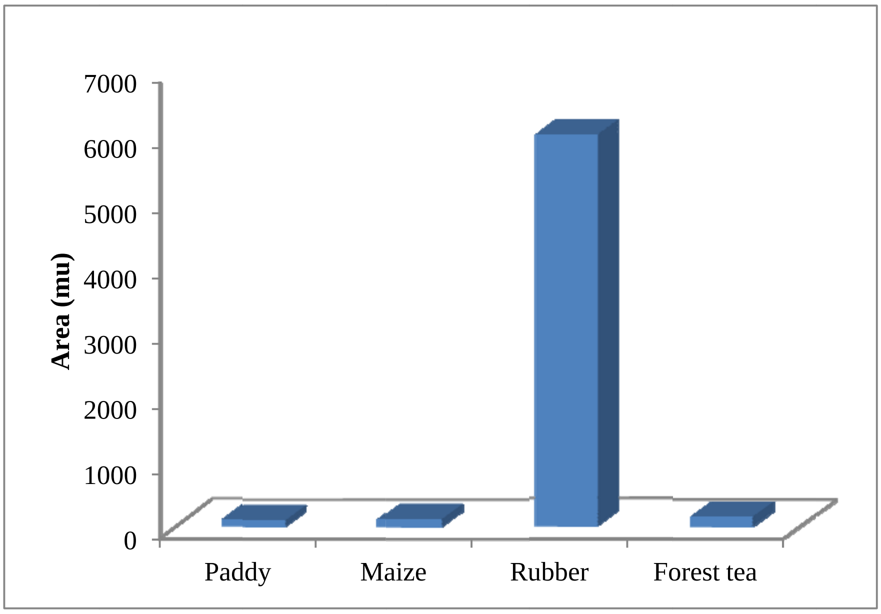


Figure 7. The area of the main land use types in Manlin village

In Mansai village,the average landholding per household is 68.4mu. The total land area of the surveyed 50 households is 3417.9mu out of which paddy land is 227mu(6.6%), rubber is 1653.5mu(48.4%)and private mountain is 37.4mu (1.1%) (Figure 8).

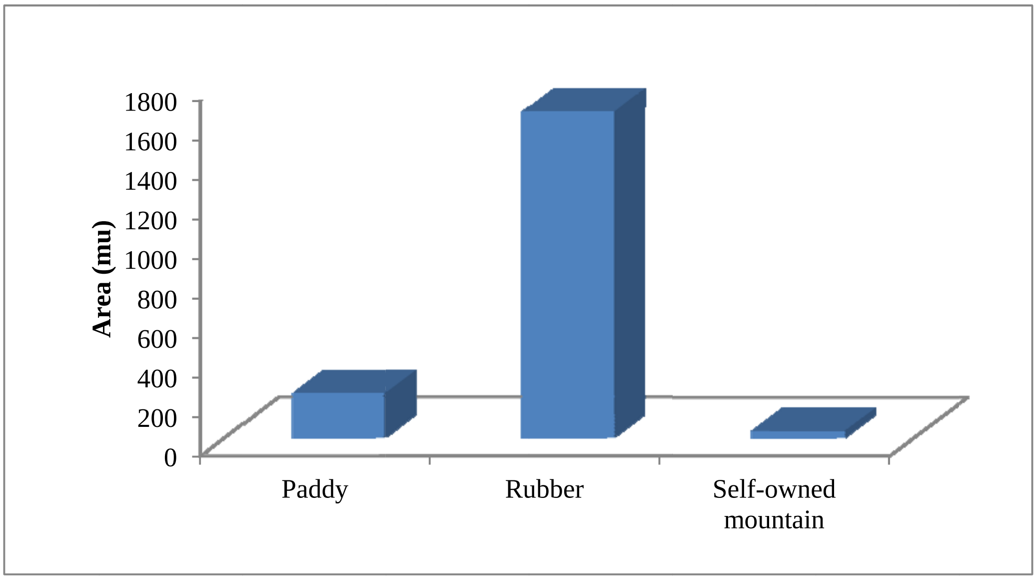


Figure 8. The area of the main land use types in Mansai village

3.3. Poverty and equity

Manlin Village

Historically, 'Labour force' has been the main household differentiation factor as the land was distributed in 1983 according to the labour availability of each household. Households with a lot of labour force could produce rice surpluses as they had more productive land than others (paddy + dry land). They had bigger areas of dry rice and larger livestock herds. Better-off households were able to benefit from the rubber boom of the 1990s. They gradually expanded their rubber areas, especially when their first plots entered into production.

Key differentiation criteria

'Rubber area' is a key differentiation factor. Rubber productivity depends to a large extent on the elevation of the plots and the quality of management (weeding, tapping, etc.). Best yields are for elevation < 600m (5 households), average yields for elevation 600-900m (16 households), marginal areas are located above 900m elevation (10 households).

'Tea plantation areas' comes second, after rubber.

Local people started expanding their tea areas in forests (ancient forest tea) andprivate mountain plots in 2005 when the tea price increased from 70 yuan/ kg in 2005 to 200 yuan per kg today.

3 categories of households were identified as depending on tea area: > 10 mu = good / 5-10 mu = average / <5 mu = poor.

Tea factor is better expressed as ‘kg harvested per year’. >100kg = good / 50-100 kg = average / <50 kg = poor.
‘Housing’ categories: <300.000 yuan house = good / 100.000 to 300.000 yuan = average / < 100.000 yuan = poor.
‘Car’ categories: > 100.000 yuan = good / 50.000 – 100.000 yuan = average / no car - only motorcycle = poor
Pigs are used for self consumption only. They are therefore not a good differentiation factor.

Mansai village
‘Paddy land’ used to be the most important criterion to differentiate households
Today the difference between households is made by ‘Total rubber area’ and ‘Rubber area under production’. Land was distributed to individual households in 1983 according to their available labour force. The differentiation process started at this time with ‘Labour force’ as a major factor of economic differentiation in relation with ‘Land endowment’
Before the rubber period, paddy land was important to secure rice sufficiency. People with a higher ‘Social status’ or official position managed to engage earlier than others in new activities. They could better maintain their rubber plots at the initial stage of plantation and were the first households to expand their rubber areas. The s is true for banana plantations in paddy fields. In 2010, entrepreneurs came to invest in banana plantations. They contacted the local authorities for obtaining land from the village. The village officials planted banana on their own paddy plots in the same year when entrepreneurs started banana plantations on the land rented from the village. They could benefit from technical support and training from three entrepreneurs to engage in this risky innovative system.

Better-off households have invested in:

- Excavators: 4 units have been bought recently by a group of households who invested collectively. They provide service as contractors to build roads and houses.
- Trucks: 4 units have been bought by individual households.
- Shops: restaurant, bar, motorcycle repair shop have opened recently
- Land speculation: some households have engaged in land speculation by buying land at low price for rubber plantation and then selling after a few years for a higher price as a young rubber plantation.

Main expenditures using rubber capital are: house building, electric appliances (TV, fridge, etc.), cars, children education

Equity analysis (gini index on income distribution)
In order to analyse the equity of incomes, a decomposition analysis was applied using Gini coefficient that ranges from 0 (equal distribution of income) to 1 (total concentration of income). Gini decomposition is commonly applied in economic analysis, using the formula that was developed by Fei et al (1978) and Pyatt et al (1980). The equity of income was higher in the Manlin village (41%) than in the Mansai village, as indicated by a lower Gini ratio (33%).

The assessment of income inequity used the concentration coefficient. A source of income is influential in improving income equity if it has a concentration coefficient of less than 1. On the contrary, if the concentration coefficient is higher than 1, the source of income is influential in causing income inequity.

Appendix 2: I-REDD+ WP5 Country Report: Indonesia

by Khairil Fahmi, Janudianto, Noviana Khususiyah, Sri Jimmy Kustini, Ole Mertz, Arief Rahmanulloh, Eri Panca Setiawan, Suyanto, Zulfira Warta (in alphabetical order)

1. Context: village description in the regional context

1.1. Village location

The two villages studied for this report are Batu Majang and Penarung, both located in Kutai Barat District (Figure 1). Kutai Barat District covers 3.2 million hectares and the northern part of the District is highland and mountainous with tracts of still intact forest. The southern part is relatively flat and some parts contain peat and swamp areas. Kutai Barat is located between two National Parks: Kayan Mentarang National Park in East Kalimantan and Betung Karihun National Park in West Kalimantan, making Kutai Barat a corridor between these two National Parks. The Mahakam River flows from north to south in the District and is one of the most important catchment areas in East Kalimantan. The District capital is Sendawar, which can be reached from Samarinda by road (10 hours) or by ship (>12 hours) and from Samarinda or Balikpapan by air (40 minutes). There are also roads connecting the district with Central Kalimantan.

Batu Majang represents the hilly transition area from the flatter southern part to the more mountainous northern part of the District and Penarung represents the southern part of the district. The natural vegetation in both villages is mixed dipterocarp lowland rain forest, much of which has been disturbed by various land use types (see more information in the village profiles below).

1.2. Characteristics of the study villages compared to the other villages in the region

Kutai Barat District has 223 villages that range in area from about 5,000 to 40,000 hectares and in population from about 400 to 5,000 people. The native people of Kutai Barat are Dayak groups such as Tunjung, Benuak, Bentian, Kutai, Kayan, Bahau and Kenyah. Non Dayak ethnic groups are Jawanese, Bugis, Makassan, Mandar, etc.

The traditional land use is dominated by forest, swidden cultivation, agroforestry and small settlements, but currently land use in several villages, mainly in the south eastern area is increasingly dominated by coal mining, oil palm, rubber and acacia plantations. Land use for oil palm plantations is expanding especially fast in Kutai Barat. Though currently only about 50,000 ha planted are planted with oil palm, the District Government has already issued licences for oil palm plantations on about 500,000 ha to about 40 different companies. The expansion of coal mining is difficult to get data on, but can be observed in the field. Community land tenure in Kutai Barat is still strong. Households or families either own land or have usufruct to community land, whose distribution is often governed by the community. However, community land ownership is under significant internal and external pressure

The main source of subsistence income in the villages is hill and wet rice as well as vegetables from swidden cultivation. Fruit is grown in agroforests called *Lembo*, where medicinal plants and building materials are also grown. Traded commodities are mainly rattan, rubber, cocoa and various non timber forest products. Timber has been a source of income between 1990 and 2000, but is rapidly decreasing because of reduced stocks of commercial timber and also an increase in government law enforcement on illegal logging. Some areas also obtain income from gold mining.

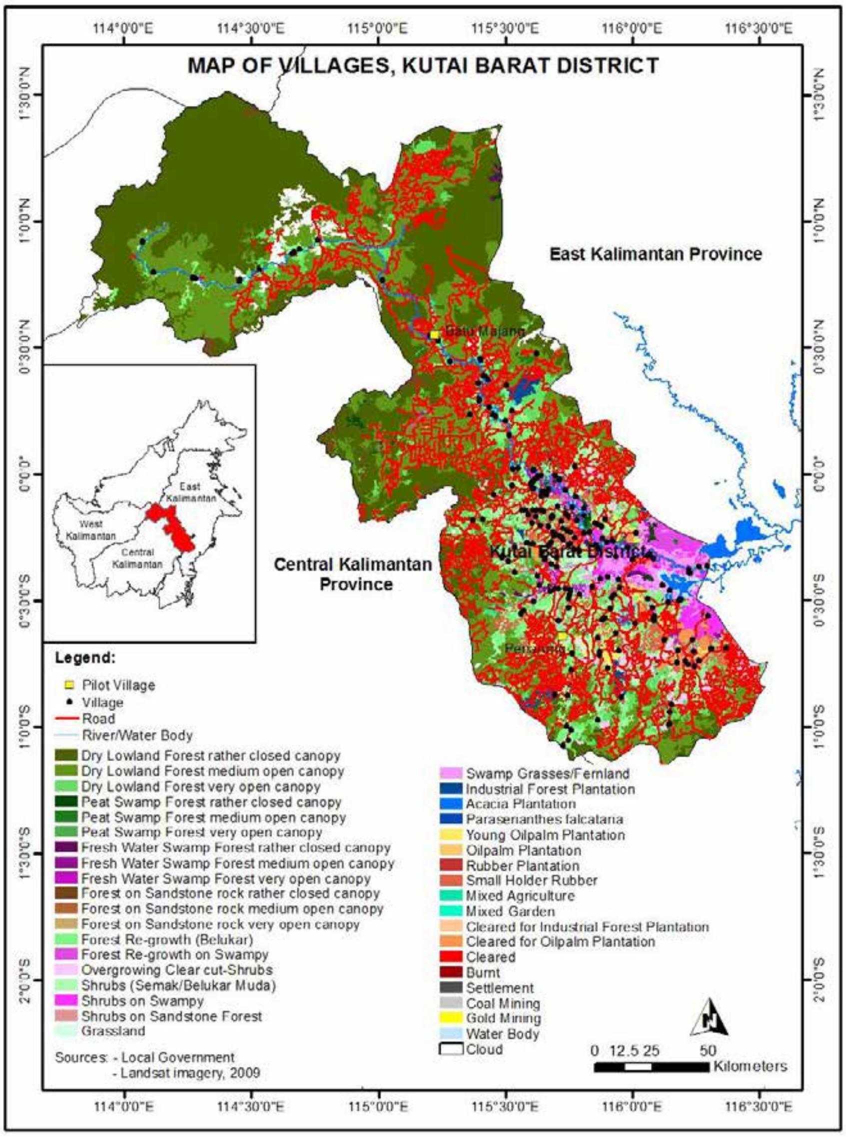


Figure 1. Kutai Barat District land use with location of study villages

One of the traditional land use types of many communities is conservation areas called *Tana Ulen*. It is found in the two study villages and in many other villages in Kutai Barat. However, because the Indonesian legal land tenure system does not recognize community land tenure, many of these community-managed forests are included in concessions given to timber, land development or mining companies. Although some of these areas are recognized voluntarily by timber companies, such as in Batu Majang, this is not the case in many other areas, where timber companies legally can cut timber from community protected areas.

Profile of Batu Majang

Batu Majang is located on the upper Mahakam River in Long Bagung Sub-District and is only accessible by river from Sendawar, although there is a large network of logging roads in the area (Figure 2). Travel time to the village is 3 hours by speedboat from Tering, which is one hour by car from Sendawar. Travel time is longer with other means of river transportation. The village was first established as a small settlement in the 1960s when Kenyah moved here from Apo Kayan. In the following years people moved here gradually – especially in the 1980s. People moved mainly to be close to the Mahakam River in order to market their products and have better services from government. Today the migration has stopped as Apo Kayan is also receiving government support. The area was inhabited, but widely forested, when the first settlers arrived and logging companies arrived in the 1980s after obtaining concessions in the area. Today most of the village land is within the concession of Sumalindo Company, but they have agreed with the village not to touch their community forest area and the swidden cultivation area is of little interest to them.

Today the village has 265 households and about 1060 inhabitants. Swidden cultivation of upland rice and vegetables, rubber, cocoa, gaharu (agar wood) and fruit gardens are the main agricultural activities. Previously, in the 1980s, government schemes supported coconut and coffee cultivation, but they were not successful. Cocoa was first planted in 1996 and yields are often limited because of squirrel attacks, but people still plant new cocoa. The first rubber was planted in 2001 and a larger wave of planting started in 2004 and is still on-going as upland rice fields are often planted with rubber after harvest. Batu Majang also has a community forest and a river with local artisanal gold mining. Moreover they get income from working for the Sumalindo Timber Company, which is now an FSC certified company. The average household income in Batu Majang in January 2012 is about IDR 4 to 4.5 million.

There is no support or payments for protecting the community forest at present, but a micro hydroelectric facility is projected to supply the village with electricity – the annual fuel expenditure for generators amounts to about IDR 2 billion per year, which is close to the costs of establishing a micro hydropower station. The grant for the station would be conditioned by forest protection and thus is a kind of benefit obtained for reduced deforestation.

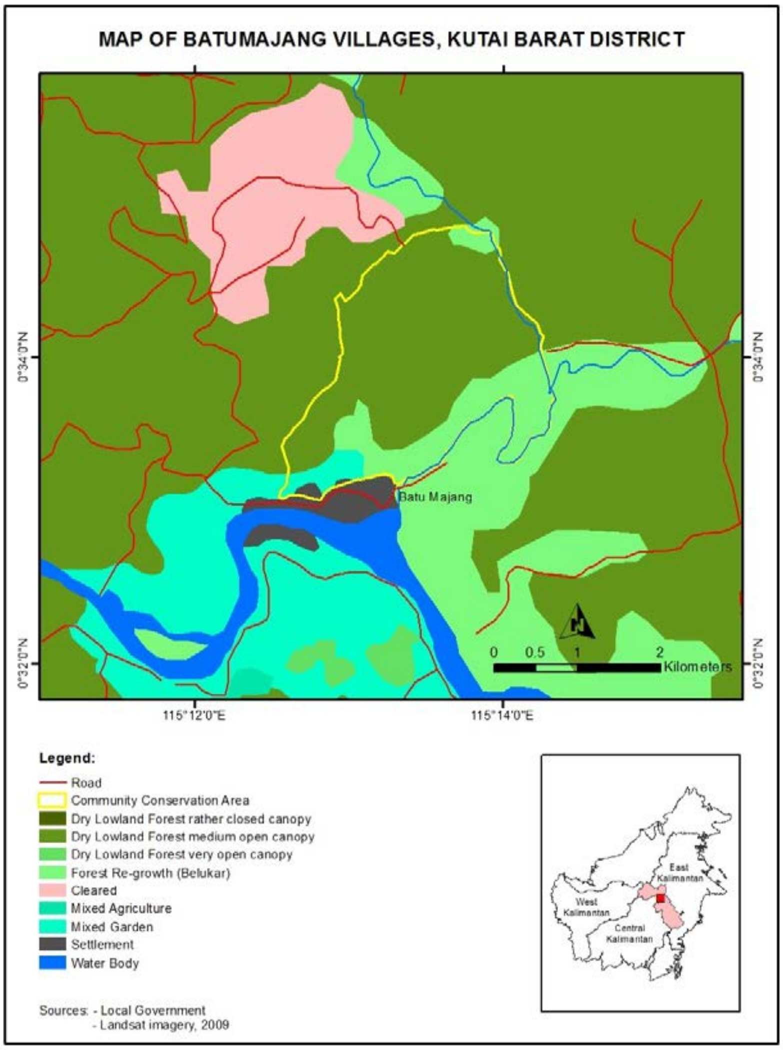


Figure 2. Batu Majang land use

Profile of Penarung

Penarung is located south of Sendawar on the Lawa River, a tributary of the Mahakam in Bentian Besar Sub-District (Figure 3). The village was established around 1950 by several smaller communities that moved together in a larger settlement. The village is accessible by dirt road from the main road connecting Kutai Barat District with Central Kalimantan and about 1½ hours drive from Sendawar. The village has 82 households and the people are mainly ethnic Benuaq Bentian and Tunjung.

Land use in the village area is relatively complex and dominated by the following activities:

- Logging was active in the area until 2002, but there are currently no activities as many of the logged areas have been integrated in swidden cultivation cycles
- Large open coal mining operation PT Banpu is taking place on land already sold by villagers. This is located som 10 km from the villag. Prospecting for further mining in the area is still on-going, including in the protected forest of the village.

- Mixed hill rice, rattan and fruit gardens are frequently found along rivers and old logging roads southwest of the village. Hill rice is normally farmed 1-2 years and followed by a 20-25 year productive fallow with rattan and sometimes fruit trees. Rubber is also planted in harvested swiddens and seems likely to be replacing much of the rattan.
- A 370 ha rubber plantation along the access road to the village was planted in 1993 and supported by the logging company as a form of compensation for the timber extraction on land claimed by the villagers. The rubber plantation is considered communal, but each household has a plot to tap rubber, which is usually done by hired laborers. Parts of the area burned some years ago and are in the process of being been replanted.
- A 2000 ha oil palm plantation is currently (2012) being developed by a plantation company. The land used for the plantation belongs to Penarung and several neighboring communities. A compensation of Rp 500,000 per ha was provided to those villagers who agreed to engage in the program. The company has promised 20% share of the land – equivalent to 400 ha – for the villagers to harvest. So far this land has not been allocated and the nature of the agreement is not completely clear. Some farmers have a few oil palms in their gardens used for feeding animals.
- Small plots with agarwood, sugar palm and ironwood have been planted in various locations for sale and local consumption.
- About 460 ha of community forest is under active protection by the village. A new project conditioned by this protection will provide 50 million for seedlings, animal feed and other services. The project started in December 2011. However, the protection area may be under threat by conversion to mining as noted above.
- Small areas with forest have also been protected since ancestral times, in total five locations with 2-5 hectares each. The community would like to develop this for eco-tourism, e.g. a site with a waterfall.

The subsistence income of households in Penarung as of January 2012 was based on hill rice, fruits and vegetables, whereas cash income averaged IDR 3 to 3,5 million, mainly from rattan, rubber and off-farm work.

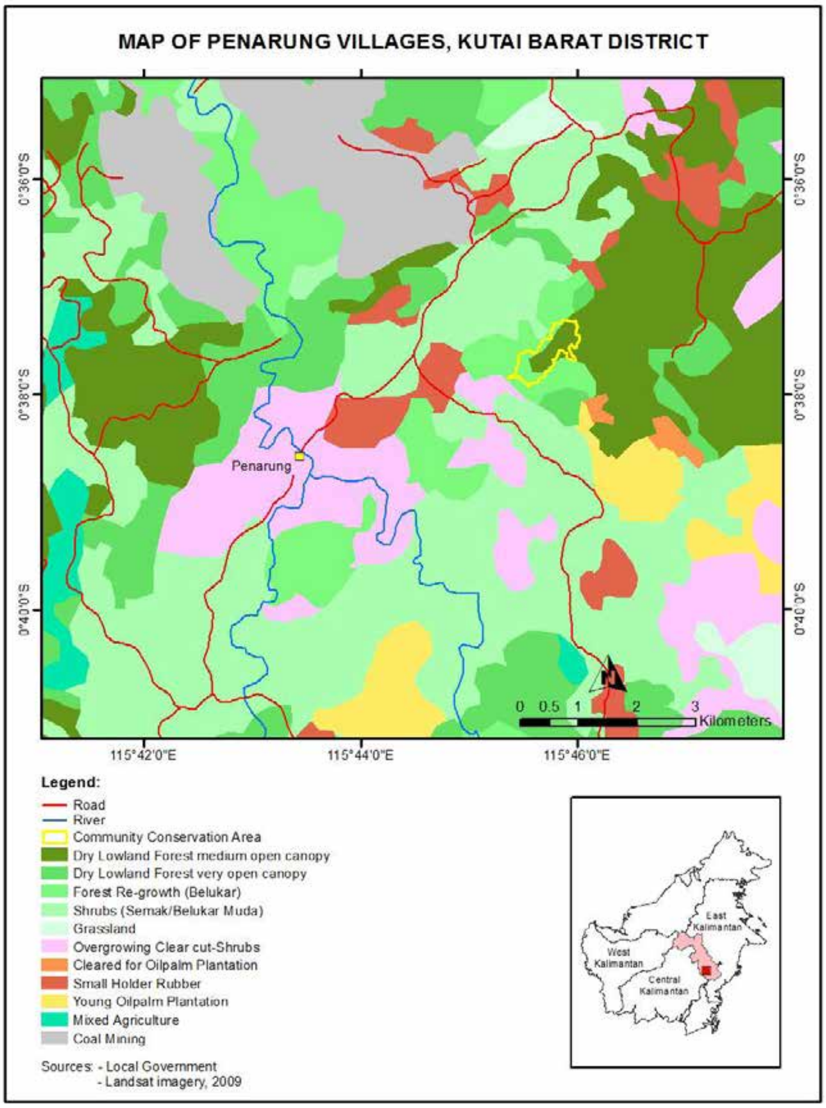


Figure 3. Penarung land use

1.3. Land use trajectories and drivers

As mentioned above, rapid land use changes are occurring in Kutai Barat and in the two study villages. Concessions for timber extraction, large scale plantation development and mining already cover a large part of the territory of the district and remaining forests – whether protected or not by local communities – are under serious threat of being converted. Oil palm plantation development and coal mining are of particular importance as external drivers of land use change.

Communities are also influencing land use changes by increasing reliance on goods and services for which cash is needed. Hence, conversion of swidden areas to rubber and other cash crops is frequent, but this does not differ much from previous strategies of swidden cultivators in Borneo, perhaps except for the scale of the current conversions. Further information on drivers of land use change can be found in I-REDD+ Deliverable 7.1.

2. *Profitability of land-use types*

2.1. Land-use characteristics

Swidden rice

The swidden cultivation system has been practised for many generations in Borneo with hill rice as the main crop. Households in both Batu Majang and Penarung use this cultivation system and it is an important source of subsistence food. Households managed 1–2 ha of swidden rice fields and harvested once a year. Fallow periods were in Batu Majang mostly three or five years, but in Penarung much longer and up to 20-25 years. Besides hill rice, several types of vegetables, such as chilli, maize, cucumber and pumpkin were also planted. Fertilizers or pesticides were not used in the cultivation, the planting materials were local, and the level of mechanization and support from extension services were limited. Most stages in the cultivation cycle, but especially planting and harvesting, were done jointly by groups of households. Swidden fields in Penarung were located relatively close to the village, whereas in Batu Majang, they were located as far as 13-14 km away. Rice yields in both villages were similar, in Batu Majang usually about 681 kg/ha and in Penarung around 656 kg/ha.

Smallholder agroforest

'Smallholder agroforest' refers to land planted with commercial trees mixed with other trees that combined serve several functions, such as cash income, self-consumption or providing shade for the main commercial trees. In both villages, households managed this type of agroforestry system on 1–2 ha using relatively little family labour. Cocoa cultivation needed higher input compared to other land uses in Batu Majang. In this system, households managed cocoa trees along with some fruit trees, such as rambutan (*Nephelium lappaceum*) and durian (*Durio* sp). To maintain cocoa agroforests, households conducted some activities, such as pruning and spraying, but did not use fertilizer. Households began to harvest the cocoa beans in the fourth year. On average, this system produced about 475 kg of cocoa beans per year.

Rubber agroforests were also mixed with other trees, mostly fruit. The relatively new rubber in Batu Majang had not yet been tapped, whereas in Penarung, the rubber was mature. Fertilizers were not used for rubber, but herbicides were applied during the first three years. This relatively extensive system of rubber agroforestry has low productivity and rubber farmers in Penarung only produced about 675 kg wet latex per year. New rubber was being planted in after upland rice cultivation in both villages.

Mixed garden

'Fruit garden' refers to land uses that consist of various types of vegetation, but mainly fruit trees. Households allocated little or no inputs to maintain these gardens, but they fruits were collected. In Penarung, households also collected rattan from their mixed gardens. In addition, herbs for traditional medicine, firewood and timber for construction were also collected. These types of land included '*lembo'* or '*lepo'*, a local term that refers to abandoned land. Some plants commonly found in mixed gardens included durian (*Durio sp*), lay (*Durio kutejensis*), rambutan (*Nephelium lappaceum*), mata kucing (wild longan, *Dimocarpus longan*).

Some households in Batu Majang had planted agarwood in such gardens in 2004 and they are now received training on the use of inoculants to initiate of the fungus that produces the scented agarwood.

Community forest

Both Penarung and Batu Majang have community forests that are locally protected from agricultural and other commercial activities. Villagers are allowed to take small amounts of forest products to use for household needs such as firewood. In Batu Majang, the community forest is protected by strong local customs (*adat*) and timber can only be used activities considered *adat*, such as traditional ceremonies.

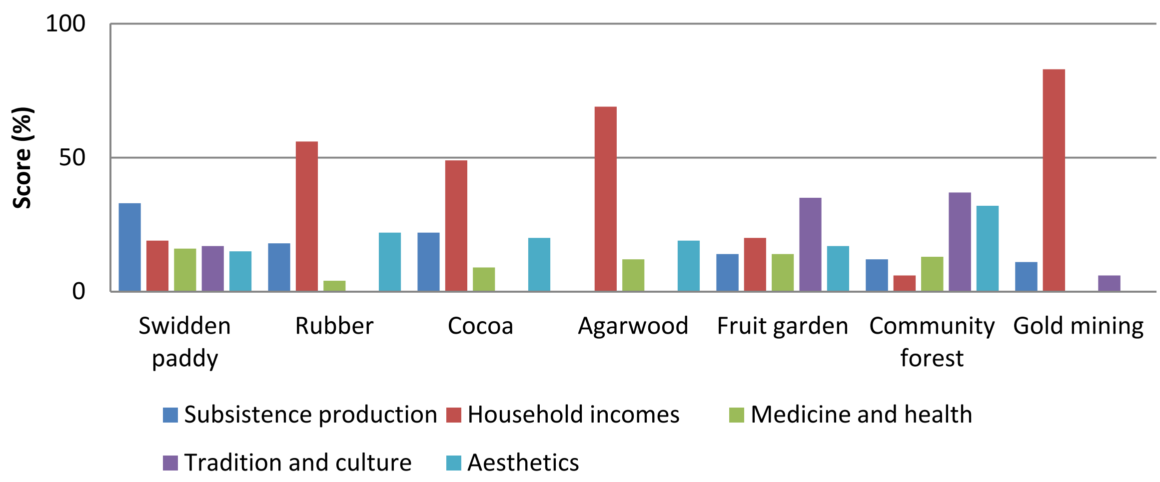
Other land uses

In Batu Majang, secondary forest land under the logging company concession was not actively used and hence covered with relatively old forest. In Penarung, there was a rubber plantation of approximately 600 ha managed under a revenue-sharing system in which the land owners receive about one-third from the tapped rubber while the tappers get the rest. The rubber plantation was developed by a logging company as part of a community development program (Bina Desa) the early 1990s.

Penarung was surrounded by two large-scale business operations: an oil palm plantation and coal mining. The oil palm was still immature and the company involved villagers under a 'plasma' mechanism.

2.2. Importance of land uses

The value of land uses was assessed by groups of male and female farmers in both villages. The value of land uses was separated between the value for livelihoods and for environmental services. The value of livelihoods consists of subsistence production, household incomes, traditional medicine, tradition and culture, and aesthetics. Another variable also assessed grouped values of ecosystems, as follows: water regulation, soil conservation, biodiversity and fresh air and climate.



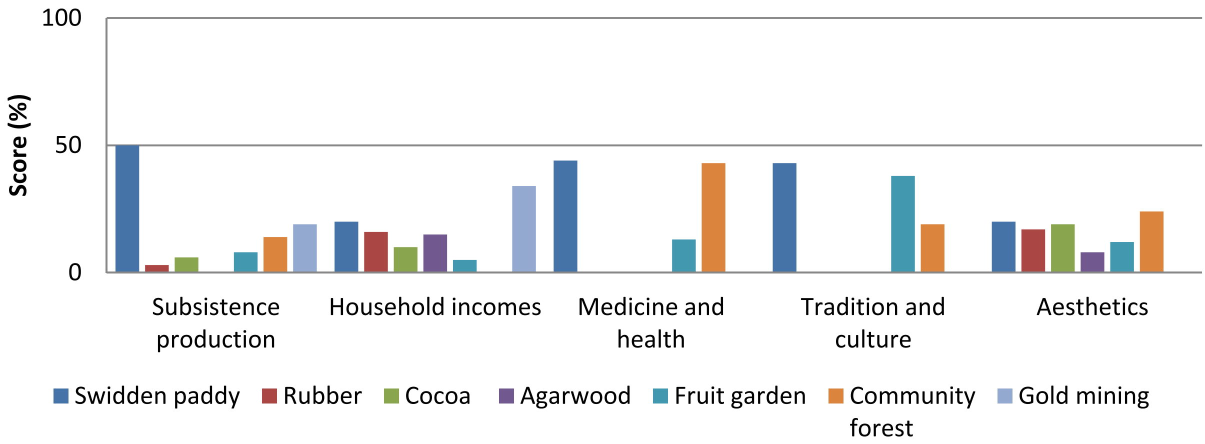


Figure 4. Livelihood value assessment for each land use and land use value assessment for each livelihood factor by male group in Batu Majang.

As seen in Figure 4, the male group considered swidden rice cultivation the most important land use (33%) for the subsistence production livelihood category and this was reiterated when participants were asked to rate the importance of each livelihood variable against all land uses. The group in Batu Majang expected rubber gardens to be the main income source. Rubber, cocoa gardens and agarwood were confirmed to be the most important sources of land based income, but gold mining was the single most important income source for the men. The women valued gold mining slightly lower but still as the most important income source. Fruit gardens in Batu Majang were linked with traditional and cultural values, especially for the male group, whereas the female group saw the fruit garden more as one of the household income sources. Community forest in Batu Majang was linked with the function of tradition and culture as well as medicine and health.

The same exercise carried out in Penarung showed relatively similar results – part of the results from the female group is shown in Figure 5. The difference is that oil palm and rattan were important land uses and especially oil palm is important for income. Oil palm was also mentioned as important for subsistence, but that reflects that the money is used for buying food for subsistence rather than using palm oil products directly from the farm.

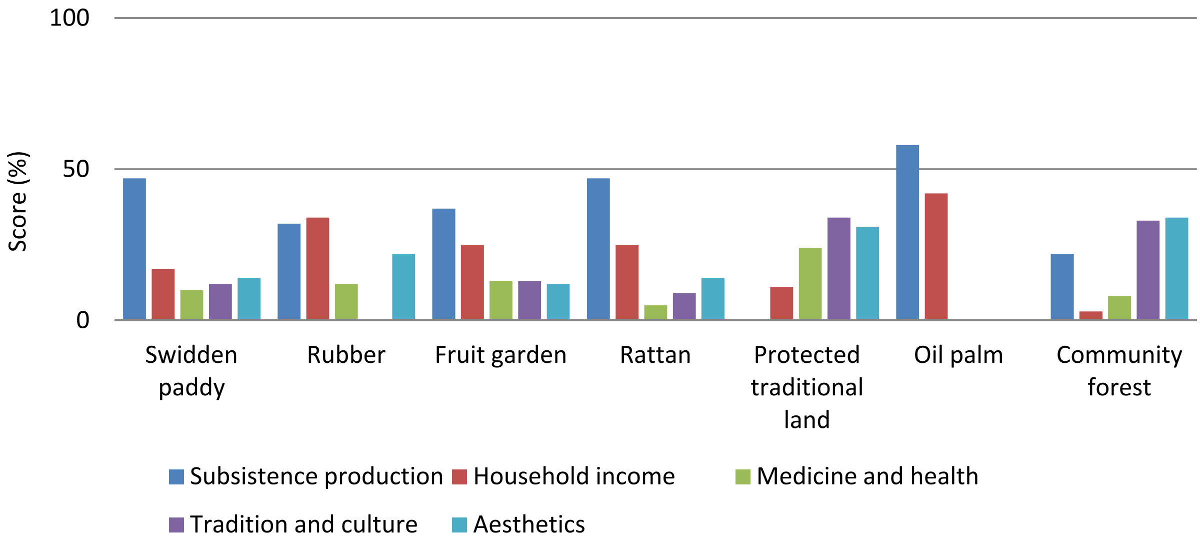
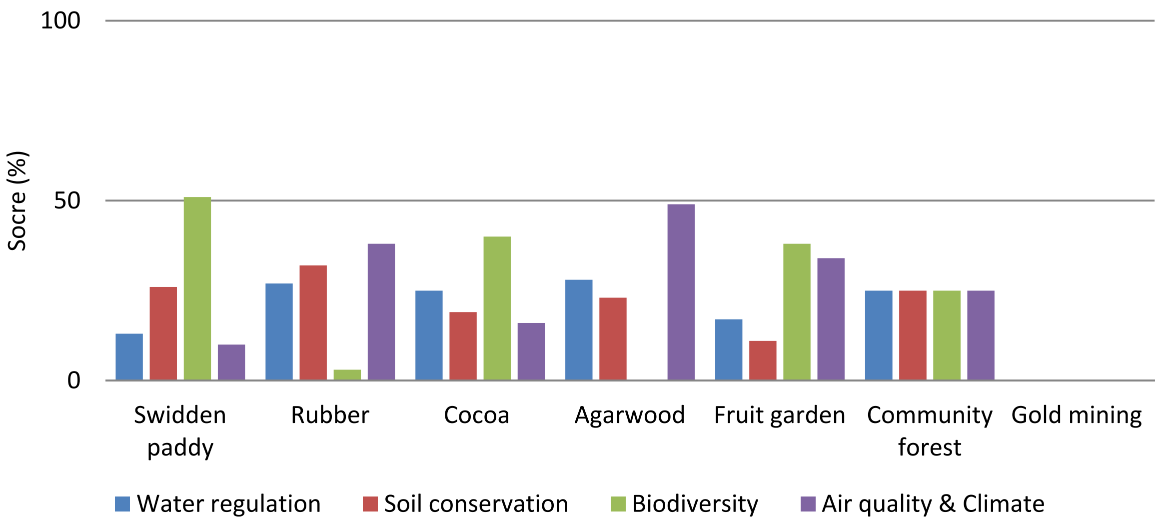


Figure 5. Livelihood value assessment for each land use by female group in Penarung.

Swidden rice and fruit gardens were valued highest for maintaining biodiversity and good air quality by the groups in Batu Majang (Figure 6), but when valuing each land use across ecosystem functions, the community forests were rated higher than any other land use. In Penarung, the valuation of ecosystem services was similar, but swidden rice (and its fallow) and rubber were assessed to provide soil conservation, whereas oil palm was perceived to provide low levels of ecosystem services by both men and women.

Finally, Figure 7 shows a comparison between livelihood values and environmental services in both male and female groups in Penarung. The female group saw household income as more important (34%) than the male group (21%), and women were generally more concerned with livelihood values than men. In Batu Majang, the male and female groups were more even.



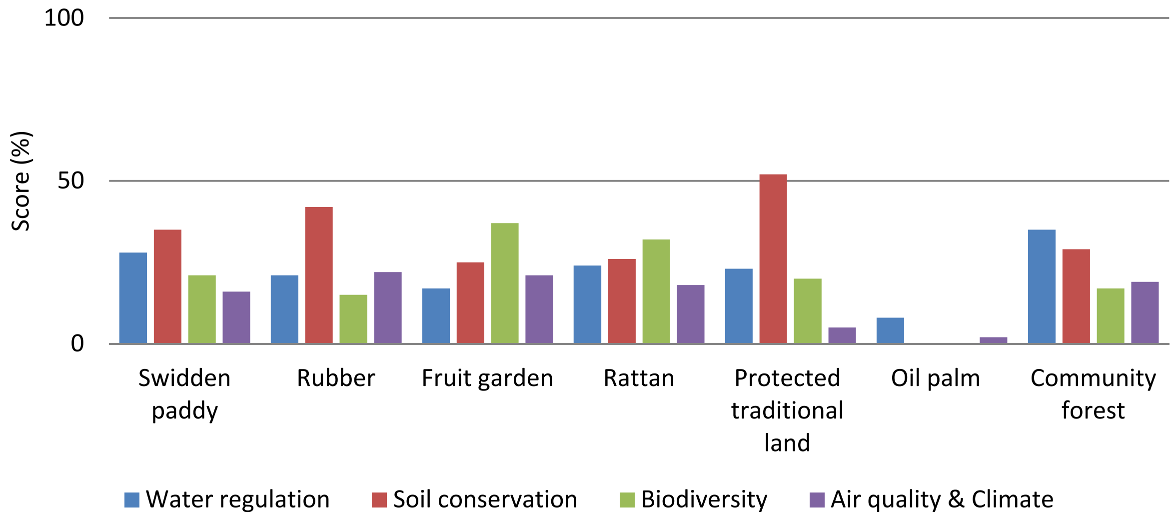


Figure 6. Ecosystem value assessment for each land use by female group in Batu Majang (top) and by male group in Penarung (bottom).

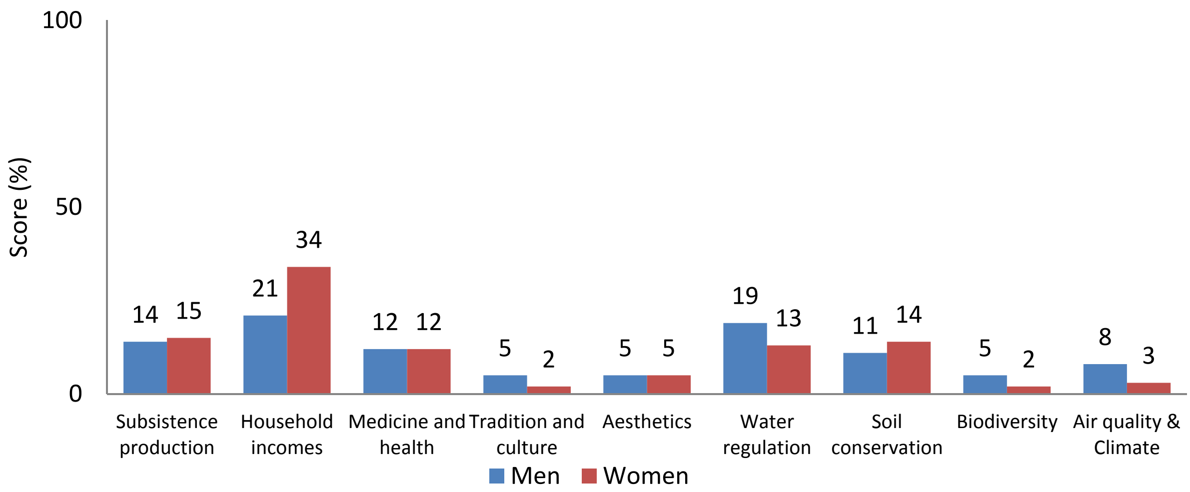


Figure 7. Priorities of livelihood values and ecosystem services by male and female groups in Penarung

2.3. Opportunity costs of land use

The opportunity cost estimation requires the result of profitability assessment for each land use, indicated as the Net Present Value (NPV). This study estimates the profitability for each land use under the following assumptions: discount rate: 7.8%, wage labour: 5.5 US$/day

We thus employ real interest rate (interest rate net of inflation) as discount factors used to value future cash flow in current term. The rate of 7.8% is a lower bound for the actual cost of capital for smallholder farmers because of imperfections in capital markets in the study location. For agricultural wages, we use the same wage rate as the daily unskilled labour rate in the village as indicated by farmers and key informants when the data was collected in 2012.

The analysis for NPV must have the same time horizon across land uses in order to remain comparable. This study uses a 30-year timeframe because we are interested in the opportunity cost of entering a REDD+ contract.

Table 1. Land Use Profitability

	Land-use type	NPV (US$/ha)		Return to Labour (US$/day)	
		Batu Majang	Penarung	Batu Majang	Penarung
1	Swidden rice	396	751	6	6
2	Rubber agroforest	2,377	2,587	11	11
3	Fruit mixed garden	395	234	10	8
4	Rattan mixed garden	n.a.	231	n.a.	8
5	Cocoa agroforest	2,531	n.a.	11	n.a.

The profitability assessment result (Table 1) shows that all main land uses in both villages are positive in terms of land to land (NPV) and land to labour. A land use with positive NPV indicates its feasibility for investment in terms of creating an economic surplus. The result showed that tree-based systems are the most profitable land uses, both in Batu Majang and Penarung. Rubber agroforest provides the highest return to land (NPV) followed by cocoa agroforest in Batu Majang. In Batu Majang, cocoa agroforest created a higher NPV than swidden rice and fruit gardens. However, farmers in Batu Majang experienced low productivity of cocoa production because of pest attacks and no fertilizer application and their plantations produce cocoa beans at only 475 kg/year on average.

The rubber agroforest was the second most profitable land use after cocoa agroforest in Batu Majang. The estimation was based on a rubber price of Rp 9000 per kg estimated productivity. This figure could be higher if farmers used better planting materials. The swidden rice of Batu Majang created low NPV because of the higher cost, especially in transportation. The distance between the settlement and the rice field implied additional costs for Batu Majang farmers.

Rubber agroforest in Penarung is the best option to obtain high profitability followed by swidden rice, fruit mixed garden and rattan mixed garden. Rattan mixed garden created lower NPV than fruit mixed garden simply because of the low price of rattan products and the amount of labour for harvesting. According to farmers, the revenue of selling rattan was too small compared with the cost of harvesting.

In terms of return to labour, all land uses in both villages assessed had higher returns compared to daily labour wage (5.5 $US/day). Specifically for tree-based systems, it is almost double the daily wage rate. Return to labour indicates how attractive a system is for farmers to allocate resources. The higher the value of return to labour of a land-use system, the more attractive that land-use system is for farmers to engage in. In Batu Majang, cocoa agroforest provided almost the same as rubber agroforest in generating return to labour (11 $US/day), followed by fruit mixed garden and swidden rice. In Penarung, the most attractive land use for famer was rubber agroforest, which generated about 11 $US/day.

3. Livelihood typology and reliance on different land-use types

3.1. Household typologies

General household typologies were established in the two villages through focus group interviews (Tables 2 and 3). In Batu Majang, the two group discussions were done with nine men and five women in order to identify their perception of how households can be distinguished based on different levels of well-being. The term well-being – or in Indonesian *sejahtera* – was used instead of the term wealth, as it was considered inappropriate to rate households by this term. Relatively few clear categories were defined by the respondents, probably because they were reluctant to divide people into better and worse off categories. They were especially hesitant to fill in the 'low well-being' column as they did not want to expose poor families among themselves.

Table 2. Household typologies developed in a group of 9 Men and a group of 5 women in Batu Majang.

Male group		
Low well-being	**Intermediate well-being**	**High well-being**
Hill rice field < 1 ha	Hill rice field around 1 ha	Hill rice field 2 or more ha (= 14 or more ha of fallow)
	Low or no income from vegetables garden, gold mining, own car for transport/taxi, fishing, hunting,	Income from: Vegetable garden, gold mining, own car for transport/taxi, fishing, hunting,
	Lower expenditure than the 'high well-being' category	Minimum expenditure 4-5 mill Rp per month
		Own their house
No electricity	No electricity	Have electricity
Some children not in school, some until first primary school levels	Children in school	Children in school
		Enough food and fuel
	Can afford health services	Can afford health services
Female group		
Less than intermediate	Hill rice field 1 ha (2 cans of seed to sow)	More than intermediate
	Other income sources: gold	
	Expenditure about Rp 4 mill/month	
	Child in school up to lower secondary	

Table 3. Household typologies developed in a group of 11 Men and a group of 10 women in Penarung.

Male group		
Low well-being	**Intermediate well-being**	**High well-being**
Fields < 4 ha	Fields 4 ha, harvest 1500 kg	Field > 4 ha
Income < 3 million/month	Income about 3million/month. Various income sources: labor, rubber, hunting, fishing, handicraft from rattan	Income > 3 million/month
No electricity		Have electricity
Do not have own house		Own their house
Children in school up to primary school		Children in school to or beyond secondary school
Female group		
Hill rice < 2 ha	2 ha hill rice with 200 *kaleng* rice harvest	Hill rice > 2 ha
	Expenditure 3.5 million per month	
Income < 3.5 million	Income 3.5-6 million	> 6 million per month
Children in school until primary school	Children in school until primary school	Children in secondary school
House in poor condition or do not own it	Own their house (e.g. inherited from parents)	Own their house with electricity
		Own handphone

3.2. Landholdings

Average land holdings of households in Penarung were larger (12.3 ha) than those of Batu Majang (5.5 ha). The average land holdings per household by land use type are shown in Figure 8. Besides the total area, the main differences between the villages were in the amount of fallow land or bush land, which was much higher in Penarung, where fallow periods tend to still be much longer. With 7,5 ha per household, fallow land thus account for more than 50% of land holdings in Penarung.

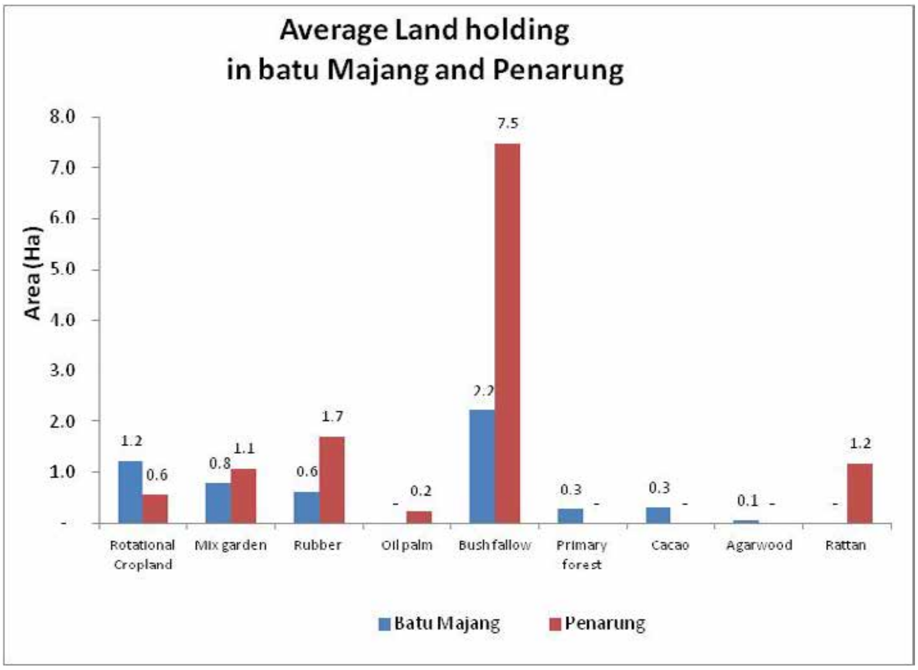


Figure 8. Landholdings per household in Batu Majang and Penarung.

3.3. Income

The calculation of income included the value of commodities consumed. However, most income came from cash earned from gold mining and labouring in oil palm and coal mining companies (Table 1). The average total income per year per household in Penarung was higher than in Batu Majang. However, the difference in income between households within Batu Majang and Penarung was also high. The major source of income in Batu Majang and Penarung was also different.

In Batu Majang, the major source of income was from working in gold mining (about 44%). Most villagers were paid gold miners working in group with three or four labourers. Other sources of income in Batu Majang were from open access to natural resources such as forest products (about 20%) whereas income from rotational cropland represented only about 14%. This category is important for subsistence food production and thus for food security. The share of income from other agricultural practices was relatively low.

In Penarung, workers in oil palm plantation and coal mining companies had the highest incomes, with their total income share being about 40%. This indicated a high dependency on non-farm activities and also indicates why villagers are often open to such companies buying land in the area. Forest products accounted for 19 % of income whereas the share of income from other agriculture in Penarung was low.
Table 1. Source of income by activity type in Kutai Barat, East Kalimantan

Sources of Income	Average income per Household				Income per capita	
	Batu Majang		Penarung		Batu Majang	Penarung
	IDR	%	IDR	%	IDR	IDR
1. Agriculture						
Rotational cropland	5,122,940	14.25	1,124,200	2.71	1,000,574	278,267
Mixed garden	729,950	2.03	1,742,000	4.20	142,568	431,188
Rubber plantation	91,520	0.25	2,914,534	7.03	17,875	721,419
Cacao plantation	389,200	1.08	-	0.00	76,016	-
Rattan plantation	-	0.00	873,100	2.11	-	216,114
2. Forest product	7,366,382	20.49	7,892,760	19.05	1,438,746	1,953,653
3. Livestock	655,600	1.82	1,118,700	2.70	128,047	276,906
4. Passive income	718,000	2.00	3,652,000	8.81	140,234	903,960
5. Gold mining	15,759,920	43.83	-	0.00	3,078,109	-
6. Labouring	1,796,400	5.00	16,506,864	39.84	350,859	4,085,857
7. Entrepreneur	972,000	2.70	1,936,000	4.67	189,844	479,208
8. Professional	2,352,720	6.54	3,677,456	8.87	459,516	910,261
9.Total income per year	35,954,632	100	41,437,614	100	7,022,389	10,256,835
10. Income per day					**19,239**	**28,101**

Working for oil palm and coal mining companies was a more important livelihood in Penarung. This work included various activities such as planting, weeding, fertilizing and field supervision (in oil palm plantation companies) and as driver, security and field supervision (in coal mining companies). It was generally done both by men and women.

The calculation of share of income from forest products included the value of commodities consumed (Figure 9). In Batu Majang, fuelwood, fish and game were the most important, whereas in Penarung, timber was the most important forest product in economic terms, followed by fish, fuelwood and game.

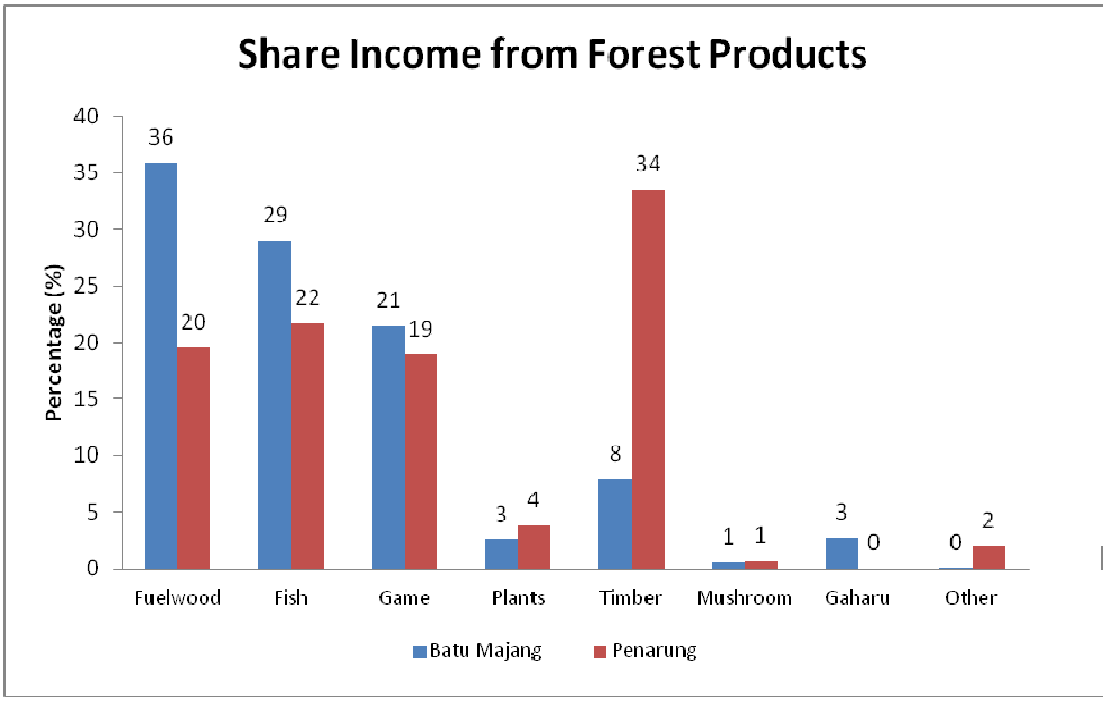


Figure 9. Share of income from forest products.

The daily income per capita of farmers in Batu Majang was IDR 19 239 (USD 2.1)1; Penarung was IDR 28 101 (USD 3.1). The average family size ranged from 4.02 to 5.12 members at both sites. Using the international poverty line standard of USD 1.00 a day (World Bank standard), none of the respondents in Batu Majang and Penarung were living below the international poverty line.

[1] Average exchange rate in 2012 was USD $1 = IDR 9,000.

Appendix 3: I-REDD+ WP5 Country Report: Laos

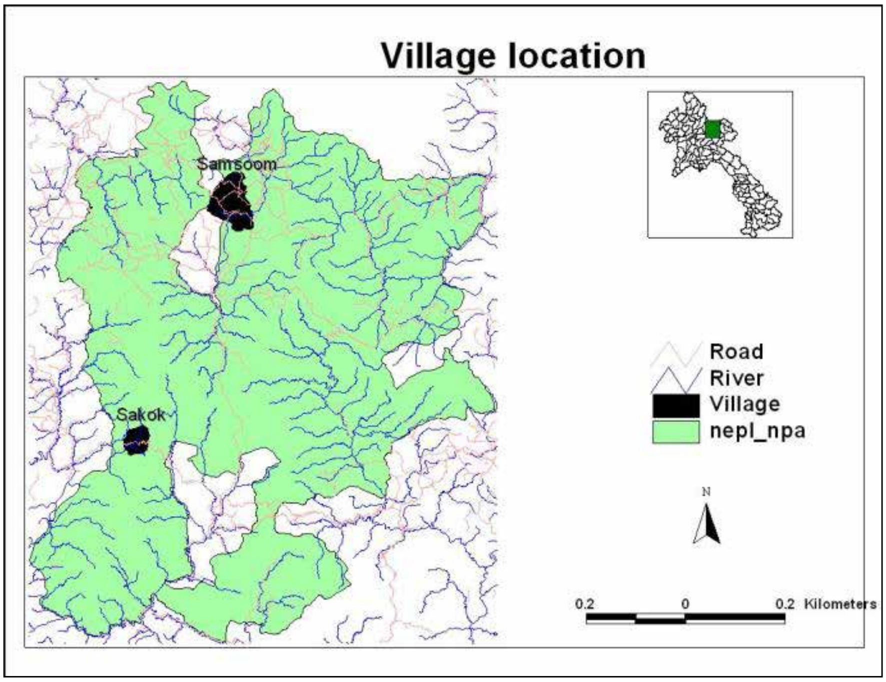
by Thoumthone Vongvisouk and Jean-Christophe Castella

1. *Village description in the regional context*

1.1. Village location

Sakok village is located in the core-zone of the Nam Et-Phou Loey National Protected Area (NPA), while Samsoom village is located in the control use zone of the northern part of the NPA (Figure 1). The villages belong to Viengthong District of Houaphan Province in north-eastern Laos.

Figure 1: Location of WP5 target villages in relation with the Nam Et-Phou Loey National Protected Area.



1.2. Characteristics of the village compared to the other villages in the region

Background information on Samsoom village

Samsoom village is a Khmu village which was originally located on the top of a mountain called "*Samsoom*". Because of security reasons and health problem, Samsoom villager successively moved from their original settlement area to different locations, which are located at lower elevation than their original village location. The current location is the seventh settlement in the village history. In 2005, villagers moved at the foothill close to Nam Et river following the recommendations of the district authorities to relocate closer to the road with easy access to public services.

Since the creation of the village, the population has never been stable. People moved around for security reason and to find suitable locations for upland rice cultivation. Some families came from and moved to Huangmeuang district of the same province (Huaphan), while some other moved to other villages in Viengthong district.

The most recent population movement were recorded during our field investigations Table 1. According to demographic data of the village, the population growth rate is the double of the national population growth rate, which are 6.4 and 3.2 respectively.

Table 1: Population trends in Samsoom Village

Year	Household	Population	Female	Births	Deaths	Immigration	Migration
2012	71	368	187	2	0	0	0
2011		360		6	0	0	2
2010		353		8	1	0	0
2009	47	347	176	7	1	0	0
2008		338		11	2	0	0
2007		327		12	1	0	0
2006		323		5	1	0	0

Source: I-REDD+ field data collection, 2012.

Although Samsoom villager resettled seven times, their production areas remained the same. Only the village settlement was moved. However, the cropping intensifies varied according to the distance to the settlement. As a result, the land use systems in Samsoom have not changed much in the recent years. However, since they are currently located closer to road, villagers have better accessibility to market and opportunities for income generation. In 2007, they began to cultivate hybrid maize to replace opium cultivation. The production of cash crops was promoted by the government as part of a policy on eradication of opium cultivation.

Villagers in Samsoom have shortened their fallow period since the boundary of the Nam Et-Phou Loey NPA has been enforced in 2005. Previously they practices 12 – 15 years rotation of their swidden rice depending on household labour. To date, their upland rice fallow is approximately 7 – 8 years depending on number of swidden plots held by household. Villagers in Samsoom conduct their upland rice in the same large area that they open collectively for cultivation every year. The cultivation area is divided into individual plots based on land held by each household trough traditional tenure system and labour available for each household a given year. If some families do not own land in the production area that is cleared a given year for swidden cultivation, they negotiate with other families to borrow land for their swidden. For example, a family who doesn't have land in current swidden field borrows land from relatives: "*I hold only four plots of swidden land, which are about one hectare each. This is because my father was an opium addict, he did not manage to secure land for the next generations. Today, I have to negotiate with my relatives to borrow their land for upland rice cultivation. Fortunately, every year some relatives allow me to borrow their land in the place selected by the village to cultivate upland rice field. However, I am afraid that I will face greater difficulty in the near future when population in this village increases. Almost the whole village land is now allocated to individual families*". The lives of local people who rely on upland rice cultivation only will be more difficult in the future because of population increase, as the land suitable for upland rice has remained stable or even decreased as compared to 10 years ago.

Since local people moved from their former village, they abandoned some of their former upland fields that are now located half day walk distance to their village settlement. Local people would like to build a road to their former village location which is quite flat and suitable for paddy rice terraces.

The socio-economic status of Samsoom village is currently better than when villagers lived in their former settlement. This is because they now have better access to public services such as school, sanitation, road and market. Though there are largely dependent on natural resources for their household consumption, they can generate cash income from agricultural production, especially hybrid maize. Non-timber forest products (NTFPs) have gradually decreased in the recent years because of unsustainable collection since the village opening to market economy. Besides, the NPA limits access of local villagers to forest resources (e.g. NTFP collection, hunting). Since the national protected area and village boundaries have been clearly demarcated, local people keep their upland field in specific areas. The agricultural production fields (including fallow) are demarcated and forest has been divided into three different management types, i.e. conservation forest, utilization forest (production forest), and watershed protection forest. Village protected and conservation forests are the densest forest among the 3 village forest types. Local people still use resources from village protection forest, but not for logging as it is supposed to protect water sources, both quality and quantity, for the village. Two categories of grassland are distinguished: *Imperata cylindrica* fields where grass is used for house roofing and natural grassland for livestock grazing.

Background information on Sakok Village

The village was created by lao lum (lowland lao or Lao Lum) people in 1978 after the asphalt road was built by Chinese workers in 1977-1978. Before villagers lived in Nameuang, a flat area with paddy fields is now located inside the NPA. They lived in Nameuang for many years since the French colonial period. At that time there were about 60 households in the village, all of them were lowlander (Lao Lum). The first Sakok villagers who moved from the former village in Nameuang used the Chinese camp as their temporal resettlement before their built new houses.

The initial name of the village was Koksa because there is a big Sa tree in this village. The local legend says that the village name changed to Sakok because of a khmu elder who was fishing in the stream close to the road when three men from Luang Prabang came to the village and asked him '*Grandfather, where do you live?'*. The elder man was very scared to answer as there was a lot of insecurity in the area at that time due to counter-revolutionary movements. The old man responded '*I am living in Sakok village*'. Then he ran away because he was afraid those men would kill him.

In 1988, almost all families left the village and moved to Oudomxay and Vientiane provinces because of the insecurity in the area due to fights between government forces and counter revolutionary movements. In 1992, 15 households came back from Donekhoun village of Viengthong district (Huaphan province). Only 3 households from the former village moved back to Sakok. In 1998-1999, soldiers moved to the village to secure the area.

In 1992, 36 households practiced mainly shifting cultivation. They did not have any equipment and experiences to grow paddy rice. Although local people practiced only upland rice field, they could produce enough rice for their household consumption. This is because they had enough land for upland rice cultivation for every household, coupled with availability of fertile soil in the area due to the presence of dense forest. The 2 first years they grew swidden rice on 10 to 15 years fallows that had been left over by previous villagers. Yields were quite high and labour productivity of swidden was much higher than for paddy fields.

However, since the demarcation of Nam Et-Phou Loey NPA and Land and Forestland Allocation (LFA) in 2000, villagers have to limit their upland rice field into the allocated areas with maximum 7-8 plots per household depending on household size and labour availability. Currently most villager in Sakok practice a 3 year rotation of their upland rice fields, because large parts of their former swidden areas have been converted to hybrid maize cultivation since 2009.

Most of the current village population migrated recently (15 years) from villages and districts such as from Viengthong, Viengkham (Luangprabang) and Vientiane province. Sakok population is now dominated by the Khmu ethnic group with 54 Khmu households and only 5 Lao Lum households. The population has been quite stable since the land allocation has been implemented in the village (Table 2). As the village is located in the core-zone of the park, restrictions have been imposed on immigration.

Table 2: Population trends in Sakok Village.

Year	Household	Population	Female	Births	Deaths	Immigration	Migration
2011	59	321		9	0	2 daughters in law	0
2010		310		5	0	5 (teacher family) + 2 daughters in law	0
2009	52	300	148				

Source: I-REDD+ field data collection, 2012.

Hybrid maize is a booming cash crop in this region. Many middlemen contract villagers to produce maize. Those middlemen provide hybrid maize seeds to local villages as credit, which local people return when they sale their maize production to the contracted middlemen. In Sakok village, villagers contracted with a middleman from Viengthong district in 2009. The village chief signed on behalf of the villagers then submitted the contract to the district authorities to sign as third party or witness. The price of hybrid maize production stated on the contract is based on the average market price. Unfortunately, the price of hybrid maize dropped from 800 LAK[2] per kilogram in 2009 to 500 LAK in 2010, then villagers refused to produce maize in 2010. They cultivated maize again since 2011, which they sold in early 2012 with the price 1,000 LAK per kilogram. As part of the contract, the middleman built two roads (1 km in 2010 and 3 km in 2011) to maize areas, which indebted villagers for five years. Because of the improved road accesses to the areas, which eased the burden of harvest transportation, many households converted their swidden areas to hybrid maize cultivation. Households who have less land cultivate many crops into the same plot, for example they cultivate rice the first year and hybrid maize the second year. Some households cultivate traditional maize and tobacco mixed with their upland rice for self-consumption, while some other have large field of traditional maize (1 or 2 hectares) to feed pigs.

[2] Exchange rate on June 2012: 1USD = 8,000 LAK.

Since local people in Sakok have relocated in this village they started growing paddy rice again. 20 households out of 59 do not have paddy field. Those families settled in the village later than the others and paddy rice fields were already occupied. Also, some young families did not inherit paddy fields from their parents. Though other 39 households hold paddy field, 34 out of them are still practicing swidden. This is because the rice production from their paddy rice field is not sufficiency to cover their household consumption. Only five households are not involve in the upland rice cultivation, three households raise livestock and collect NTFPs to buy additional rice, while the other two household can produce enough rice for their household consumption from their paddy fields. This year villager in Sakok increased their paddy area of about 10 hectares. The maize middleman provides paddy field terracing services with price 350,000 LAK per hour of excavator/bulldozer if paid in cash and 400,000 LAK per hour paid my credit. Villagers can reimbursement their credit in maize.

Similar to Samsoom village, people in Sakok village generate most of their cash income from livestock, hybrid maize and NTFP collection. NTFPs are usually collected from fallow, production forest and protection forest. These NTFPs sold include broom grass, cardamom, bamboo shoot, galangal and so on. A few households generate additional income from off-farm activities such as house construction, small scale trade but the total off-farm income represent less than 4% of the cash income generated by the whole village .

Since Sakok is located in the core-zone of Nam Et-Phou Loey NPA, some villagers are involved in forest conservation activities such as patrolling and awareness raising. Many people in the village involve in patrolling activities, which they have to stay overnight at the outpost close to the village.

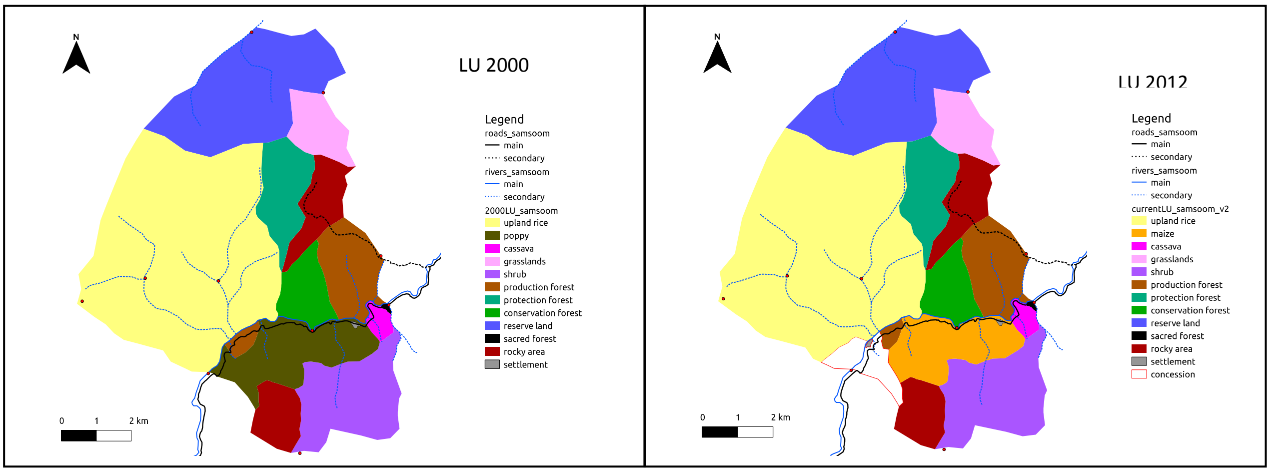
1.3. Land use trajectories and drivers

Land use changes in our two target villages depended to a large extent on their relative accessibility. People in Samsoom village mainly rely only on upland rice cultivation for their livelihoods. They were still practicing opium poppy cultivation in 2000 as their main source of cash income. People in Sakok are practicing both upland swidden and paddy. They have been under high pressure from the district authorities and NPA management to reduce swidden cultivation and to convert more land to paddy. Hybrid maize provided a new income generation opportunity that was further invested in terracing new paddy fields.

Since the Nam Et-Phou Loey NPA has been demarcated, local people access to forest resources has been restrained, to a larger extent in Sakok, close to the park headquarters and more loosely in Samsoom due to the distance that explains a relatively lower administrative pressure.

However, in both villages, local people have shortened their swidden fallow from 10-15 years to 7-8 years. Swidden intensification process is delayed in Samsoom as compared to Sakok but it follows the same pattern. In Sakok, land scarcity after land allocation leads farmers to cultivate the same upland area for two or three consecutive years depending on soil fertility. With only 3 years rotation, this means that the fallow is gradually disappearing. In Samsoom the swidden area of 2012 has already been cropped two years and they continue with a third cropping year. While the rotation is still officially 7 years, this intensification looks like a prelude to a shortening of the fallow period towards a gradual demise of swidden agriculture like in Sakok. This trend has been actively promoted by the Lao government in an attempt to convert subsistence based agriculture to commercial agriculture. The rapid expansion of hybrid maize in the study area is consistent with the government policy to gradually segregate agriculture and forest on the map and only for household livelihoods. In 2007 hybrid maize was introduced in Samsoom by a middleman from Viengthong district. Since then, hybrid maize cultivation has expanded in former opium cultivation area, while other land uses remained stables (Figure 2).

Figure 2: Participatory land use maps in Samsoom Village in 2000 (left) and 2012 (right).

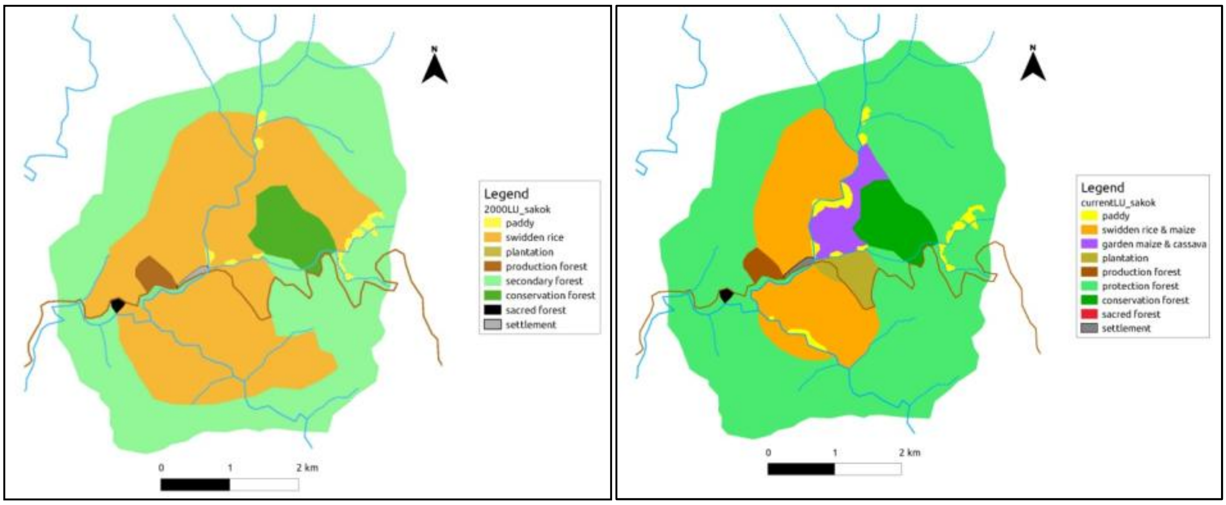


Unlike in Samsoom, land uses in Sakok village changed a lot over the past decade (Figure 3). The land allocation program implemented in 2000 considerably reduced the agricultural land area used by each household so as to increase forest protection in the core-zone of the NPA. Farmers could not expand their fields due to restrictions imposed by the NEPL-NPA and household land endowment was reduced at each generation. This led to a shortening of the swidden rotation cycle from 10 years to 3 years, which is not enough to maintain rice productivity. For those households who do not have paddy land (20 HH), this policy had a strong negative impact on their livelihoods. Such increase in poverty rates after land allocation as been reported in many other villages in the region.

In 2009, people in Sakok began to convert some of their swidden to hybrid maize cultivation areas. Maize cultivation allowed them to intensify their swidden system with one year cropping and two years fallows. Households who owned less than 3 plots started growing maize on their plot the year after upland rice and then maize every year as upland rice could not be grown anymore in the absence of fallow. Since the rotation is getting shorter, local people have to spend more time and for weeding. They weed their upland rice field three times a year. Overwhelmed by weed problems, farmers start using herbicides.

Increased production costs in turn increase their economic vulnerability while land degradation due to increased erosion in upland cropping systems without fallow increases their ecological vulnerability. To reduce the economic risks, some household diversify their production by growing traditional maize and tobacco into the hybrid maize cultivation areas. The traditional maize is used for household consumption and for feeding pig, while tobacco is for sale.

Figure 3: Participatory land use maps in Sakok Village in 2000 (left) and 2012 (right).



2. Profitability of land use systems

2.1. List and description of land use types

Paddy: Paddy usually includes irrigated paddy and rainfed paddy. However, paddy in our target village is only rain-fed, i.e. local people build traditional small irrigation systems to get additional water from small streams during the wet season.

Upland rice rotational field: areas used for upland rice cultivation including cultivated areas and fallows. Current rotation ranged from three to seven years in the study areas.

Maize rotational field: areas served for hybrid maize cultivation. Current rotation period for hybrid maize cultivation ranges from two to four years depending on numbers of plots or parcels that each household own.

From the five types of forest officially recognized in the 1996 forestry law: 1) conservation forest (pa sa-ngouan) 2) protection forest (pa pongkanh), 3) production forest (pa phalit), 4) degraded forest (pa seuam som), and 5) rehabilitated forest (pa feun fou), only the three first types were still present in the 2007 forestry law. The two last types, which corresponded to the broad definition of 'secondary', 'unstocked', or 'degraded' forests have been removed from the official categories as they were prone to replacement by tree plantations. Specific land tenure rules are also associated to each forest class: conservation and protection forest are 'state land' while 'production forests' can be either 'state land' or 'communal-village land'. Tree plantations can be privately owned. The tenure status of degraded forest has not been clearly defined, certainly because they are supposed to disappear in the long term.

The 2007 forestry law defines the three main types of forest as follows:

Conservation forests are forests classified for the purposes of conserving nature, preserving plant and animal species, forest ecosystems and other valuable sites of natural, historical, cultural, tourism, environmental, educational and scientific research experiments. Conservation Forest consists of National Conservation Forest areas and Conservation Forest areas at the Provincial, District and Village levels which are described in the specific regulation.

Protection Forests are forests classified for the function of protecting water resources, river banks, road sides, preventing soil erosion, protecting soil quality, strategic areas for national defense, protection from natural disasters, environmental protection and so on.

According to local people in our study site, they are allowed to access protection forest for NTFPs collection and hunting by using traditional tools for hunting such crab and so on, but they are not allowed for logging and conversion to other land uses.

Production Forests are natural forests and planted forests classified for the utilization purposes of areas for production, and wood and forest product businesses to satisfy the requirements of national socio-economic development and people's living.

Production forest is also called "*utilization forest*" by local people, because they have free access to this forest type for NTFP collection, hunting, collecting firewood, wood for fencing or house building. However, local village have to submit their logging proposals to village's chief for approval (if the required timber is not more than five cubic meters). The chief of village will have to submit the proposal for timber logging to district level refer to District Agriculture and Forestry Office.

The land use classification in our certain target villages is shown in Table 3. These land use classes were defined by local villagers themselves during focus group discussions.

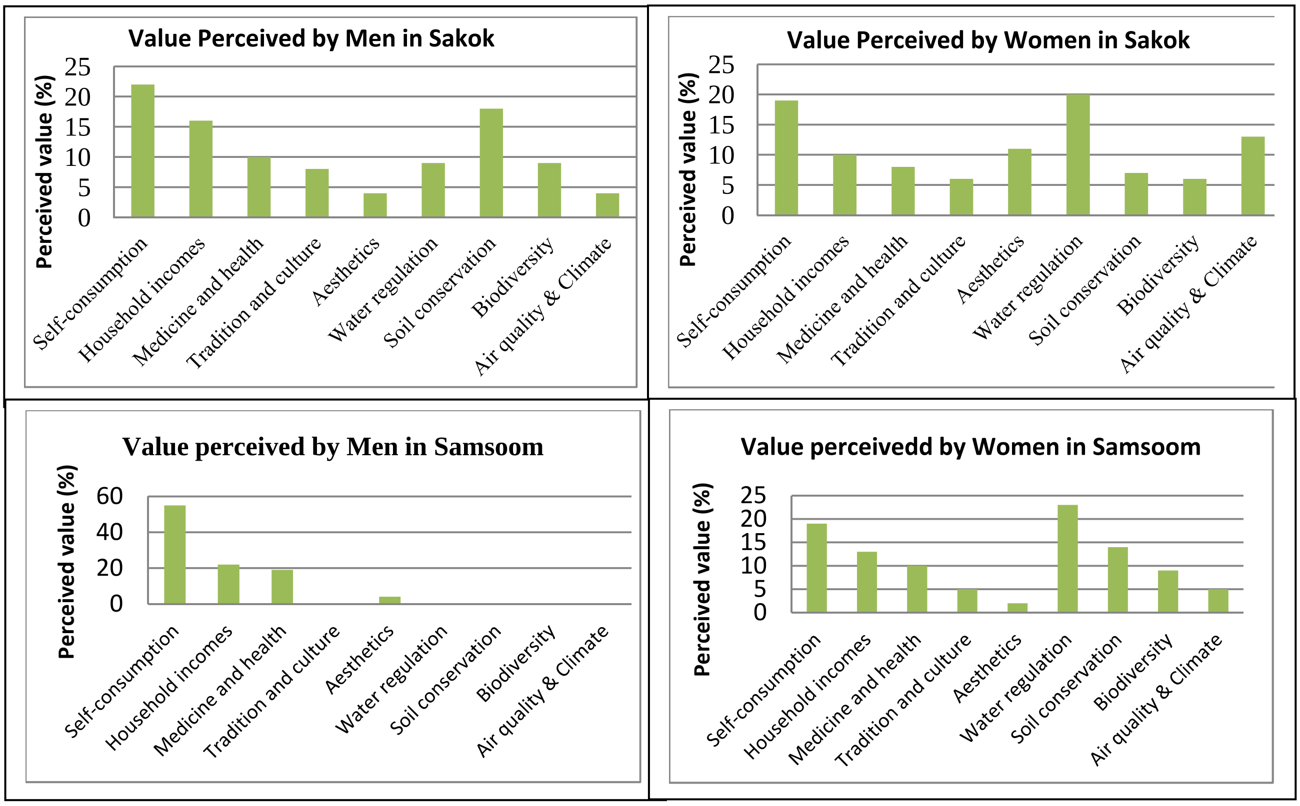
Table 3: Land use categories in Sakok and Samsoom villages in 2012.

Sakok	Samsoom
1. *Paddy*	1. *Upland rice rotational field*
2. *Upland rice rotational field*	2. *Maize rotational field (+ cassava)*
3. *Maize rotational field (+ cassava)*	3. *Grassland*
4. *Sacred forest*	4. *Sacred forest*
5. *Conservation forest*	5. *Conservation forest*
6. *Protection forest*	6. *Protection forest*
7. *Production forest*	7. *Production forest*
8. *Tree plantation*	8. *Reserve land*

Perceived value of the different land use types for village households was assessed through a pebble game. In both study villages separate men and women focus groups were organized to investigate the perceived importance of the main land use types for local livelihood (i.e. self-consumption, household incomes, medicine and health, tradition and culture, aesthetics) and ecosystem services (i.e. water regulation, soil conservation, biodiversity, air-quality and climate).

As expected in region dominated by subsistence agriculture, local people were more concerned by rice sufficiency than cash income generation or other services such as medicinal plants or aesthetic dimensions. Men groups in both villages gave values for household incomes higher than those values given by women group. In Sakok, men were highly concerned by erosion and land degradation, while women gave higher value to water regulation service provided by forest cover. Women groups in both villages are concerned by water sources and quality as they are traditionally responsible for collecting water for household consumption and use, while men are concerned by declines in agricultural productivity in relation to land degradation. Local people gave very low perceived values for climate quality and biodiversity as these concepts are very abstract to them. For example they did not see the link between land use changes and climate change (Figure 4).

Figure 4: Perceived values of land use types by local people in Sakok and Samsoom Villages,



2.2. Opportunity costs of land use

We used economic parameters (table 4) for assessing the profitability of the different land uses in our target villages.

Table 4: Economic parameters

Price data	2011
Exchange rate	LAK 8,000 = 1 USD
Wage rate	25,000 LAK in Sakok, 23,000 LAK in Samsoom or 3 USD/man.day
Discount rate	5%
Timeframe	30-years

The net present value (NPV) was calculated for all land use types. All NPVs are positive and return to labor values are higher than the actual wage rate in the study area (Table 5).

Table 5. Net Present Value and return to labor of land uses in Sakok and Samsoom villages

Land use	**Net Present Value (USD/ha)**		**Return to labor (USD/man.day)**	
Village	***Sakok***	***Samsoom***	***Sakok***	***Samsoom***
Paddy rice	3015	-	3.9	-
Upland rice	638	556	3.8	3.6
Maize	706	941	4.3	4.0
Cassava	-	282	-	3.9
Production forest	240	256	6.3	3.8

As expected, paddy is the most profitable land use followed by maize, upland rice and cassava. This result is consistent with the perceived values assigned to the different land use types by local villagers during focus group discussions. The return to labour of the different land use systems are relatively similar with higher value for maize. This explains why maize expansion is related to the extension of 'maize roads' on the hillsides. Mechanization of the transportation of a heavy maize harvest from field to farm is increasing a lot the return to labour for this land use type. The return to labour for swidden rice has decreased in the recent years with the shortening of the fallow period shifting the interest of traditional shifting cultivators towards paddy fields. The area under paddy has increased tremendously in Sakok village in the recent years (e.g. 10 more ha terraced in 2011) and Samsoom villagers expressed their interest in terracing paddy fields close to their former settlement if they can build a road to reach that site more easily, that is avoid walking half day to reach the site which would reduce the productivity gain of producing paddy rice.

Cassava represents the less profitable and efficient land use in both study villages. Villagers continue producing marginally to feed the pigs for household consumption and as safety net in case of rice shortage (in Samsoom especially).

Production forests present low economic performances in term of NPV from NTFP collection but fairly high return to labour, especially in Sakok village which is close to the national protected area and therefore enjoy better quality forests.

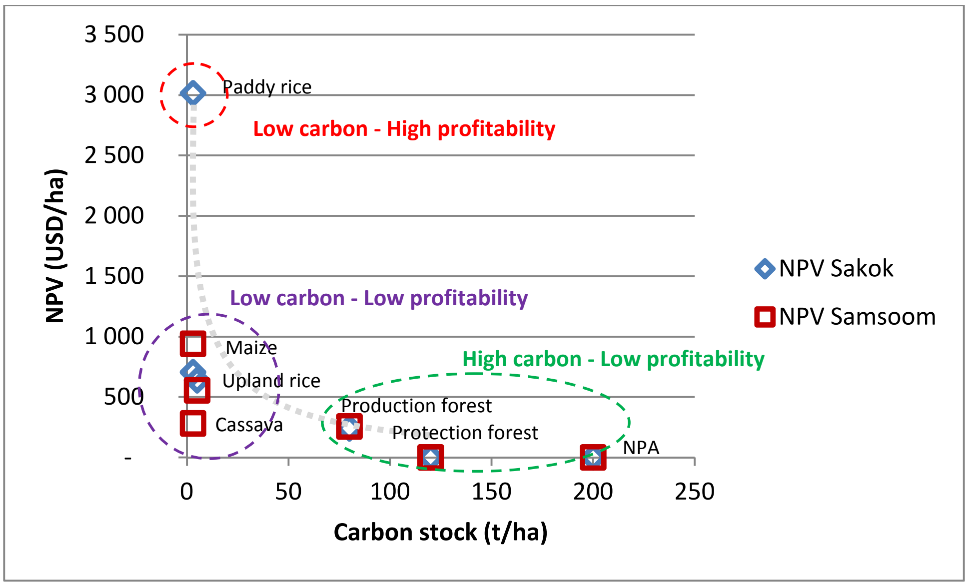
2.3. Trade-off curves of different land-use systems

Time-averaged carbon stocks for the different land uses were estimated on the basis of the literature available and carbon estimations used by a GIZ project for their REDD+ feasibility study in the target area as indicated in table 6 (CliPAD Project, 2012). As shown by the trade-offs curve below (Figure 5), most existing land use systems in the study villages fall into “low carbon stock-high profitability” and “low carbon stock-low profitability” clusters. Protection forests (and to a lower extent production forest) are included in a “high carbon stock-low profitability” cluster. In these conditions, supporting the reconstitution of biomass and carbon stocks in production forests and protecting larger tracks of forest represent attractive REDD+ policy priorities. In Sakok protected forests have certainly attained their limits as land use is already largely constrained by the presence of the national protected area. The only room fr maneuver would be enrichment of production forests. In Samsoom village there is certainly sufficient land available to expend the forest area under protection under a REDD+ project.

Table 6. Time averaged carbon stocks (above ground only) of land uses in Sakok and Samsoom villages

Land use	**Carbon stock (ton/ha)**
Paddy rice	3
Upland rice	5
Maize	3
Cassava	3
Village production forest	80
Village protection forest	120
Village conservation forest	120
National Protected Area	200

Figure 5. Trade-offs curve and clusters of land use systems in Sakok and Samsoom villages



3. *Livelihood typology and reliance on the different land use types*

3.1. Farming system and livelihoods options

Based on focus group discussions and individual household data collected through survey, village households were classified into 4 main types (Table 7) based on criteria set agreed by the villagers. Main criteria for household classification are:

- Housing index. This criterion aims to assess the housing conditions of local people. Permanent houses usually have walls made of concrete or wood and roofed with metal plaques or tiles. Temporary houses have wood or bamboo walls and roofed with straw or bamboo. Access to electricity is another indicator of housing quality. In our target villages electricity can be generated by water turbines using energy from streams or solar panel whenever a specific project has equipped some households. Connection to the electricity grid is planned for the end of 2012 in Sakok and 2014 in Samsoom.
- Economic status. Total household incomes from difference sources, including products for self consumption (LAK/household/year), and household assets in monetary value (LAK/household).
- Land. Land ownership is an important indicator of wealth in the area as subsistence agriculture is highly dependent on the land available in relation with labour force that defines household capacity to crop the land so that enough rice is produced to fulfil the family needs (land tenure and food security).
- Livestock husbandry. Raising large livestock (buffaloes and cattle) is considered as an important aspect of household differentiation. Livestock plays the role of living savings. Animals are sold for large investments (e.g. house building) and to cover costs of special events (e.g. birth, death, wedding)

<u>Table 7</u>: Household Topology in Sakok and Samsoom Villages

Type	Total land (ha/hh)	Total annual income (LAK/hh/year)	Total value of assets (LAK/hh)	Housing index (from 1 to 3)	Large livestock (head/hh)	Description
A	< 1	<1 mil.	<1 mil.	<1,50	<3	Poor
B	1 - 2	1 – 5 mil.	1 – 5 mil.	1,50 – 2,00	3 - 5	Middle
C	>2 - 3	>5 – 10 mil.	>5 – 10 mil.	>2,00 – 2,50	6 - 10	Well-off
D	>3	>10 mil.	>10 mil.	>2,50	>10	Most well-off

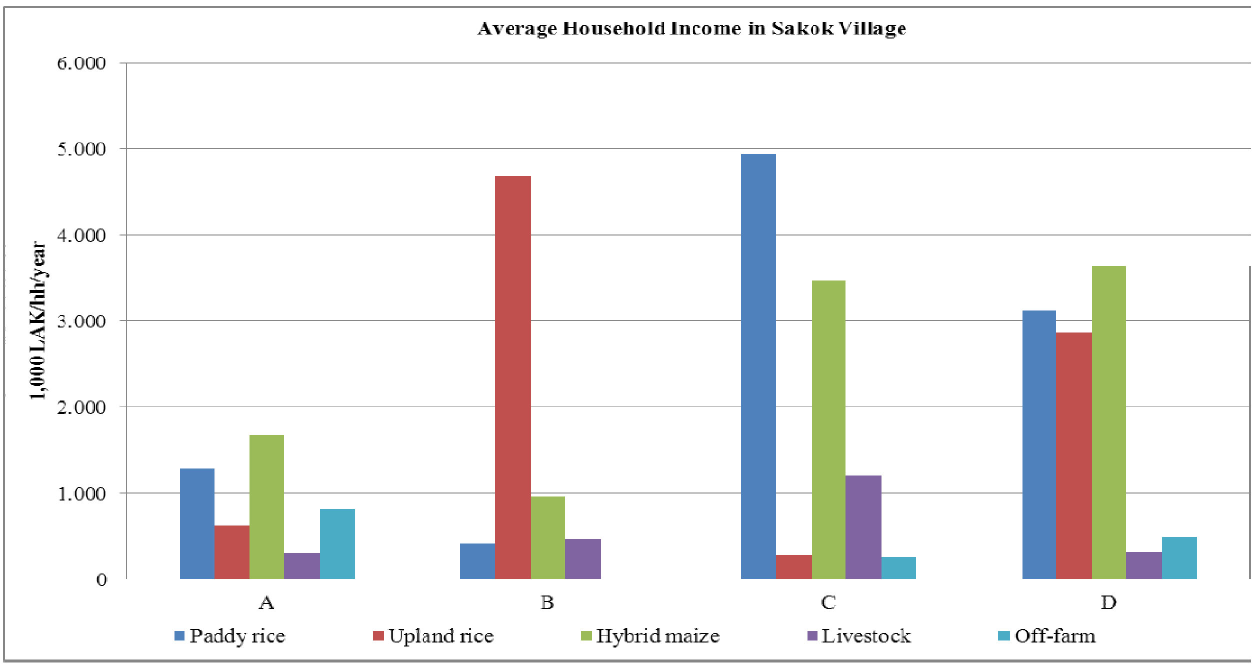
Sakok Village

Most households in the village are involved in swidden rice cultivation. Only five households have stopped practicing swidden cultivation. They buy rice to complement their paddy rice production so that they can cover their rice needs. Households usually sell livestock, collect NTFPs and work off-farm to generate cash income for purchasing additional rice to cover their household rice consumption.
According to local people during our group discussion, young households (new comers are not allowed in the core-zone of the NPA) will not have agricultural land for rice cultivation if they do not receive from their parents or relatives. Families that rely on swidden rice cultivation are expected to face greater difficulties in

the future due to land scarcity. Since local people in Sakok village have limited agricultural land, they try to compensate by raising large livestock such as buffaloes and cattle that roam freely in the swidden fallows and surrounding forests. There is no specific land delineated for livestock grazing and local people expect that livestock roaming will be restricted in the future which will require major changes in their livestock raising practices. Improved pasture systems and cut-and-carry foraging systems have been tested by the NPA staff in the area to avoid roaming domestic animals to penetrate the dense forests of the NPA.

Results from household survey indicate that income from off-farm activities of the poorest households (type A) is higher than income from the same source of other household types within the village (Figure 6). Lack of land, often due to recent installation (young couple with little paddy land given by their parents) is the main constraint and there is little prospect for these households that they can acquire new land as access to land is highly restricted in the core zone of the park. Maize cultivation provides additional income on intensively cropped upland fields. Type B are typical shifting cultivators relying primarily on upland rice cultivation for their livelihood. These households do not have much labour force left to enlarge their maize area or diversity productions. Type C are the lowlanders who concentrate on paddy rice production. As the production is not sufficient to cover their rice needs, these households traditionally practices shifting cultivation. But with the shortening fallow periods the labour demand for weeding is too high and competing with paddy rice calendar. These households have gradually turned their swidden field from rice to hybrid maize production. Type D households combined all income generating activities. Historically, these early settlers got access to the largest and most productive paddy fields so that they could cover they rice needs thanks to additional upland rice cultivation. The surpluses were invested hybrid maize cultivation and then diversify towards ff-farm activities such as trading or services (e.g. transportation with truck owned by the household) and livestock husbandry. The kind of off-farm activities that Type A and D farmers are practicing are therefore very different. Type A households are daily wage earners while Type D households are small investors.

Figure 6: Sources of household incomes of people in Sakok Village



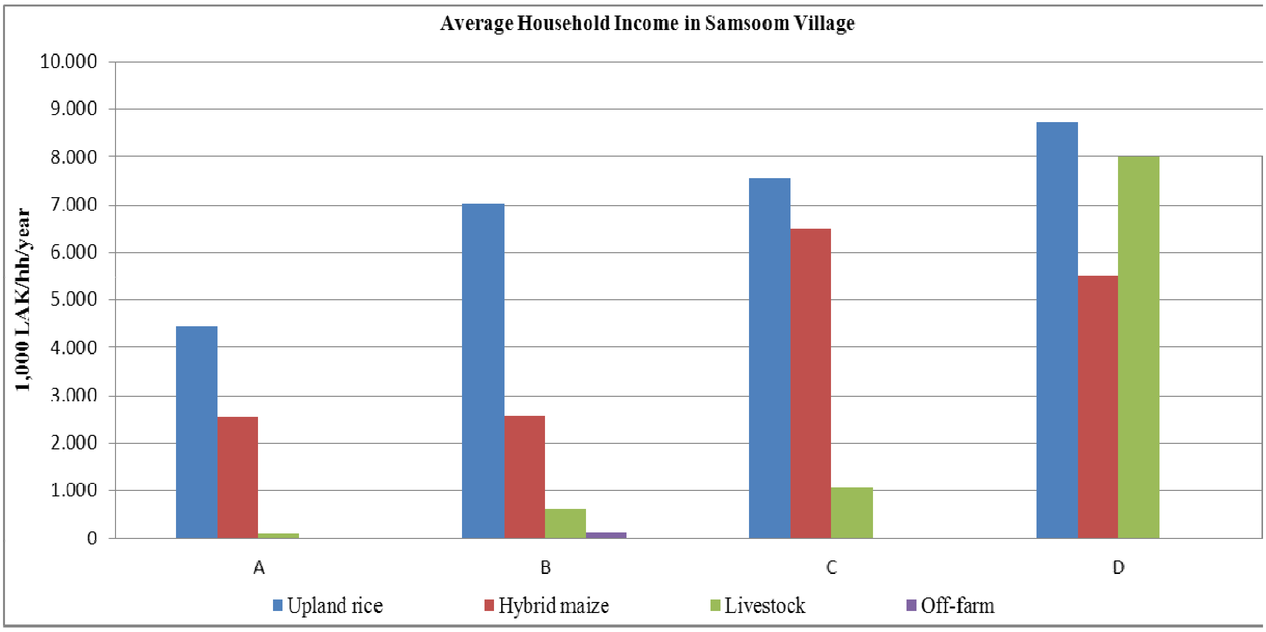
Samsoom Village

The swidden system is managed collectively. The village agricultural land dedicated to swidden is divided into 7 large fields where all households cultivate together a given year. In principle, each household own one plot in each of the 7 fields that are cropped successively. Every year, representatives from all households meet to decide which field they will open this year or if they will crop the same field as the previous year in the case soil fertility would be still high. Then, the whole community goes to the selected field to negotiate the location and size of individual plots for each household. Most household crop again the plot they had cropped 7 years before but in case they would have less labour force than before or more mouths to feed the area can be adjusted and negotiated with other households. The whole community stays in the field until a general agreement is reached (sometimes more than one day). The village leader plays a key role in the negotiation. He supposed to accommodate the needs of all families and satisfy all households. This traditional swidden management relies on collective land tenure and mutual help. It also help spreading the risks of damage from climatic incidents or pests over larger areas (i.e. avoid destruction of single isolated plots in the case of individually managed swidden).

Local people in Samsoom village do not usually fence their swidden fields nor maize cultivation areas because they raise their livestock (buffaloes and cattle) in specific grassland areas. They manage to bring their livestock far from the field which is cropped a given year. The main grazing area is located close to their former Samsoom settlement, about half day walk from the current village settlement. To avoid leaving their animal roam freely, local people have organized a fixed schedule for each household to look after the village livestock herd. Once a month, each household has to send someone to tend the animals. As many households still have temporary houses in their former village, they also raise small livestock suck as pig and poultry at the same location. They raise only small numbers of pig and poultry close to the village for their daily consumption or in case they would need money urgently.

Beside swidden rice cultivation livestock raising is the main livelihood option for households in group “D” or well-off households in Samsoom village (Figure 7). The household type gain annual income from livestock about 8,000,000 LAK per household. On the other hand, the poorest household gain little incomes from livestock (about 100,000 LAK/household/year). This is because the poorest households are mostly new couples who do not have enough labour for diversify activities. Since local people in Sasoom rely on upland swidden rice cultivation, all household types in the village consider that upland rice is an important option for their livelihood. Similar to upland rice, all household types in Samsoom village gain their household cash income hybrid maize production. Unlike in Sakok village, aside well-off households in Samsoom not involve in off-farm activities as they spend much labour for livestock raising beside upland rice and hybrid maize cultivation.

Figure 7: Sources of household incomes of people in Sakok Village



3.2. Landholdings

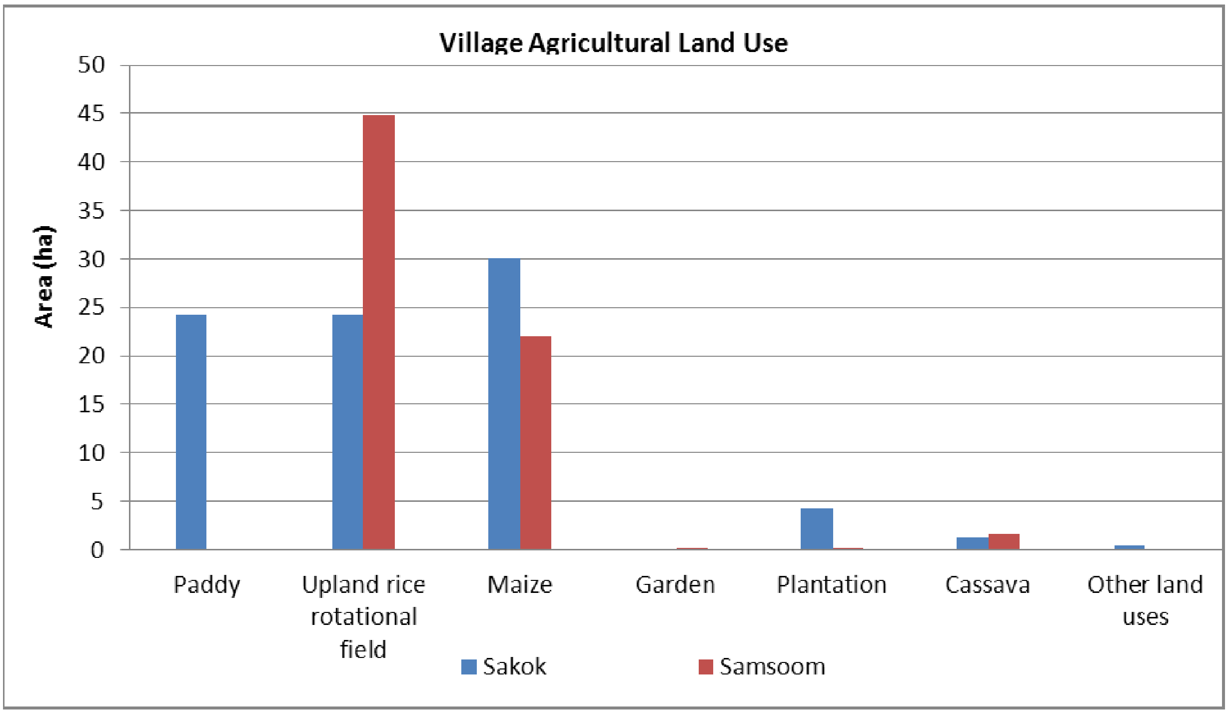
Referring to our household survey data, agricultural land use in Sakok is larger than those in Samsoom village (Table 8). This is because there are more households in Sakok than in Samsoom and local people in Sakok village hold also paddy rice field, while there is not paddy rice field in Samsoom village. Since local people in Samsoom do not have paddy rice fields, they have almost double swidden rice area compared to Sakok village. On the other hand, area cropped with hybrid maize in Sakok is larger than in Samsoom village (Figure 8). Land scarcity and better market accessibility in Sakok lead local people in more intensive cropping system, which they get higher return on land.

Table 8: Land tenure in Sakok and Samsoom Village

Land tenure	Sakok	Samsoom
Total (ha)	136	124

Source: Household survey, 2011.

Figure 8: Land tenure by agricultural land use type, in Sakok and Samsoom Villages



3.3. Poverty and equity

We used the gini index to assess income inequalities in the two target villages. Gini coefficient ranges from 0 (equal income distribution) to 1 (total concentration of income). The Gini index is 0.52 in Sakok and 0.56 in Samsoom.

Appendix 4: I-REDD+ WP5 Country Report: Vietnam

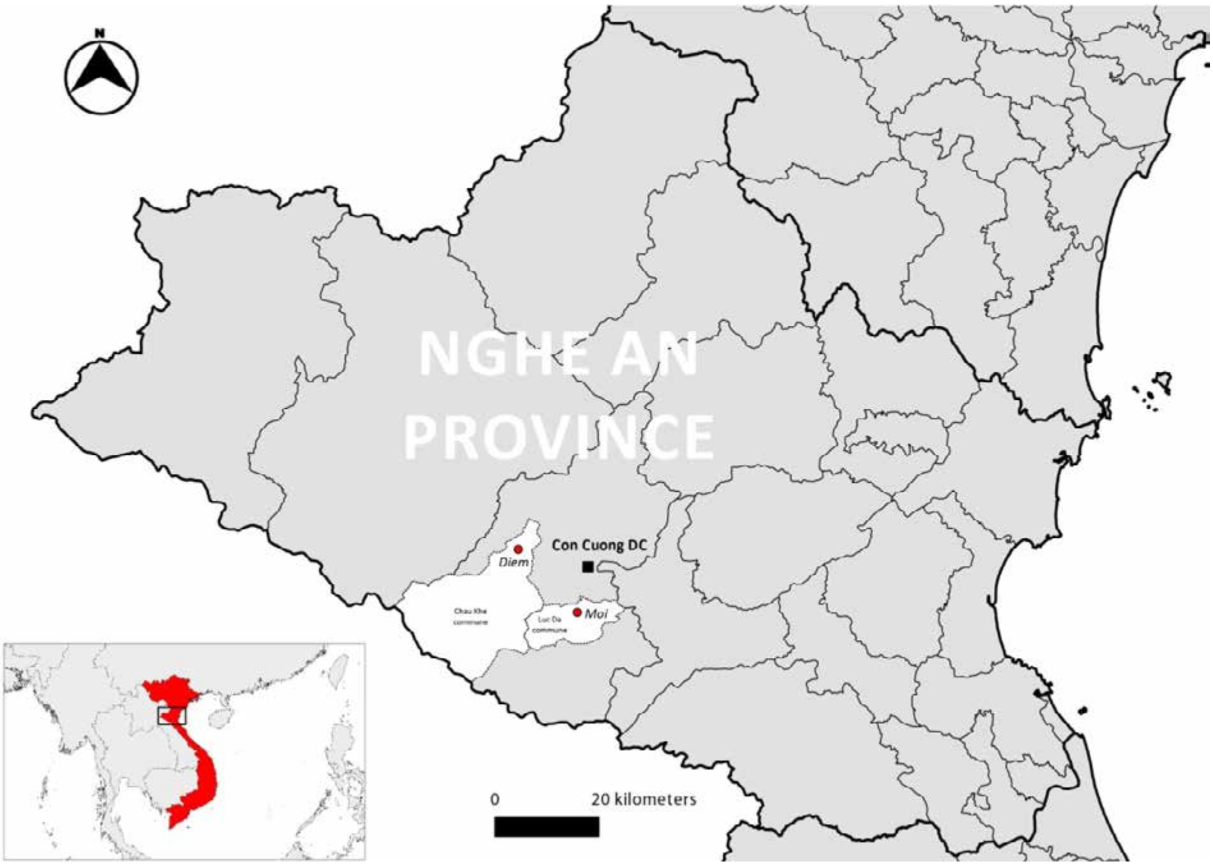
by Guillaume Lestrelin and Nguyen Dinh Tien

1. *Context*

1.1. Location and history of the study villages

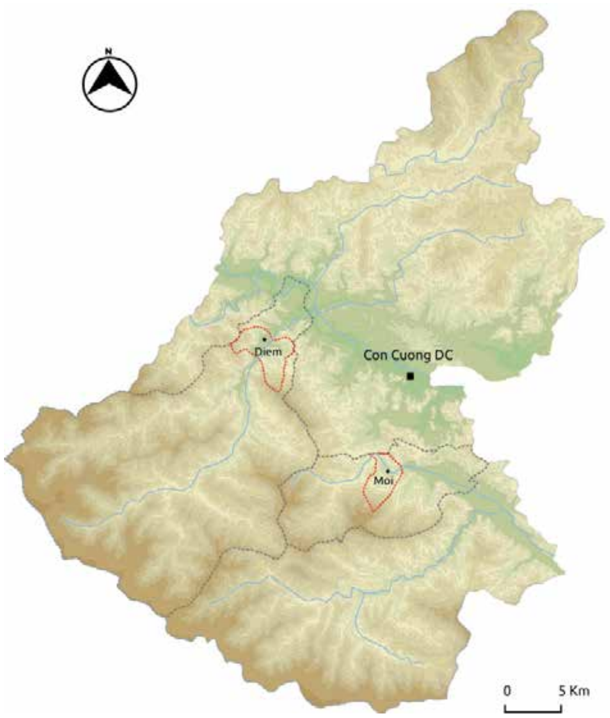
The study sites in Vietnam are Diem and Moi villages of Chau Khe and Luc Da communes, in the southern part of Con Cuong district, Nghe An province (Figure 1). The altitudes of Diem and Moi are approximately 80 and 120 metres respectively but parts of their land rise above 900 meters (Diem) and 1200 meters (Moi) with fairly steep slopes (Figure 2). The villages are characterised by a tropical monsoon climate with two main seasons: a hot season from April to October with temperatures reaching up to 430C and a winter season where temperatures can drop to 50C in January.

<u>Figure 1</u>. Location of the study sites



Located in Chau Khe commune, Diem village was established in the late 19th century by 15 men from the Kinh ethnic group. These men came from Do Luong district (about 60 km away from Diem), looking for land and better livelihood opportunities. The newcomers established families with original residents from the Thai ethnic group. Although the villagers were initially dispersed on a large area, they gathered (spontaneously) in the same site around 1989. The current population of Diem is 682 individuals (145 households), all from Thai ethnicity (Table 1). About 75% households in Diem village are officially classified as poor and about 50% of the villagers are illiterate. Nowadays, there is much more in-migration than out-migration in the village. The large dirt road passing through Diem village and linking Chau Khe commune (15 minutes drive) to the border with Laos was built in 1956. The village was connected to the electric grid in 2000.

Figure 2. Topographic characteristics of the study sites



Moi village is under Luc Da commune administration, which is about 45 minutes drive from Con Cuong district center to the south. The village is bordering the buffer zone of Pu Mat National Park. Moi is less accessible than Diem due to poor road condition (heavily degraded dirt road). The village is composed by households from Thai (mainly), Dan Lai and Kinh ethnicity. The village was established in its current site more than 200 years ago. Some households from the Thai ethnic group came first, others joined gradually before an epidemic disease pushed the community to leave the area. Ten years after the event, some 15 households (former residents) came back. Around 1920, the village burned entirely and was rebuilt by the villagers. The village was populated by 45 households at that time. In 1993, 4 households came from another district to join relatives in the village. Currently, the administrative village is divided into 2 hamlets: the main site is populated by 123 households while the other site, located 2 kilometers away, is populated by about 30 households (relatives in each hamlet). 97% of the village households are officially classified as poor and about 50% of the villagers are illiterate. The recent years have been characterized by significant out-migration driven by limited local economic opportunities.

Table 1. General population characteristics in Diem and Moi villages

		Diem	Moi
Population	Households	145	153
	Individuals	682	711
Gender distribution	Women	49%	48%
	Men	51%	52%
Age distribution	<15y	22%	35%
	15-60y	74%	57%
	>60y	4%	8%

1.2. Socioeconomic and land-use characteristics of the research sites

Diem village benefits of more opportunities for economic development than Moi due to better road infrastructure and better access to markets (significant traffic between the commune and the border with Laos). Although we could not access official data on the total surface area of the village, participatory mapping exercises conducted with villagers suggest that the current village area would be around 1,500 hectares. Diem villagers have stopped shifting cultivation after implementation of forest land allocation (FLA) programme in 1999. Before that period, the main land uses were composed by shifting cultivation of upland rice, cassava and taros. Villagers were generally self-sufficient. At that time, villagers engaged in animal husbandry, including cattle, pig and poultry, for subsistence only. The FLA was undertaken through land use zoning, definition of land use plans and allocation of land ("green books" or temporary land use titles) to villagers. Since 2001, "green books" on paddy and rainfed areas are progressively replaced by "red books" (permanent land use titles). Villagers' rights on forest land remain under a temporary basis. The villagers do not pay taxes on land. Plantations of bamboo and acacia trees have rapidly developed in the village since 2000s and are now mainly used for commercial purposes. Over the past decade, maize (hybrid variety) and cassava have become the main crops planted in rainfed areas while paddy rice is grown along to the river banks. According to the villagers, crops play a very important role for food security (mainly for consumption) and cattle (cows and buffaloes) represent the main source of cash incomes. Cattle are raised through a free roaming system in secondary forests and bush lands. Since 2006, off-farm activities have also rapidly developed. Off-farm job opportunities have in part been promoted by officials from the commune after advertizing from entrepreneurs on job offers (e.g. garment, industrial plantations). The first grocery shop was opened in 2003 and there is now a total of 8 shops in the village.

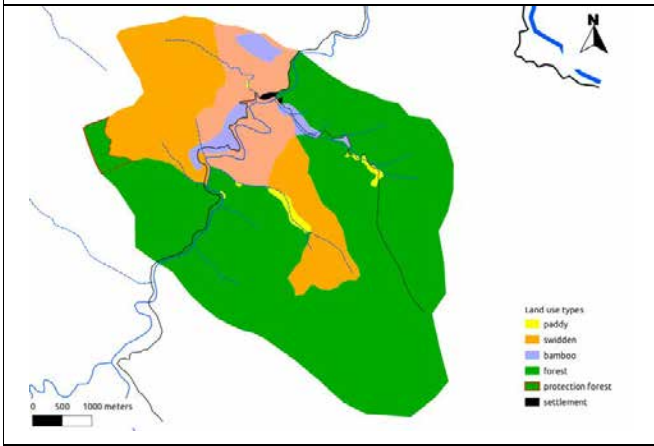
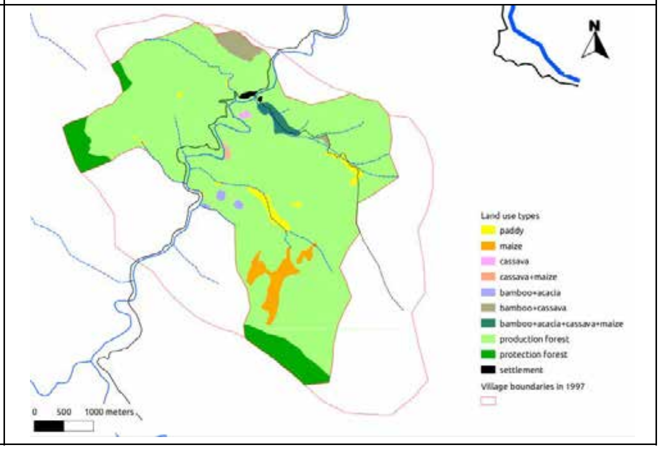
As compared to Diem, Moi has less opportunity for economic development due to poor road conditions and limited market accessibility. Officially, the total area of Moi village is estimated at 917.29 hectares. As in Diem village, shifting cultivation of rice stopped with the implementation of the FLA programme in 1999. Through this process, almost all upland fields and secondary forestlands were allocated to the 97 households residing in the village at that time. The households did not receive equal shares of forest lands because land allocation was based on geographical features (e.g. summits, ridges and valleys) with no clear estimation of the surface areas. Villagers have "red books" for both paddy and forest land. Paddy land was allocated to individual households in 1993 when each village household received 200 square meters of land. Official data shows that there is now a total of 21 hectares of paddy land in the village. According to the village leader, paddy rice is the main subsistence crop in the village. However, the production is generally not sufficient (in average, Moi households have to face 6 to 8 month rice shortages). As a result, crops like cassava and hybrid maize generally serve of substitutes for rice, not as feed for livestock. Villagers rely very strongly on government-subsidized rice (10-13 kg of rice per villager in 2012), a support that they have received since the land allocation was done in 1999. Bamboo and acacia plantations have also developed in the village but, in contrast with Diem, these engage only a small share of the population (2 households for acacia and 5 households for bamboo). Limited road access and traffic result in very low incomes from bamboo and acacia plantations. The two households who have planted acacia have not been able to sell yet (no buyers) and bamboo is sold at a very cheap price (5,000 VND per stem, against 10,000 VND in Diem). Villagers do not have a lot of cattle (1 per household in average) and concentrate generally on buffalos. Forest products (mainly bamboo shoots, medicinal plants and timber) represent an important source of incomes for the villagers. Off-farm activities represent also a key source of cash incomes and about 50 villagers are working off-farm outside the village (mainly as construction and forestry workers for local companies but also for rubber plantations near Ho Chi Minh City). Households with members working off-farm have generally better incomes than others but the ability of households to engage in off-farm is strongly linked to family labor availability.

1.3. Land use trajectories and drivers

Alongside locally-specific opportunities for land development (e.g. good market access favouring bamboo and acacia production in Diem), village boundary delineation and the FLA programme have played critical roles in shaping local land use trajectories. By allocating land to individual households, the government hoped to restrict villagers' access to hillsides and forested areas and, thereby, put an end to slash-and-burn shifting cultivation practices. In both study villages, land was allocated by the district authorities in 1999. Land allocation has been accompanied by a forest protection policy that limits the forest use rights of villagers to non-timber forest products (NTFPs) and firewood collection. These restrictions and, in particular, the ban on the clearing and burning of forest land had critical impacts on local livelihoods – as large amounts of land with good soils and high agricultural potential became classified as forest land.

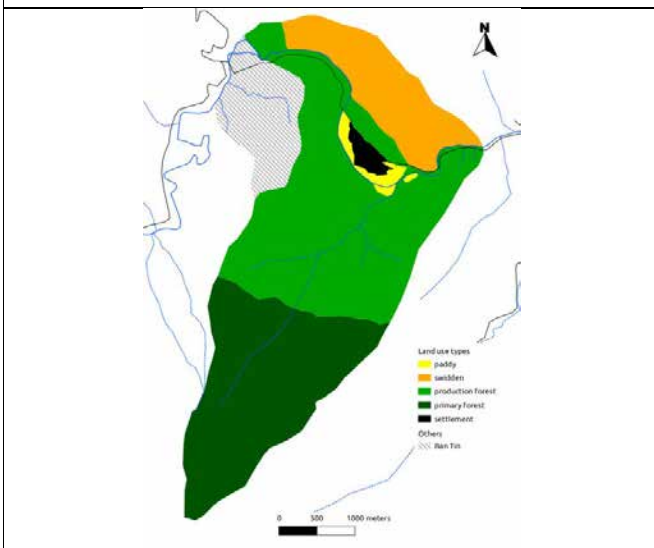
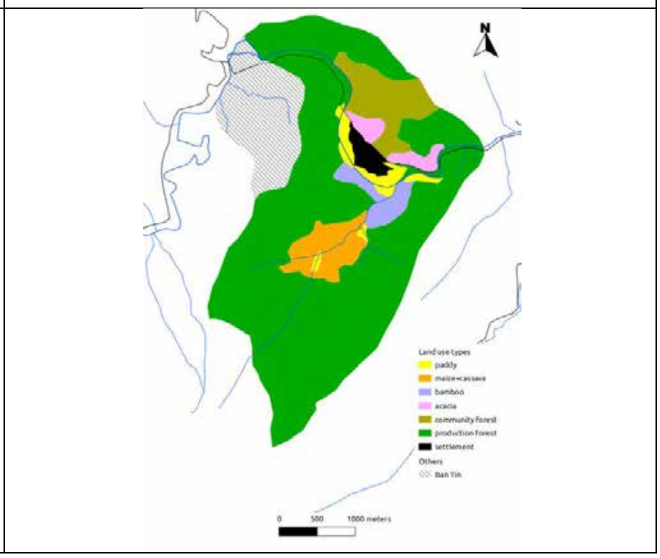
Another important driver for land use change in Diem had been the redefinition of the village boundaries. After the 1999 FLA, large tracts of land located in peripheral areas (some of them used for shifting cultivation) were redistributed to neighboring villages (Figure 3). Thus, the total surface area of Diem was reduced from 2,680 to 1,550 hectares. Most of the land previously used for shifting cultivation was allocated to individual households as forest land ("production forest") and banned from agricultural activities. Some of the existing forests at the periphery of the village were classified as protected forests. In recent years, making up for the lost agricultural opportunities, the villagers have developed a number of bamboo and acacia plantations and have terraced additional paddy land.

<u>Figure 3</u>. Participatory maps of land use change in Diem village (1998-2012)

1998	2012
	

Moi village has also undergone a redefinition of its boundaries when around 200 hectares of primary forest in the southern part of the village were classified as buffer zone for the Pu Mat National Park and put under the authority of the Con Cuong district forestry company (Figure 4). Thus, the total village area was reduced from around 1,230 to less than 1,000 hectares (917.29 ha according to official data). As the land reallocated was not used for agriculture, this process limited mainly the opportunities for villagers to collect forest products. At the same time however, the FLA programme resulted in the conversion of all shifting cultivation areas into individual forestland and a large plot of community forest (both land uses banned from agricultural activities). Thus, as in Diem village, some villagers engaged in bamboo and acacia plantation. Some plots of maize and cassava were also established and new paddy land was terraced in order to make up for the conversion of shifting cultivation areas.

<u>Figure 4</u>. Participatory maps of land use change in Moi village (1998-2012)

1998	2012
	

2. Profitability of land use systems

2.1. List and description of land use types

The following (7) land uses were selected for our research[3]:

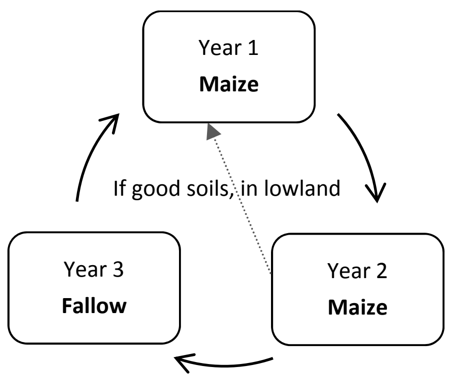
Paddy rice

This land use constitutes the primary source for subsistence production of rice in both study villages. While it has replaced dry (upland) rice cultivation as a main source for rice only recently in Diem (after the construction of an irrigation system in the 1990s), paddy rice production has been practiced for several decades in Moi (located in a flatland area with very good access to a large stream for irrigation). In both villages, hybrid varieties of paddy rice are grown two seasons per year, with chemical fertilization but no mechanization: the plots are ploughed with buffalos and terracing is done by hand (labor exchange). As illustrated by the results of the "pebble game", in both study villages, paddy rice is valued by villagers as a main source of subsistence and a key element for the maintenance of traditional and cultural values (Figure 9 and Figure 10).

Maize

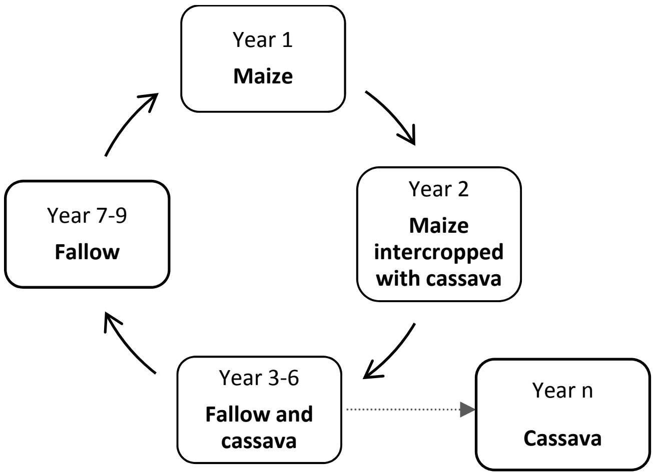
Hybrid maize is cultivated in both study villages. The crop is grown in rainfed conditions, with chemical inputs (fertilizers and pesticides) and through different land use systems applied by farmers on a case by case basis, in function of the location and level of fertility of their plots (Figure 5 and Figure 6). In Diem, it is generally cultivated 3 years in a row before a 2-year fallow. Cassava can also be intercropped in this system before conversion of the plot into perennial plantation of cassava. In Moi, maize is generally grown in low- or flatland 2 seasons per year.

Figure 5. Rotation upland rice – maize (Diem)



[3] While upland rice used to be a common land use, it was abandoned in Moi after forestland allocation in 1999 and is rapidly disappearing in Diem (only 3 households interviewed). For that reason, it is not included in the analysis.

Figure 6. Rotation upland rice – maize + intercropped with, or leading to, cassava (Diem)

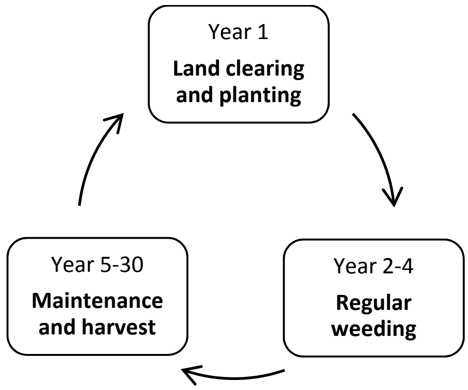


Similar to paddy rice, maize is valued as an important source of subsistence (pig feed) and an element of tradition and culture. To a lesser extent, it also contributes to household incomes.

Cassava
At the exception of intercropping with maize, bamboo and acacia by Diem villagers, cassava is generally grown as a monoculture, with no inputs and no mechanization. Cropping systems are different in the two study villages. In Moi, cassava is planted in year 1, harvested during the two following years and replanted in year 4. The cycle would be applied for an indefinite number of years. In Diem, cassava cultivation involves a fallow period: the crop is planted in year 1, harvested from year 3 to 5 and left in fallow during three years before being replanted. Perceptions of cassava are different in the two study villages: as a cash crop, it constitutes an important source of incomes in Diem while, as a substitute for rice during shortage periods, it contributes more significantly to subsistence in Moi.

Bamboo
Bamboo constitutes one of the main sources of cash incomes in the two study villages. The development of this crop was promoted and supported between 2000 and 2004 by the authorities of Pu Mat protected area (i.e. provision of seedlings and technical training). Bamboo is generally grown on the slopes (in replacement of upland rice and maize) without chemical inputs. Cassava can be intercropped during the first 4 years of establishment of the bamboo plantation.

Figure 7. Bamboo cropping cycle

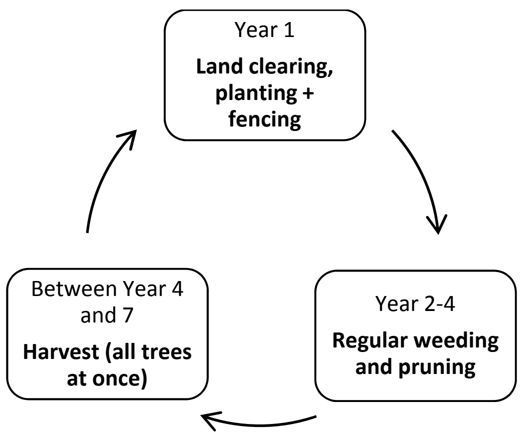


The results of the pebble game illustrate the key role of bamboo in the generation of cash incomes in the two study villages. More generally, bamboo is considered a highly valuable land use for both livelihoods (consumption of bamboo shoots, use of bamboo stems) and the environment (water regulation, soil conservation, climate regulation).

Acacia

Acacia constitutes one of the main sources of cash incomes in Diem and its development was supported by the authorities of Pu Mat protected area (i.e. provision of seedlings and technical training between 2000 and 2004). In contrast, only a few households are growing acacia in Moi as the village is less accessible and no buyers have shown interest for existing plantations so far. As for bamboo, acacia is grown on the slopes in replacement of upland rice and maize. The cropping cycle lasts around 7 years and requires chemical inputs (fertilizers and pesticides) during the first 2 years. When the trees are mature enough to be harvested, timber buyers pay for the standing trees and clear the plot. Villagers can then purchase new seedlings and replant (Figure 8). As for bamboo, acacia plantations are perceived by Diem villagers as a valuable land use providing a diversity of livelihood and environmental services, in particular income generation and soil conservation.

Figure 8. Acacia cropping cycle



Production (individual or collective) forest

Production forests are a key source for Non Timber Forest Products (NTFPs), including bamboo shoots and stems, firewood, medicinal plants and honey. These forests are constituted by fallows older than 5 year that have been allocated to villagers ("green books" in the two villages) or communities (collective forest in Moi) and that are left unused because of labor shortage, distance and/or government pressure for reforestation. The collective production forest in Moi is also managed as an area for extensive livestock grazing. Production forests are among the most valued land uses in the two study villages. With protected forests, they provide a wide range of livelihood and environmental services: i.e. contributing to the regulation of water and climate, soil and biodiversity conservation, provision of medicinal plants as well as subsistence and commercial NTFPs.

Protected forest

Part of Diem village land (78 hectares) is classified as protected forest and constitutes a buffer zone for the Pu Mat national park. Diem villagers collect bamboo shoots and medicinal plants in this area. With authorization from the park authorities, villagers can log inside the buffer zone for non commercial purposes (e.g. house construction). 8 households have land inside the protected forest and are compensated by the Pu Mat park (100,000 VND/ha/year). As for production forests, protected forests are highly valued in both study villages for the wide range of livelihood and environmental services they provide.

<u>Figure 9</u>. Perceived value of land use types in Diem
(pebble game results - men and women aggregated, 1800 pebbles)

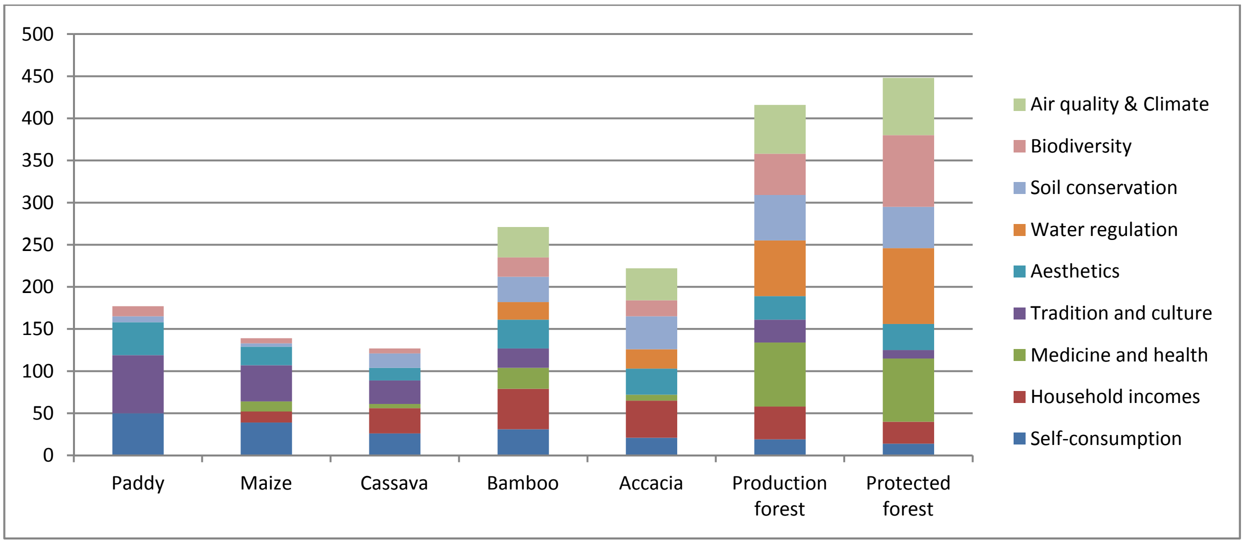
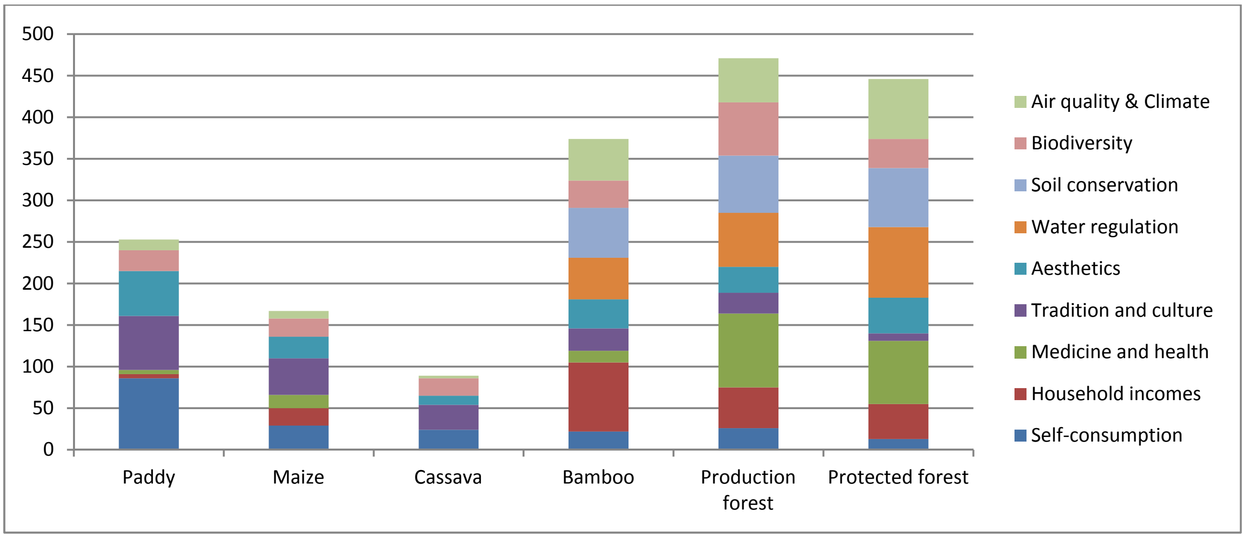


Figure 10. Perceived value of land use types in Moi (pebble game results - men and women aggregated, 1800 pebbles)



2.2. Opportunity costs of land use

The following economic parameters were used for assessing the profitability of the different land uses:

Price data	2011
Exchange rate	VND 20,000 = 1 USD
Wage rate	60,000 VND or 3 USD/man.day
Discount rate	5%
Timeframe	30-year

The results of the opportunity costs assessment show that all land uses analysed can be considered profitable, as all NPVs are positive and return to labour values are higher than the actual wage rate in the study area. Bamboo plantations represent a very profitable and efficient land use, with high NPV and return to labour values. Indeed, the crop requires limited labour and investment for establishment and maintenance and allows for significant income once the plantation is in production. These characteristics contrast with acacia plantations which, while providing significant incomes after 7 years, require also significant investment in capital and labour during the establishment period. The economic profitability of acacia appears also strongly dependent on the accessibility of the production area. As mentioned by villagers and illustrated by differences in NPV and return to labour between the two study villages, the poor accessibility of Moi represents an important limit to the development of profitable acacia plantations. Furthermore, in order to offset some of the establishment costs of acacia, villagers in Diem often intercrop cassava during the first years of the plantation, allowing for a higher NPV but decreasing significantly the return to labour due to high labour requirements for harvesting cassava. As a matter of fact, when grown as a monoculture, cassava represents the less profitable and efficient land use in both study villages. Production forests present slightly better economic performances which suggest that their conversion to cassava plantations would represent an economic aberration. More “traditional” land uses like paddy rice and maize, finally, tend to prove valuable options in terms of return to land but necessitate significant labour throughout the cropping cycle, which translates in fairly low return to labour.

Table 2. Net Present Value and return to labor of land uses in Diem and Moi villages

Land use	**Net Present Value (USD/ha)**		**Return to labour (USD/day)**	
Village	***Diem***	***Moi***	***Diem***	***Moi***
Paddy rice	3 980	2 390	4.5	3.7
Maize (3 y cropping – 2 y fallow)	2 130	-	4.6	-
Maize (2 seasons, 2 y cropping – 1 y fallow)	-	1 630	-	4.3
Cassava	590	830	3.6	3.5
Bamboo	2 890	2 890	15.2	15.2
Acacia	700	580	13.3	8.5
Production forest	630	560	4.3	4.4
Protection forest	310	-	5	-
Bamboo (cassava first 4 years)	4 040	-	9.8	-
Acacia (cassava first 2 years)	1 270	-	7.9	-

2.3. Trade-offs curve of different land-use systems

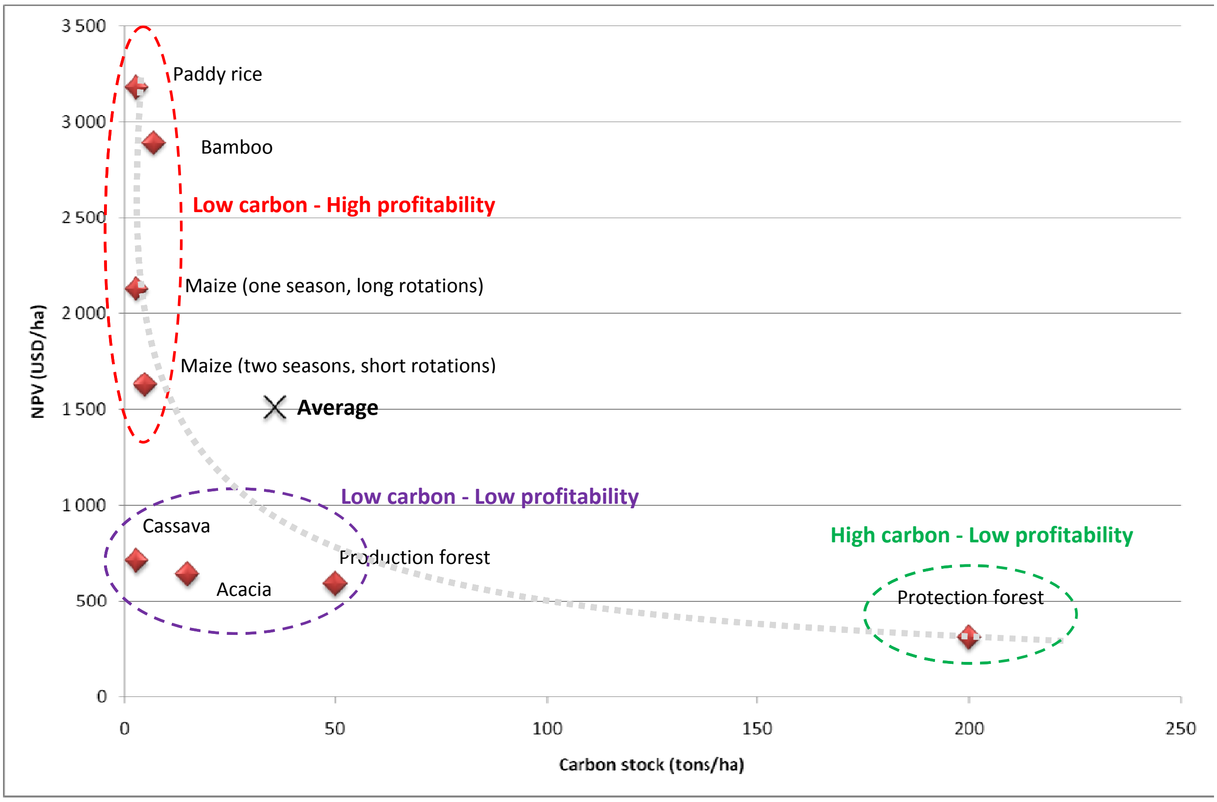
Time-averaged carbon stocks for the different land uses were estimated on the basis of previous research in the study area (Christiansen 2006)[4]. As shown by the trade-offs curve below (Figure 11), most existing land use systems in the study villages fall into "low carbon stock-high profits" and "low carbon stock-low profits" clusters. Protection forest constitutes the only component of a "high carbon stock-low profits" cluster. Focusing on the low profitability land uses, supporting the reconstitution of biomass and carbon stocks in production forests and converting cassava and acacia plantations (i.e. two low carbon – low profit land uses) into more profitable land uses could represent attractive REDD+ policy priorities.

Table 3. Time averaged carbon stocks of land uses in Diem and Moi villages

Land use	**Carbon stock (ton/ha)**
Paddy rice	3
Maize (3 y cropping – 2 y fallow)	5
Maize (2 seasons, 2 y cropping – 1 y fallow)	3
Cassava	3
Bamboo	7
Acacia	15
Production forest	50
Protection forest	200

[4] Christiansen L. 2006. *Land Use Management Projects under the CDM: A Village Case Study of Global and Local Potentials and Consequences*. MSc thesis, Institute of Geography, University of Copenhagen.

Figure 11. Trade-offs curve and clusters of land use systems in Diem and Moi villages



3. *Livelihood typology and reliance on the different land use types*

3.1. Farming systems and livelihood options

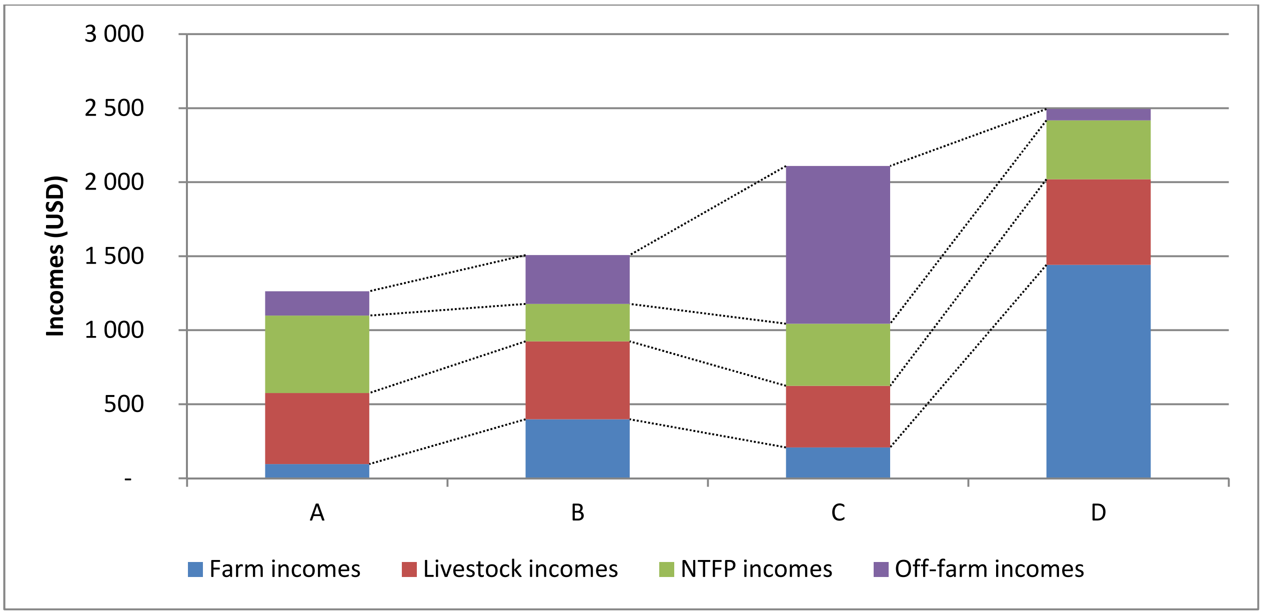
Building on focus group data (wealth ranking and typology exercises) and data from questionnaire surveys, a typology was developed to characterize the socioeconomic situation and livelihood strategies of the households studied. In contrast with other I-REDD+ sites characterized by an important socioeconomic diversity across study villages (e.g. China), relatively similar typologies could be used in Diem and Moi villages. Starting with individual situations re. access to land (paddy in particular), engagement in off-farm activities, bamboo and acacia plantations, livestock farming and reliance on NTFP collection, four different types of households could be identified:

- Type A: These households have a very limited access to land and, in particular, no or very small paddy land. Off-farm employment is not a major source of incomes. Rather they rely strongly on NTFP collection for both subsistence and cash incomes.
- Type B (Diem): These households have fairly diversified livelihoods: small paddy areas, no or few young plantations (not yet productive) and some off-farm activities.
- Type B (Moi): These households have a very limited access to land and, in particular, no or very small paddy land. They are are largely involved into off-farm activities.

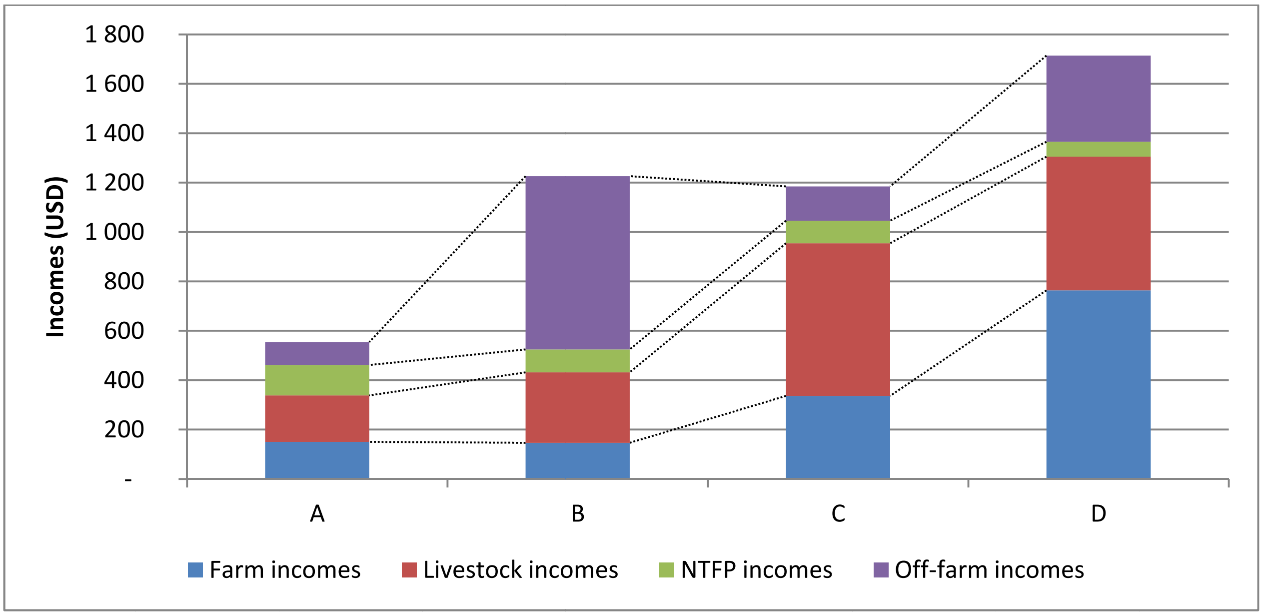
- Type C (Diem): The households benefit of relatively important paddy areas, have no or very small bamboo and acacia plantations and are largely involved into off-farm activities.
- Type C (Moi): The households benefit of relatively important paddy areas, have no or very small bamboo and acacia plantations but have important livestock herds (cattle and buffalos). They do not engage significantly in off-farm work.
- Type D: These households are the largest landowners, strongly engaged in on-farm activities. They have large areas of paddy (rice self-sufficient), important livestock herds (cattle and buffalos) and they have put important surface areas under bamboo and/or acacia plantations.

As shown in Figure 12 and Figure 13, these four household types correspond also to four levels of incomes, with type A generating the lowest annual incomes and type D the highest.

Figure 12. Average annual incomes per source and per household type in Diem

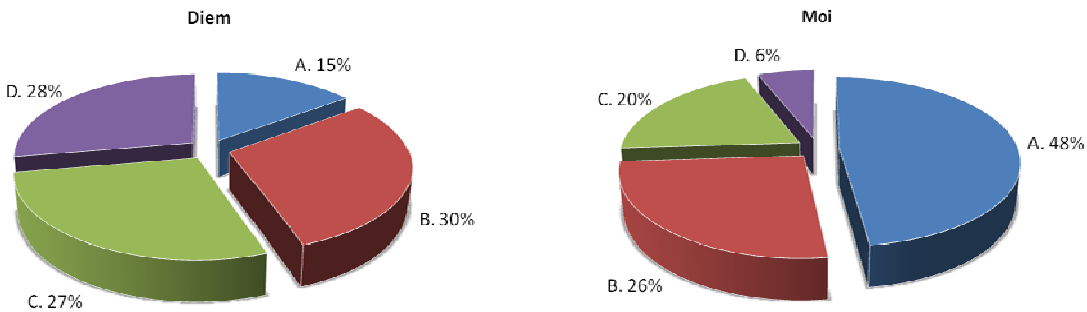


<u>Figure 13</u>. Average annual incomes per source and per household type in Moi



As pointed out by interviewees, type A households would be constituted either by new settlers or by new families (that could not inherit land from their parents) – both of which established in the study villages after the allocation of production forests to individual households. These households have only limited social networks and poor access to information on off-farm employment opportunities. As a result, they rely strongly on NTFP collection for subsistence and cash income generation. Type B (Diem) and type C (Moi) households correspond to“average” farming households yet with some degree of economic diversification linked to the emergence of off-farm employment opportunities (mainly off-farm wage labour) after the mid-2000s. In contrast, type C (Diem) and type B (Moi) represent emerging classes of household (most probably former types B in Diem and A in Moi) that have followed the mid-2000s wave and largely shifted toward an economy based on off-farm activities. Finally, type D in both study villages correspond to households that have built on their significant land resources to accumulate (capitalization in livestock), develop large plantations of bamboo and acacia and, for some, develop off-farm activities as collectors/middlemen. The distribution of the different household types in the two study villages is presented in Figure 14.

<u>Figure 14</u>. Distribution of the different household types in the study villages.



3.2. Landholdings

As indicated in the description of the typology above, type A and type B (Moi) households are characterized by a very limited access to land when compared with other household types (Figure 15 and Figure 16). They have no or very small paddy and plantation areas. In Moi village however, these households have a relatively good access to production forests, with an average tenure (individual "green books") of 1.5 to 2 hectares. While type B households in Diem village have some land used for plantation of bamboo and acacia, the largest surface areas planted remain with type D households. More generally, the latter are by far the largest landowners with an average land tenure of 9.3 and 10 hectares in Diem and Moi respectively.

Figure 15. Average household land tenure and tenure per land uses in Diem

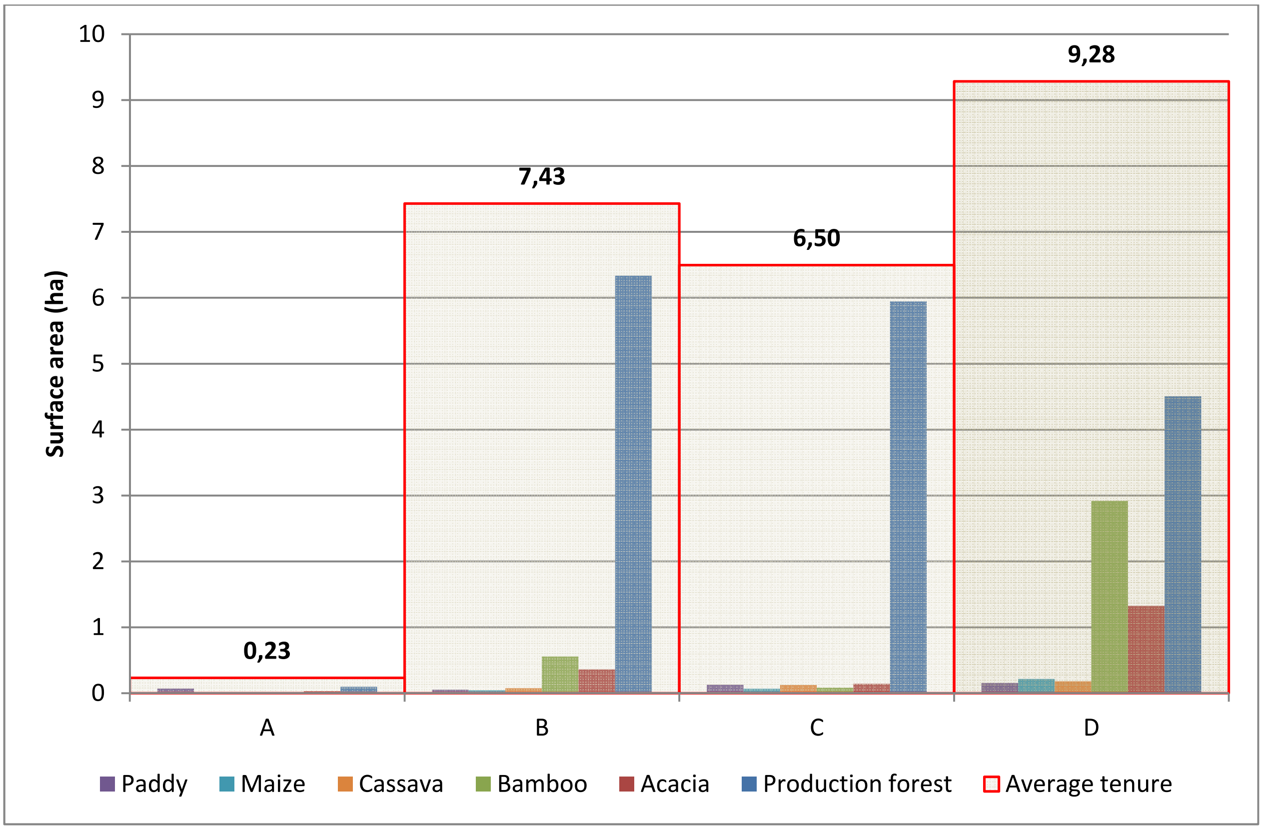
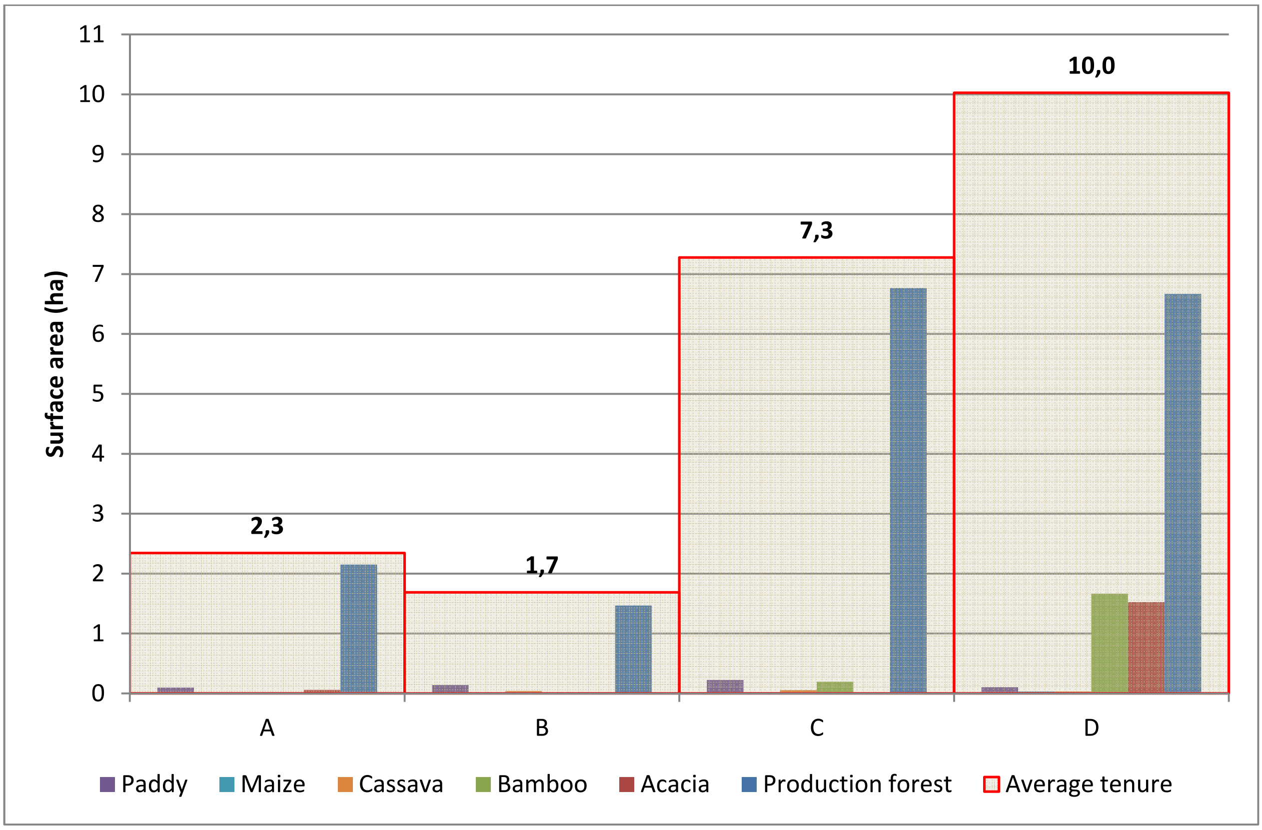


Figure 16. Average household land tenure and tenure per land uses in Moi



3.3. Poverty and equity

Focus groups were organized in both study villages aimed at identifying indicators of poverty and socioeconomic differentiation commonly used by local populations. The results of these focus groups showed significant concordance between the perceptions of interviewees in Diem and Moi villages (Table 4). According to these indicators, a poor household would be:

- living in a temporary house,
- have no transportation means or mechanical agricultural equipment,
- have no or very small plantations (bamboo and acacia) and livestock herds (cattle and buffalos),
- limited family labor and access to off-farm employment, with subsistence as main objective (as opposed to accumulation).

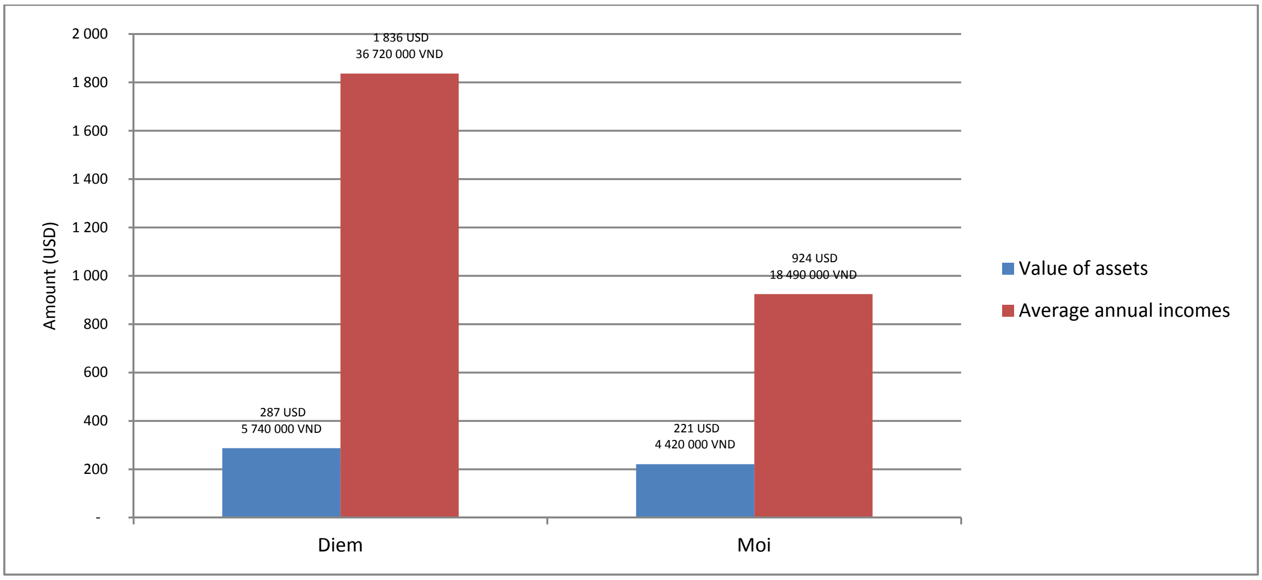
As described above, some of these indicators were then used to build a household/livelihood typology in the two study villages.

Table 4. Qualitative poverty indicators identified by local populations

Category	**Moi**	**Diem**
Housing & Assets	Temporary housing (bamboo, thatch), absence of transportation means and mechanical equipment	
Land tenure	No differences in land tenure (government policy)	
Land uses	No plantations	Plantations < 10% of total tenure
Off-farm	Lack of access to off-farm opportunities	Off-farm incomes used only for subsistence
Labour	Limited family labor	
Livestock	No cows and buffalos	No or very few (subsidized) cows and buffalos

Data on household incomes and assets (production/transportation tools and housing equipment) collected through questionnaire survey were also used as quantitative indicators to assess poverty. At the household level, the results show similar levels of capitalization in the two study villages but much lower annual incomes in Moi than in Diem (Figure 17). The difference between the two study villages appears also clearly when looking at incomes per capita per day. With 1 USD/capita in average, Diem village is just at the limit of the international poverty standards while Moi is clearly below the poverty line with 0.6 USD/capita.

Figure 17. Households' average assets and annual incomes in the two study villages



In order to analyse the equity of incomes (per capita), a decomposition analysis was applied using the Gini coefficient that ranges from 0% (equal distribution of income) to 100% (total concentration of income). Again, clear differences emerge between the two study villages with a relatively balanced income distribution in Diem (*Gini = 37%*) and marked income inequalities in Moi (*Gini = 65%*).