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WORKING PAPER

# Using Forests to Enhance Resilience to Climate Change:

## THE CASE OF SMALLHOLDER AGRICULTURE IN SAVANNAKHET PROVINCE IN LAO PDR

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## Acknowledgments

This study on the role of forests in enhancing landscape resilience to climate change is part of a larger multicountry project designed and led by Diji Chandrasekharan Behr (Sr. Natural Resources Specialist, World Bank) on the role of forests for enhancing resilience to climate change (www.profor.info/node/2032). The larger project aims to capture the role of forests in enhancing the other sectors' resilience to climate change. It examines how sustainable management of forests can contribute to strengthening social and physical resilience of systems in other sectors. Using forest and tree management as part of a broader strategy to enhance resilience to climate change could provide a low-cost option for local landscapes while also helping to balance production, livelihood, adaptation, and mitigation goals.

The field data collection and preparation of the case study was conducted by the Center for International Forestry Research in collaboration with two national partners: the Forestry Research Center within the National Agricultural and Forestry Research Institute and the Department of Forestry. The following individuals were responsible for the work in-country on this case study: Aaron J. M. Russell[1] (team leader), Joost Foppes,[2] Sounthone Ketphanh,[3] Somphachanh Vongphasouvanh,[3] Serge Rafanoharana,[2] Bruno Locatelli,[4] Laykham Sihanat,[5] Phayvone Phonephanom,[5] Khonesavanh Louangsouvanh,[5] Nellie Anyango Nakondiege,[5] and Somcham Nanthavong.[5] The report submitted by the field team was revised by Diji Chandrasekharan Behr with inputs from Maria Ana de Rijk (Consultant, World Bank). The report was formally reviewed by Lao PDR Country Management Unit, and comments were provided by Sergiy Zorya (Senior Economist) and Kanta Kumari (Lead Environmental Specialist). The report was finalized by Diji Chandrasekharan Behr.

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# Executive Summary

The 2014 Intergovernmental Panel on Climate Change report observes that the mean annual temperature increased over the past century in Southeast Asia. The projections are that average changes in mean annual temperature will exceed 3oC in Southeast Asia. The increased occurrence of floods, droughts, and changes in the seasonal rainfall pattern are expected to have negative impacts on crop yields, food security, and livelihoods in vulnerable areas. In parts of Southeast Asia, climate change could exacerbate existing levels of poverty because of the changes in rice crop production and increases in food prices and the cost of living. The consequence of climate change, however, will vary across countries in the region.

In the Lao People's Democratic Republic (PDR), climate change is expected to modify the frequency, intensity, and location of existing climate hazards, straining existing common coping mechanisms—especially for people living in rural and remote places. With regards to chronic changes, efforts to enhance resilience could result in rewards. Ecosystem-based adaptation (EBA) measures can be suitable for enhancing resilience to climate change, especially for sectors that rely on natural systems. EBA uses biodiversity and ecosystem services as part of a general adaptation strategy to help people adapt to the adverse effects of climate change. This concept is based on the idea that ecosystem services reduce the vulnerability of society to climate change across sectors and subsectors. These measures can complement other adaptation measures and often generate co-benefits for the implementing households.

Poor farmers are the most vulnerable group in Lao society. This report, one in a series of studies, explores how forests can reduce the vulnerability of this segment of the Lao PDR population.[6] It looks at how forests, through the provision of ecosystem services, contribute to adaptation of other sectors to climate change and aid the adaptation of poor smallholder agriculture households in the southern part of Lao PDR. The objective is to bring evidence to discussions among decision makers in government and development partner organizations about the linkages between agriculture and forests in the context of climate change (that is, about the role of forests in enhancing the resilience of an agricultural subsector) and to examine the implications for development and enhancing resilience to climate change in Lao PDR.

## Country context

Lao PDR experienced steady economic growth of 6.5 percent per year on average between 1990 and 2009, following the introduction of market-oriented reforms beginning in 1986. A big part of the past and current development gains are from foreign direct investment. Concessions and leases play a significant role in the Lao PDR economy. Agricultural concessions are the second highest type of demand and are primarily granted to foreign investors. A large number of these concessions have been granted in the south of Lao PDR, in Savannakhet Province. The issuance of concessions has unintentionally changed the access of poor agricultural and forest-dependent households to forests and to land for paddy. This in turn, can undermine the resilience strategy of these households.

6. For more information on the set of case studies, please visit www.profor.info/node/2032.

# Study area and approach

The study focuses on Savannakhet Province, which is considered to be the hottest and driest province of the country. Savannakhet is rich in natural resources, including agricultural land, forests, rivers, mineral deposits, and biodiversity. Located along a major economic development corridor connecting with markets in Vietnam and Thailand, it is also a province with a significant number of concessions.

A disproportionately high amount of dry dipterocarp forests (DDFs) (roughly 50 percent or 607,000 ha) is found in Savannakhet. Due to slow growth rates and the trees' stunted appearance, limited research and conservation efforts have focused on DDFs. Consequently, their value is poorly understood. Decision makers who are not aware of their value in terms of ecosystem services see these as degraded forests with limited value. The lack of awareness has resulted in decisions to allocate land for certain uses without considering the full value of the resource and the cost of degrading DDFs.

The study applies an integrated socioecological systems approach to analyze the impacts of different land and forest policy decisions on both local livelihood resilience and the supply of ecosystem services. This includes a climate and land use change model and livelihood vulnerability analysis. The data are collected from three groups of villages—a village with no commodity concessions (Participatory Sustainable Forest Management (PSFM) village) and two villages with different types of concessions (sugarcane and eucalyptus). The study also includes climate change and land use modeling to examine how the two interact.

# Impact of climate change and land use change on small agricultural households

Using the mean projections of four global climate models based on four main emission scenarios, the models forecast an increase in temperature in central Savannakhet by 2030 and 2080. While there are uncertainties regarding precipitation, the models raise the possibility of transition from a rainy season that involves five months of rainfall exceeding 250mm/month to a shorter, three- to four-month period, which would be certain to have impacts on all ecological and agricultural systems. One of the expected impacts of such climate change is either stable or increasing net primary productivity by 2030 and by 2080.

When the climate change models are integrated with land use change models, the outcome is different. The combined models predict that land use change in Lao PDR will reduce any expected gains in net primary productivity from the climate change scenarios over the next 20–50 years. Land use change both increases the exposure of poor small agricultural households to climate change and increases their sensitivity. The surveyed households in the PSFM village were the most economically and financially sensitive, yet they also had the most adaptive capacity because of their access to forestland for livestock grazing and to augment household nutrition and incomes through consumption and sale of non-timber forest products (NTFPs). In contrast, the sugarcane and eucalyptus villages had lower, though still notable, "levels" of financial and economic sensitivity. They, however, did not have the same level of adaptive capacity due to their diminished access to forestland and their low levels of income compared with expenditures.

One reason for the level of sensitivity and adaptive capacity is that livestock resources are a key part of small, poor agricultural households' resilience strategy. Livestock raised in DDFs are a key source of resilience for local farmers, compensating for the risks of rainfed rice farming on drought-prone shallow soils. The conversion of forests or reduced access to them decreases the feasibility of maintaining livestock resources for this purpose.

The key findings on the consequences of land use change in the studied areas include:

- Loss of forestland reduces livestock resources, which are a key source of resilience;
- DDF ecosystem services represent critical and sustainable resources that are used by all income groups, not only by the poor;
- Communities believe that DDFs regulate the supply of water to drinking wells and paddy fields and protect their land from erosion, although this is not substantiated by adequate research to quantify the values;
- Conversion of communal forestland to concessions increases land conflicts;
- The poor DDF soils limit the success of forest conversions to plantations;
- The conversion of forests without consideration of the full ecosystem value may result in "maladaptations" to climate change, as it can undermine existing resilience strategies and result in irreversible change in the landscape.

One option for assisting poor households is to offer alternative resilience strategies. The expenditure and income patterns of these households, however, suggest they would require significant public financial and technical support to adopt other strategies. Furthermore, the benefits that households in the studied areas derive from concessions in and around their villages rarely compensate for the benefits they would derive from access to land and DDFs.

## Recommendations

Policy makers and decision makers in Lao PDR wanting to ensure that economic growth does not occur at the expense of the adaptive capacity of marginalized and poor agricultural households or natural assets should consider undertaking the following:

- Investing in better understanding of the values of DDF ecosystem services and incorporating these in all decision making and planning around the conversion of DDF land; national partners should also explore ways to include measurable values into land use planning processes;
- Facilitating EBA adaptation strategies for poor smallholder agricultural households in coordination with more conventional measures to enhance resilience; this could minimize the loss of natural assets and promote the sustainable and participatory management of these resources;
- Putting more effort into improving land use planning, designing drought-resilient livestock and agricultural systems;
- Enforcing existing regulations to duly compensate communities for the full value of the resource they have lost access, and ensuring that, prior to allocating concessions, the full value of the natural resource being converted is internalized in the economic analysis.

# List of Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| DAFO | District Agriculture and Forestry Office |
| DDF | Dryland Diptercarp Forest |
| DoF | Department of Forestry |
| EBA | ecosystem-based adaptation |
| FDI | foreign direct investment |
| FOMACOP | Forest Management and Conservation Program |
| GCM | global climate model |
| GDP | gross domestic product |
| GoL | government of the Lao PDR |
| IMAGE | Integrated Model to Assess the Global Environment |
| IPCC | Intergovernmental Panel on Climate Change |
| IUCN | International Union for Conservation of Nature |
| JFM | Lao-Swedish Joint Forest Management project |
| KIP | Lao currency |
| LPA | Lao Plantation Authority |
| LUC | land use change |
| NAPA | National Adaptation Programme of Action |
| NPP | net primary productivity |
| NTFP | non-timber forest product |
| PAFO | Province Agriculture and Forestry Office |
| PDR | (Lao) People's Democratic Republic |
| PRA | Participatory Rapid Appraisal |
| PROFOR | Program on Forests |
| PSFM | Participatory Sustainable Forest Management |
| TFESSD | Trust Fund for Program for Environmentally and Socially Sustainable Development |

## List of Non-English Terms

| | |
|---|---|
| chap chong din | land claimed by an individual for future expansion of paddy |
| khao peuak | non-milled rice |
| khao san | milled rice |
| mai chik | Shorea obtusa |
| mai koung | Dipterocarpus tuberculatus |
| mai hang | Shorea siamensis |
| mai sat | Dipterocarpus obtusifolius |

**Conversion Rate**

$ 1 = 8,000 KIP

All dollar amounts are U.S. dollars unless otherwise indicated.

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# 1. Introduction

The 2014 Intergovernmental Panel on Climate Change (IPCC) report provides substantial evidence on the anticipated impacts of climate change across geographies, ecosystems, and sectors. It points to the fact that even under the most stringent mitigation scenarios, temperatures will continue to increase. This is confirmed by modeling done in the World Bank reports entitled *Turning Down the Heat* (2012b, 2013), which underscores the point that with the current mitigation commitments and pledges fully implemented, there is a 20 percent likelihood of exceeding 4°C by 2100. These realities render adaptation strategies a necessity for long-term local and national planning.

In the context of Southeast Asia, the IPCC report observes that the mean annual temperature increased over the past century.[7] The increase at the country scale across Southeast Asia was at a rate of 0.14ºC to 0.2ºC per decade since 1960. In the same region, precipitation increased. The annual total wet-day rainfall increased by 22 mm per decade, and rainfall from extreme rain days has increased by 10 mm per decade. The 2007 IPCC report projected that mean changes in mean annual temperature will exceed 3ºC in Southeast Asia.

The increased occurrence of floods and droughts and the changes in the seasonal rainfall pattern are expected to result in negative impacts on crop yields, food security, and livelihoods in vulnerable areas.[8] In parts of Southeast Asia, climate change could exacerbate existing levels of poverty because of the changes in rice crop production and increases in food prices and cost of living. The consequences of climate change, however, will vary across countries in the region.[9]

In the Lao People's Democratic Republic (PDR), climate change is expected to modify the frequency, intensity, and location of existing climate hazards, straining existing common coping mechanisms—especially for people living in rural and remote places. There are constraints on what adaptation measures can do to reduce the impact of extreme events like typhoons. For more chronic changes, however, efforts to enhance resilience could result in rewards. Currently, climate change combined with the demographic and economic shifts in the country have made poor farmers the most vulnerable group in Lao society. The traditional resilience of the agricultural sector and food production in general has also diminished (UNDP 2010).

Ecosystem-based adaptation (EBA) measures are often considered a suitable approach for enhancing resilience to climate change, especially for sectors that rely on natural systems. EBA uses biodiversity and ecosystem services as part of a general adaptation strategy to help people adapt to the adverse effects of climate change. This concept is based on the idea that ecosystem services have the potential to reduce the vulnerability of society to climate change across sectors and subsectors. These measures can complement other adaptation measures and often generate co-benefits for the implementing households.

In many rural societies, households rely on more than one source of income. Often very poor and less poor households in rural areas may rely on forests, agricultural, livestock, fisheries, and other sources of income (Angelsen et al., 2014; Wunder et al., 2014). A study on poverty forest linkages in Lao PDR (Ingles et al., 2006) found that during times of food insecurity, households often rely on forests for non-timber forest products (NTFPs). After rice, wild forest foods dominate the daily diet. More than 450 edible species have been identified, and collectively they provide the bulk

7. See ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap24_FGDall.pdf.
8. Ibid., p. 23.
9. See ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap24_FGDall.pdf.

of animal protein, leafy green vegetables, and micronutrient intake of rural households (Clendon 2001; Foppes and Ketphanh 2000, 2004; McLennan 2004 as cited in Ingles et al., 2007). In remote upland areas, households commonly experience rice shortages for up to three months. NTFPs provide food security either through direct consumption or their barter or sale to obtain rice. The safety net function of NTFPs is extremely important during dire times when crops fail or are destroyed (Nanda and Nakao, 2003; Hansen and Jeppesen, 2004; Ingles et al. 2006; Wilson, 2007).

Evidence on the interlinkages between forests, agriculture, and food security raises possibilities of using forests as part of an EBA approach for enhancing climate resilience of small poor farmers in Lao PDR. Since 2009, work on forests and climate change has notably focused on mitigation. Studies have highlighted and reinforced the potential of the forest sector to reduce emissions of and sequester carbon. Forests play a significant role in mitigation in many countries. Forests and tree cover (in excess of 10 percent), however, can also service needs to adapt to climate change. Opportunities for integrated mitigation and adaptation responses are noted in the latest IPCC report, which discusses some land use practices that can provide both mitigation and adaptation benefits: agroforestry, ecosystem protection, reforestation, expansion of biofuel crops on abandoned and marginal agricultural lands, and forest restoration in the tropics. The report also notes that forests and their management can provide resilient livelihoods and reduce poverty while sequestering carbon.[10]

There is growing evidence from Africa, East Asia, Latin America, and South Asia regarding the role of forests in flood protection, in climate-proofing hydropower structures, in agriculture, and in other sectors (Russell et al. 2011). A 2012 review of National Adaptation Programmes of Action (NAPAs) found that several countries also feature the use of forests. Although forests offer ecosystem-based adaptation, forest based EBA is missing from most NAPAs (Pramova et al. 2012).

## 1.1 Using forests to enhance resilience of other sectors to climate change

Climate change is likely to affect populations differently, depending on their respective levels of vulnerability, characterized by McCarthy et al. (2001) as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

By providing various ecosystem services, forests can reduce the vulnerability of populations. The ecosystem services forests provide can be classified broadly into four groups (MA 2005):

- **supporting services** (such as water and nutrient cycling)
- **provisioning services** (such as forest foods, fuelwood)
- **regulating services** (such as water purification, erosion control)
- **cultural services** (such as esthetic or spiritual values)

Decision making in each ecosystem service type has the potential to assist in reducing vulnerability. Vulnerability to climate change has three components: exposure, sensitivity, and adaptive capacity (MA 2005). These have been defined by the IPCC (2007):

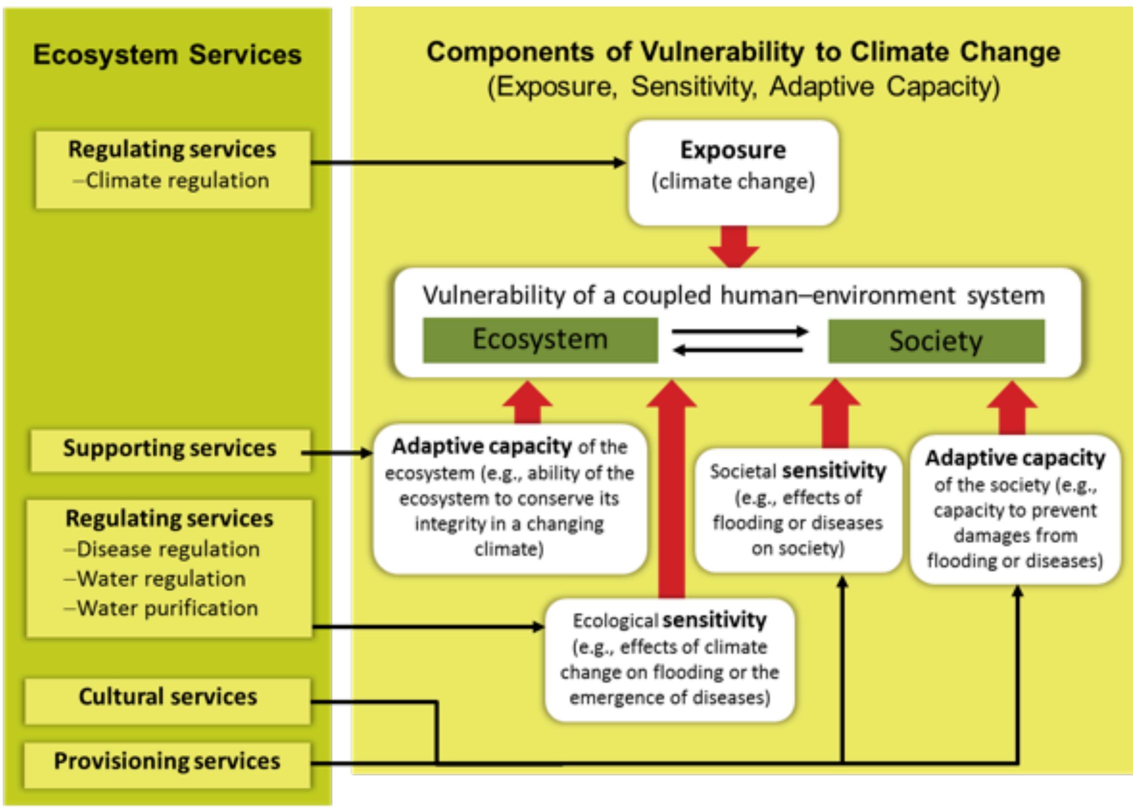
- **Exposure** is "the nature and degree to which a system is exposed to significant climate variations"

10. See ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap24_FGDall.pdf, p. 27.

- **Sensitivity** is "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli"
- **Adaptive capacity** is "the ability of a system to adjust to climate change, to moderate damages, to take advantage of opportunities or to cope with the consequences"

The contribution that each type of ecosystem service makes in influencing the exposure, sensitivity, and adaptive capacity of the socioecological system is illustrated in Figure 1 (Locatelli et al. 2008). The conceptual underpinnings of EBA and its applications in analyzing the contributions made by forests to resilience are described in Russell et al. (2011).

Figure 1: How ecosystem services relate to climate change: A conceptual framework




(Locatelli et al., 2008)

## 1.2 Scope of study

This report, one in a series of studies, explores how forests—through the provision of ecosystem services—contribute to other sectors' adaptation to climate change.[11] The study explores how forests can contribute to adaptation in poor smallholder agriculture households in the southern part of Lao PDR. The objective is twofold. The first is to bring evidence to discussions among decision makers in government and development partner organizations about the linkages between agriculture and forests in the context of climate change (that is, about the role of forests in enhancing the resilience of an agricultural subsector) and to examine the implications for development and enhancing resilience to climate change in Lao PDR. The second objective, which is tied to the broader set of studies, is to explore an approach of generating the needed evidence, given the challenges of getting access to data that would facilitate optimal decision making.

11. For more information on the set of case studies, see www.profor.info/node/2032.

The study focuses on the adaptation of smallholder farmers in Savannakhet Province, where dry dipterocarp forests (DDFs) are the dominant forest type. With an advantageous topography and climate, Savannakhet Province, also known as the breadbasket of Lao PDR, represents over a quarter of the total wet season rice paddy area under cultivation (619,950 ha) (LAC 2011). With the development of significant infrastructure supporting Savannakhet's integration with the economies of Thailand and Vietnam, there is growing pressure on policy makers to permit forest conversion for agricultural and other plantation concessions. In 2010, concerns were raised by senior officials in the Department of Forests (DoF) regarding the impact of the conversion of forests on the resource base and on households reliant on the resources to adapt to shocks, including climate change. Savannakhet thus offers the opportunity to assess the impact of anthropogenic and climate pressures and the potential to gauge the contribution of forests to enhancing the resilience of poor smallholder agricultural households.

# 2. Country Context

Lao PDR is a landlocked nation with a total land area of 23.68 million ha. It shares borders with China and Myanmar in the north, Vietnam in the east, Thailand in the west, and Cambodia in the south. Lao PDR's location in the fast-growing dynamic East Asia region positions it on a path for attracting foreign direct investment (FDI) to exploit its abundant natural resources and respond to the rapidly growing demand for electricity and natural resources in the region. Administratively, the country is divided into 16 provinces and 1 capital city (UNDP 2010).

The Mekong River forms a large part of the western boundary with Thailand and—together with some other rivers—presents a significant renewable water resource with a total basin area of 333.6 cubic km. Most of the countryside is rugged mountains covered by substantial forest, with some plains and plateaus. Approximately 70 percent of the country land area is classified as sloping hillsides and mountains. The lowest point is the Mekong River, at 70 m above sea level; the highest point is Phou Bia, at 2,817 m.

## 2.1 Demographic and macro context

During 1985–2005, the total population of Lao PDR grew an average of 3 percent per year, reaching 5.6 million in 2005 (MPI 2009). As of 2010, the annual population growth rate had declined to 2 percent per year (IUCN and NERI 2011), although any sustained decline in population growth rates is uncertain, given that the country has a very young population, with 50 percent below the age of 20 (NSC 2006). By 2010, the total population reached 6.25 million people. The most concentrated areas are towns along the Mekong River and main tributaries, including the capital city of Vientiane. Some 61 percent of the population live in rural areas (UNDESA, 2014).

Lao PDR experienced steady economic growth of 6.5 percent per year on average between 1990 and 2009, following the introduction of market-oriented reforms beginning in 1986. This is largely due to the demand for resources from its neighbors (China, Thailand, and Vietnam) and from the flow of foreign direct investment over the past decade. The increase in FDI has had positive impacts on poverty reduction in Lao PDR—the share of poverty was reduced by 30 percent in one decade, lifting one-eighth of the total population out of poverty. Per capita income has more than doubled since 1990, reaching $1,010 in 2010.

Future growth is projected to be driven largely by natural resources and the nontradable sectors. Sustainable forest and agricultural resource management is important when considering the gross domestic product (GDP) figures for 2008–10, when the sectors together contributed 30 percent. They also provided 75 percent of total employment. Domestic consumption of wood and non-timber forest products is valued at around $31.4 million, while exports are valued at around $74.4 million. In rural areas, it is estimated that NTFPs contribute between 30 and 70 percent of income for forest-dependent households (World Bank 2012a).

The Seventh National Socio-Economic Development Plan for 2011–15 of the government of Lao PDR (GoL), approved by the National Assembly in June 2011, specifies the government's intention to attract significant FDI. The government has also set a goal of increasing forest cover from 40 percent in 2010 to 70 percent by 2020. Rapid increase in FDI without suitable measures to prevent unintended consequences could undermine the government's objectives of increasing forest cover and sustainably alleviating poverty.

Despite the positive achievements from FDI, the poverty rate in Lao PDR remains higher than in neighboring countries. Furthermore, the current development path relies heavily on exploitation of resources, which has deepened inequality, especially among rural and urban areas. It also has resulted in decreased competitiveness of the non-resource sector. The potential for environmental degradation also raises questions regarding the feasibility of sustaining growth through exploitation of natural resources.

## 2.2 Trends in foreign investment in land

The demand for raw materials from Lao PDR's neighbors and the issuance of policies and regulations that facilitate investments in land and the exploitation of natural resource have resulted in a rapid increase in the area of land granted for development (Schönweger et al., 2012). The 2012 analysis of data on land concessions found that the number of land deals increased exponentially in the recent past, growing fiftyfold from 2000 to 2009. A conservative estimate of land deals (excluding mining explorations and hydropower projects) found 2,642 land leases and concessions, covering an area of 1.1 million ha (roughly 5 percent of the Lao PDR national territory). These deals do not include the contract farming arrangements that are commonly used in northern Lao PDR for many agriculture and tree plantation investments. These investments are found on forestlands and in more accessible areas.

Another similar estimate based on a concession inventory for the period of 2009–11 found that approximately 5 million ha of Lao PDR are leased or conceded to either domestic or foreign parties (approximately 21 percent of total national territory) and that 13 percent of all villages in Lao PDR have concessions inside them (Wellmann 2012). The second largest type of concession are agricultural concessions. In 2011, these covered approximately 330,000 ha. Given the country's topography, this suggests that a lot of arable land is used in these concessions. Furthermore, 15 percent of agricultural concessions are under domestic parties while 85 percent are managed by foreign entities (Wellmann 2012).

The majority of projects (roughly 62 percent) are under 5 ha in size, while 213 concessions are over 500 ha. The largest set of projects includes 89 percent of the total area under investment. Leases, on the other hand, are mostly under 5 ha. Mining is the most significant subsector, with 21 percent of total projects and 50 percent of total area under investment. Some 14 percent of projects are for agriculture and forestry. Domestic investors have 65 percent of all projects. These, however, are on average 10 times smaller than those involving foreign investors.

A spatial analysis of the data generated a conservative estimate that 1,900 villages have land under concession or lease. The analysis also found that these villages had an average poverty incidence of 27 percent, lower than the nationwide average estimate for villages of 34.7 percent. The literacy level in these villages is 7 percentage points higher than the national average of 73 percent. One-third of all concessions and leases granted occurred in lands categorized as forest; 23 percent of the investments are in land categorized as protection forests, while 45 percent have a land cover class of "unstocked forests" and 37 percent are on "forest" land.

Initial evidence suggests that FDI is resulting in the conversion of forest resources. A study by IUCN and NERI (2011) of the impacts of concessions in Savannakhet indicated a number of adverse impacts on livelihoods and ecosystem services, including decreased forest cover, forest degradation, conflicts over land, decreasing water availability and quality, decreased livestock production, loss of biodiversity and NTFPs, health problems, increased debt for farmers, and other social problems.

## 2.3 Climate change trends in Lao PDR

Floods and droughts are the major types of natural disasters for Lao PDR (WREA/UNDP/GEF 2009). Some of the key climate change trends suggest that over the last three decades the number of droughts and floods has increased. Most of the flooding occurs during the months of May to September, when monsoon rains accumulate in the upper Mekong river basin, resulting in river basin flooding. It is estimated that the south and central regions of the country, where about two-thirds of the population lives, face on average 1.5 serious floods or droughts every year (GFDRR 2014).

There has been a decrease in total rainfall between 1961 and 1998 and an average increase in temperature of 0.1–0.3°C per decade between 1951 and 2000. An increase in temperature along with a decrease of rainfall during the dry season can lead to longer and more-severe droughts. Rising temperatures increase the incidence and range of pests and, when combined with decreased rainfall and increased demand, higher temperatures can present new challenges related to water storage or water transfer mechanisms. The impact on agriculture production (in particular, rice) could in turn affect the economy of the country and food security. The impact of climate change and the increase in frequency and magnitude of weather events are expected to decrease food security in rural areas in particular (World Bank 2011).

Given the projection that the climate by the end of the century will be warmer, with longer dry seasons, that the number of wet days might increase across the Mekong River basin in 2080, and that the intensity and frequency of extreme events, especially flooding, is expected to increase, households in Lao PDR are considered to be highly vulnerable to natural disasters and shocks. If there are not measures to mitigate the impact of or adapt to the increased impacts of climate change, this could cause an increase in migration and displacement.

## 2.4 Characteristics of the agricultural sector

In Lao PDR, in 2009, 73 percent of the population live in rural areas and rely predominantly on rice cultivation for their livelihoods. Rice is central to household food security. For example, an average urban household depends on its own-grown rice for 50 percent of its rice consumption, and this increases to 94 percent for poor households (World Bank 2012a).[12] Furthermore, 20–30 percent of GDP in Lao PDR is generated through the agriculture sector (UNDP 2010). Nationally, 987,000 ha of land are under rice cultivation, with the largest proportion being wet-season lowland rice (714,000 ha) and smaller proportions in upland rice (215,000 ha) and dry-season rice cultivation (57,000 ha) (LAC 2011).

Despite the reliance on agriculture, the area under vegetables decreased between 2001 and 2006. The provinces with the largest area under vegetable cultivation in 2006 were Vientiane and Savannakhet.[13] A growing number of farmers are involved in the cultivation of commercial crops such as maize, cassava, rubber, and coffee, and they derive income from the sales of these commodities. Savannakhet is one of the provinces where there has been an increase in area under cultivation of the commercial crops. The crops meet both domestic and international demands. While seen as a promising means for reducing poverty among farmers, the actual impact is not as evident. Sales, especially for exports, are constrained by the lack of a grading system, standards, and certification, as well as by poor post-harvest handling and processing techniques.

The livestock sector is considered to have significant growth potential while also playing a very important role in the household economy of the rural poor. The contribution of livestock to agricultural GDP has increased steadily over the past 10 years in response to increasing prices and to export and domestic demand. The number of households rearing

12. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/02/16/000333037_20120216000625/Rendered/PDF/666920CAS0P1200Official0use0only090.pdf.
13. http://www.foodsecurityatlas.org/lao/country/availability/utilization/health-hygiene-and-care-practies#_ftnref1.

poultry increased from 15.3 million in 2002 to 18.5 million in 2004. Cattle, buffalo, and pig numbers have remained relatively static during this period. Pig numbers have declined in the north, and commercial enterprises have remained static at 0.2 million. Commercial production units are found on the periphery of urban Vientiane and Luang Prabang and other provincial capitals. These intensive units depend almost entirely on imported parent and growing stock for the livestock, feed, and veterinary supplies.[14]

Livestock play an important role in household income, accounting for 50 percent of annual household cash incomes in the uplands and about 30 percent across Lao PDR. Over 95 percent of all livestock is produced by smallholders.[15] The 2001 Participatory Poverty Assessment revealed that livestock are seen as an important means of poverty reduction.[16] According to the World Food Programme's Comprehensive Food Security and Vulnerability Analysis, livestock in Lao PDR are currently treated mainly as capital rather than as food for consumption (WFP 2008). For many ethnic minority groups, livestock are also important in a ritualistic capacity. They are a vital form of savings for rural households, especially where there is a constant risk of food shortages. In these regions, livestock provide an important source of food for many poor households. Nine out of 10 rural households report keeping livestock, with on average two cows/bullocks, one buffalo, one goal/sheep, 15 chickens, and one pig per household.

In Lao PDR, as in many developing countries, households use buffaloes and cows as a saving mechanism. When a disaster strikes or there is a medical emergency, families sell livestock. They act as a safety net and are often the most valuable asset in the household. Despite the national interest in improving the livestock sector, it is constrained by low productivity caused by limited technical support and feed supplies, low capital formation, poor links to market, and producers who are trapped in a system of low inputs and low outputs.

Agriculture in Lao PDR is mostly rainfed. In some parts of the country, more than 80 percent of households rely on rain water for rice cultivation. A high intensity of natural disasters can therefore increase the vulnerability of rural farmers because of the high degree of poverty in these areas. Climate change is expected to threaten and lead to losses in agricultural production (rice in particular), in turn affecting the economy and food security (World Bank 2011).

Evidence collected from the impact of the 2013 floods points to how vulnerable smallholder agricultural households are to climate events (WFP 2013). The summer monsoon season that year included a series of five major storm events that caused flooding in 12 out of 17 provinces (52 out 145 districts) across Lao PDR and affected approximately 395,000 people. Although flooding is not uncommon during that time of year, the flood events hit with varying levels of severity. The severe damage was caused to rice lands, and approximately 1,220 villages reported their agricultural land being affected to some extent. Nationally, roughly 50,250 ha of cultivated agricultural land (rice) was reported as lost for the 2013 harvest, and at the level of production the shortfall caused by the floods was approximately 7 percent of the total production in the affected areas. While the risk to national food security was considered low, poor farming households who lost their crop and livestock were considered at risk of becoming food-insecure (WFP 2013).

Widespread rural poverty limits the adaptive capacity and capability of individuals, farmers, and villagers to respond to natural disasters, flooding, and droughts. Poor farmers have limited opportunities to improve yields, increase income, or develop alternative, appropriate farming systems with greater in-built resilience to climate hazards. Furthermore, community-based organizations in support of agriculture, such as farmer-to-farmer agricultural extension services, are largely absent. Organized agricultural development at the farmer level is very limited. Resources are not shared among farmers. Technical capacity on farms, in villages, or *kum bans* is very basic (UNDP 2010).

14. Ibid.
15. Ibid.
16. Ibid.

Given the level of reliance of the rural poor on agriculture, the resilience of the smallholder agricultural sector to climate change becomes a central economic, environmental, social, and institutional issue for the development of the country and for combating poverty (UNDP 2010). In addition, women are key players in agriculture—81 percent of women contribute to agricultural export, and women traditionally manage the marketing of agricultural products and livestock production—it is also an issue for promoting equitable growth, which is inextricably linked to improving women's lives (UNDP 2010). Projects focused on rice and reducing the vulnerability of the crop to climate variability have focused on better quality of foundation seeds and seed multiplication by farmers and on increasing rice productivity. The results of these efforts have been mixed, including limited interest from farmers in buying improved seeds over paddy.

## 2.4.1 Potential resilience strategies in the agriculture sector

Resilience strategies considered for the agriculture sector in Lao PDR include:

- Mainstreaming climate change in agricultural policies, strategies, plans
- Changing cropping patterns—the variety of farming systems potentially available for each agroecological zone is not explored yet
- Enhancing conservation agriculture
- Developing and implementing new water-saving techniques
- Improving water management and flood control
- Conducting country-specific, sector-based research at the macro and village level
- Improving farmers' knowledge about proper use of weather information in carrying out agricultural activities to avoid risks of climate change
- Improving information on climate variability and seasonal climate forecasting to reduce production risk

For smallholder agriculture that is primarily dependent on rainfed rice crops, experiences from other countries point to the importance of improved rice varieties that use less water and that are more resistant to higher temperatures, salinity, droughts, and floods as a mechanism for buffering food security against climate risks and water shortages. There are also options for growing drought- and flood-resistant rice varieties for medium and longer duration or adopting the system of rice intensification. Getting such systems to work, however, requires establishing community seed banks to store traditional and resilient varieties of rice.

Enhancing resilience of smallholder farmers from variations in water availability can be useful for Lao PDR. This can be done with water management techniques, such as rainwater harvesting, water storage systems, and water conservation techniques. This approach has been successful in other countries when there is a need to manage water during times of drought. Another approach involves investing in small-scale low-cost irrigation systems in order to enable crop production when conditions are dry.

Many of the measures for enhancing resilience are effective but difficult for poor smallholder farming households to implement without adequate support. Moreover, these resilience measures do not take into account existing means by which farmers buffer themselves against shocks. For many farmers, livestock and forests are key for their resilience. For small farming households, forests are often the first line of defense against climate-change-induced risks because they are a source of fodder and other non-timber forest products. Changes in the forest landscape can therefore both directly and indirectly influence the resilience of the smallholder agriculture subsector (UNDP 2010).

### 2.4.2 Actual resilience strategies in the smallholder agriculture subsector

In practice, smallholder farmers keep livestock as a key means to build resilience to shocks. The benefits of raising livestock include a relatively assured market with generally stable prices, use of natural resources for fodder, and provision of manure for use in crop fields (Horne et al. 2000). Generally, livestock are raised using predominantly traditional methods, and output per animal is low. The animals are given free range, and they graze on natural grasslands, paddy fields, fallow lands, or in forests (FAO and MAF 2007). The main constraints to livestock production include availability of feed, particularly during dry seasons, and livestock disease, which tends to be more prevalent during the rainy season.

Constraints of feed and the potential for disease are often compounded by climate and land use change (LUC). Measures such as fencing or placing livestock in pens can help restore areas with degraded pastures. These measures have been piloted in parts of Lao PDR with success. The most productive systems, however, are those that build on existing local knowledge and use a mix of traditional practices. An example that Millar and Connell (2010) use is of mixing *Stylosanthes guianensis* with local forest taro leaves, cassava, and bran for pigs.

## 2.5 Forests in Lao PDR

Forty percent of Lao PDR is considered forest area (see Table 1). This is the highest percentage in Southeast Asia, but the total area of forest has declined dramatically—from 70 percent of the land area of 26.5 million ha in 1940, to 49 percent in 1982, and to 40 percent (about 9.5 million ha) in 2010. Between 1982 and 1989, the area of potential forest (with less than 20 percent canopy cover and areas classified as degraded forest) increased from about 8.5 million to about 11 million ha (Government of Lao PDR 2011). Annual emissions from deforestation and forest degradation were estimated at 95.3 million tons of carbon dioxide equivalent ($tCO_2e$) in 1982, declining to 60.6 million $tCO_2e$ by 2010. From 2012 to 2020, the average annual emissions are expected to be 51.1 million $tCO_2e$ (Government of Lao PDR 2011).

### Table 1: Land use in Lao PDR, 2010

| Land use type | Area (million ha) |
|---|---|
| Current forest area | 9.5 (40 percent) |
| Potential forest area (stocking < 20 percent canopy, including areas classified as degraded forests) | 8.3 (35 percent) |
| Other land uses (including agriculture, urban areas, etc.) | 5.9 (25 percent) |

Source: DoF presentation in Annual Ministry of Agriculture and Forestry Conference in January 2011, as cited in Government of Lao PDR 2011.

There have been significant changes in forestland and resource use over the past two decades, driven mainly by demand for land from neighboring countries for growing a wide range of cash crops. Forest area has been reduced, and there has been a steady fragmentation of forests and a decline in the average growing stock within the residual forest. Data on changes in forest cover suggest that during the 1990s the annual loss of forest cover was around 1.4 percent annually, giving an average annual loss of forest cover of about 134,000 ha. The available data, however, do not distinguish between forest that has been lost from the denser classes through deforestation and forest that has degraded from a dense class to a less dense one. It is assumed that both processes are ongoing. At present there are no additional recent data, but diverse information from various sources, including national and provincial records and reports, suggests that the rate of decline has continued at a similar rate until the present day.

The country has nine different forest types (see Table 2). For this case study, the focus was on dry dipterocarp forests. DDFs are a common forest type in the central and southern parts of the country. DDFs covered 1,317,200 hectares in 2002, which was 13 percent of the total forest area and 5 percent of the total land area of the country (MAF 2005).

## Table 2: Main forest types in Lao PDR

| Type | Area 1982 | Area 2002 | Change 1982-2002 |
|---|---|---|---|
| | 1000 ha | 1000 ha | 1000 ha |
| Dry dipterocarp | 1,235.1 | 1,317.2 | 82.1 |
| Lower dry evergreen | 88.6 | 56.0 | (32.6) |
| Upper dry evergreen | 1,105.8 | 1,387.9 | 282.1 |
| Lower mixed deciduous | 893.0 | 881.0 | 12.0 |
| Upper mixed deciduous | 7,792.2 | 5,499.5 | (2,292.7) |
| Gallery forest | 90.7 | 28.2 | (62.5) |
| Coniferous | 138.3 | 89.1 | 49.2 |
| Mixed coniferous/broadleaved | 293.2 | 525.8 | 232.6 |
| Plantation | - | 40.0 | 40.0 |
| **Total** | **11,636.9** | **9,824.7** | **(1,812.2)** |

Source: MAF 2005.

Evidence suggests the drivers of deforestation include fire, unsustainable wood extraction, pioneering shifting cultivation, agricultural expansion, industrial tree plantation, mining, hydropower, infrastructure development, and urban expansion. Expansion of agricultural and industrial tree plantation development, especially of rubber, has been the main source of land use and forest cover change in recent years. This is partly a function of large-scale concessions having grown fairly rapidly in the past few years.

The loss of forest is a particular concern in the Lao context given that households are very dependent on forests (along with agriculture and fisheries) for income and food. The reliance on wild meat as source of protein is high among some populations in Lao PDR: up to 20 percent of their meat comes from the wild. Malnutrition is highest (above 50 percent) in households that are most reliant on wild food and their own rice production. Thus the loss of forest has the most serious consequences for villagers who rely most heavily on the forest to achieve food security and nutrition (World Bank 2012a).

Rural households in Lao PDR use many natural resources in addition to agricultural land to supplement their income. NTFPs are documented as critical ecosystem (provisioning) services that contribute significantly to people's livelihoods. The primary contribution of NTFPs is to household food security through consumption and income earned through sales. In addition, NTFPs are particularly important during the lean months preceding the harvest and during drought years (WFP 2008). The total annual value of NTFP use in the whole country was estimated by Foppes and Samontry (2010) to be $510 million per year, or 9.7 percent of GDP in 2010. Subsistence use accounted for $383 million (75 percent) of this amount, compared with $127 million (25 percent) for cash income. A study by Zola and Fraser (2012) indicates that the significant number of large livestock kept by households (buffaloes and cows), compared with the low availability of natural or planted grasslands, suggests that the majority of the livestock's nutritional requirements are met by grazing the natural grassy vegetation in forestlands. Access to this range of common natural resources represents an "insurance policy" for rural households.

In addition to these provisioning services, forest ecosystems also provide a range of regulatory services that support agricultural and livestock production systems. The main staple crop important for national food security is glutinous rice. It is produced mostly in rainfed paddy fields, which depend on the capacity of forests to absorb and regulate flows of water. Considering the potential impact of climate change on forests, some of the initial strategies considered for enhancing the resilience of the forest sector include:

- Reforestation, afforestation, improved forest management
- Using appropriate silvicultural practices
- Raising awareness regarding forest fire prevention among communities
- Monitoring degraded forests
- Developing agroforestry systems for watershed protection and erosion reduction in steep areas
- Developing small reservoirs in upland areas in order to provide water for wildlife/aquatic animals and plants during the dry season

## 2.6 National policy context

To enhance resilience to climate change, it is important to not only buffer the impact of climate change with infrastructure or ecosystem-based investments. It is also necessary to have policies that support improved resilience to climate change. For purposes of this study, the national policies that influence forests and how they provide ecosystem services are those specific to the forest sector and policies related to concessions. The latter influence land conversion and land use. This section briefly examines the relevant policies and also how forests feature in the national policies on adaptation.

### 2.6.1 Policies related to concessions

The legal framework for granting state land leases and concessions is often unclear to the different parties involved (Wellmann 2012). An overview of the legal regulations regarding the process of concessions conducted by Wellmann presents the relevant regulations in a succinct manner. Some of the dimensions of the legal framework that are worth noting for purposes of this study include the following (Wellmann 2012):

- The Law on Investment Promotion of 2009 stipulates principles, regulations, and measures regarding the promotion and management of domestic and foreign investments in Lao PDR.
- Several requirements need to be met for granting leases and concessions of state land. For example, it is necessary to do a land survey, prepare a land map, and prepare a land use plan based on land zoning and land classification for any lease of land concession requests to be considered by the authorities.
- If the area to be leased or conceded extends into the land of local people or individual land, the land use rights of the corresponding parties are to be maintained and the external party must conclude a contract with the land owner.
- Compensation is defined by Decree 192/PM Article 3 as "payment in cash or in kind for an asset to be acquired or affected by projects at replacement cost." Replacement cost is defined as "the amount in cash or in kind needed to replace lands, houses, infrastructure or assets on the land (crops, fruit trees) and other assets (income) affected by the concession or lease." The Decree species the various responsibilities of the project owners if a "responsible government authority" concludes that a development project could have adverse socioeconomic impacts.

- The legal framework also includes Decree 135/PM, which regulates compensation in case an area of state land lease and concession covers land of people who have a legitimate land use right. The Decree on the Compensation and Resettlement No. 192/PM specifies how compensation for specific types of land use should be estimated.

The framework also specifies how concession fees are estimated and which government entities have the authority to grant concessions. For investment projects that require the granting of forest land to agricultural business and tree plantation, the forestland must qualify as degraded and barren forestland.[17] Unlike before,[18] district-level authorities are not allowed to grant land or plantations. While province-level authorities are restricted to granting only degraded forests (up to 150 ha) (or 500 ha of barren land) to investors, the central government can authorize land investments in forestland for conversion to other land uses on parcels that are 150–150,00 ha (or 500–30,000 ha for barren land). Any parcel that is bigger than this must be approved by the National Assembly (as per the PM decree No. 135/PM on land leases and land concessions, 2009). Despite these regulations, there were various inconsistencies in implementation, including the division of large parcels into smaller ones and the evasion of regulations.

The second main policy of relevance to this case study is the Ministry of Planning and Investment's Five-year National Socio Economic Development Plan VII (2011–15), whose stated objectives are to eradicate poverty by 2015 and to move the country out of the least developed country classification by 2020. A major strategy for enabling realization of this policy's objectives is to encourage foreign direct investment, with a target of converting land assets into $8–8.75 billion—primarily in the mining, hydropower, agriculture, and natural resources sectors.

The allocation and implementation of concessions has come under a significant amount of criticism (EIA 2011; Dwyer 2011; Molnar et al. 2011; Barney and Canby 2011) for poor planning, enforcement, and contradictory policies. One complication is that having different levels of government with differing powers for granting concessions creates a communication and coordination challenge. Moreover, the different levels of government are competing for sources of revenue collected from concession-holders. Barney and Canby (2011) also point to the challenges in enforcing accountability in government institutions due to the multiple regulations, decrees, and orders.

On a more local level, concessions have come under widespread criticism for coercive tactics, and there are many instances where concession-holders have cleared lands already in use by local communities, with little or no consultation or compensation (CIDSE 2009; Schönweger and Uellenberg 2009; Kenney-Lazar 2010). Periodic nationwide outcries over a range of concession-related injustices, rapid national deforestation, and government complicity have led to the government imposing several moratoriums on logging and concessions, none of which have been very effective at altering the rate of land conversion and forest cover loss (Lang 2001; Barney and Canby 2011; Dwyer 2011; Kenney-Lazar 2010; Schoenweger and Uellenberg 2009):

- August 1991—temporary nationwide ban on logging and a ban on provincial concession allocations
- May 2007—moratorium on all concessions over 100 ha, repealed in May 2009
- July 2009—moratorium on new land concessions over 1,000 ha
- June 2012—moratorium on new mining and tree cropping concessions until 2015

The most recent moratorium may be a potential window of opportunity to influence policies to fully consider the value of ecosystem services, the dynamics of rural livelihoods, and climate adaptation issues within the land and development planning and decision-making processes.

17. Degraded forestland is defined as forestland areas where forests have been heavily and continually damaged and degraded, causing a loss of balance in organic matter, which may not be able to regenerate naturally or become a rich forest again. Barren forestland is forestland areas without trees, caused by natural or human destruction (Wellmann 2012).
18. Previously, different levels of government had the right to sign concession agreements depending on their scale: District Agriculture and Forestry Office, < 3 ha; Provincial Agricultural and Forestry Office, 3–100 ha; National Department of Forestry, 100–10,000 ha; and Lao PDR National Assembly, > 10,000 ha.

### 2.6.2 Policies related to forests

The Forestry Strategy to the Year 2020 (MAF 2005) subdivides the nation's forests into five classifications: protection, production, conservation, regeneration and degraded forests, with specified regulations governing resource access and use. The overarching strategy across the first three forest types is to increase "forest" cover from the 41 percent identified in 2000 to 53 percent by 2010 and 70 percent (1 million ha) by 2020. However, the government definition of "forests" does not distinguish between natural forest and plantations, and it envisages at least 500,000 ha of plantation forests by 2020.

Lao PDR is a timber-exporting country, which has implications on forest degradation caused by uncontrolled logging and ultimately deforestation. It has traditionally exported raw logs and semi-finished products to neighboring countries (China, Vietnam, and Thailand). A moratorium on the export of logs was issued in 2001, but this has not resulted in a complete ban due to case-by-case arrangements under legal exceptions to harvest and export of timber from infrastructure projects.

Concerning land and forest allocation, PM Decree 186/1994 on Delineation and Allocation of Land and Forest for Tree Planting and Protection provides a basic legal framework for incentives and promotion of tree planting, including exemption of land tax on tree plantations containing more than 1,100 trees/ha and ownership of planted trees (use, harvest, sale, transfer, and inheritance). After 1996, several forest-related laws were approved and promulgated by the National Assembly. They included the Forestry Law in 1996, the Land Law in 1997, the Environment Protection Law in 1999, and the Processing Industry Law in 1999. The Forestry Law is comprehensive and gives relatively clear directions in many aspects of forestry. Under it, all forestland and naturally growing trees are owned by the National Community, which is represented by the State. Three categories of forest and forest area are recognized: production, conservation, and protection.

The Ministry of Agriculture and Forestry's regulation on Village Forest Management was issued in 2001 to consolidate existing provisions concerning village forests. PM Decree 59 on Sustainable Management of Production Forest was issued in 2002, providing for delineation of production forests, management planning, and the participation of villages in all aspects of production forest management. The Forest Law and subsequent regulations on harvesting, processing, and export of wood products provide legislative support for wider enforcement of sustainable timber harvesting and marketing.

### 2.6.3 Role of forests in climate change adaptation policies in Lao PDR

A review of National Adaptation Programmes of Action by Pramova et al. (2012) across 45 countries illustrates the extent to which forests and ecosystem services are viewed as central to national adaptation strategies to climate change. The role of forests are explicitly recognized by the Lao PDR government as critical for providing the ecosystem services needed for the survival of the most vulnerable populations (WREA/ UNDP/GEF 2009):

One of the main challenges faced today by the GoL concerns how to manage the impacts associated with a loss of forest and wetland biodiversity. This situation is only likely to be exacerbated by climate change. When rice crops fail, villagers all turn to the forests and wetlands to provide basic foods. If the forest has been cleared to make way for a rubber plantation and the wetland has been drained for agriculture or flooded for hydropower, where will vulnerable households find food?

However, while Lao PDR has proposed more than the average number of NAPA projects (12), the analysis by Pramova et al. (2012) found that NAPA projects themselves demonstrate relatively limited implementation of this understanding in terms of projects aimed at protecting ecosystem services.

In addition to forest policies, rural stakeholder livelihoods and the concessions that are changing the landscape interact with a number of other national policies. Several of the most significant ones identified as affecting the case studies covered in this report are listed in Annex 6.

# 3. Research Context: Savannakhet Province

Savannakhet Province is located in southern Lao PDR. It is about 470 km southeast of the capital, Vientiane, and borders Khammuane Province to the north, Saravan Province to the south, and Vietnam to the east. Savannakhet Province has a total land area of 21,774 km2. About 90 percent of the area is flat land and about 10 percent is considered mountainous. The province is rich in natural resources, including agricultural land, forests, rivers, mineral deposits, and biodiversity. According to data provided by Province Agriculture and Forestry Office (PAFO), Savannakhet has a total agricultural land area of about 1.5 million ha, representing about 68 percent of total provincial land area. However, a large share of this agricultural land is characterized by low fertility.

The province is considered to be the hottest and driest one in the country. The average temperature is estimated to be 26°C, about 2°C higher than the national average. The average rainfall is 1,598.3 mm per year, which is 173.5 mm less than the average for the country. The average number of sunlight hours per year is estimated to be 2,280 hours, which is 256.8 hours longer than the national average. However, the hot and dry climate is not a constraint to agricultural production. Because of its landscape and infrastructure development, Savannakhet has become one of the most suitable locations for investing in agriculture.

Many rivers flow through Savannakhet Province. The rivers and wetlands provide an important habitat for aquatic species, as well as a basis for the development of irrigation systems and electricity generation. Water supply, however, is an issue in the province. A 2011 study found that the local perception is that there is a connection between the growth of the plantation industry (especially sugarcane, rubber, and eucalyptus) and changes to water resources (IUCN and NERI 2011). Focus groups found that water levels in several streams and swamps have declined since an expansion in the number and size of plantations in the area. Local participants stressed that the streams and swamps used to have water all year round and were important fishing areas for local people, but that at present no water is available during the dry season. To date, no scientific study exists to validate these claims.

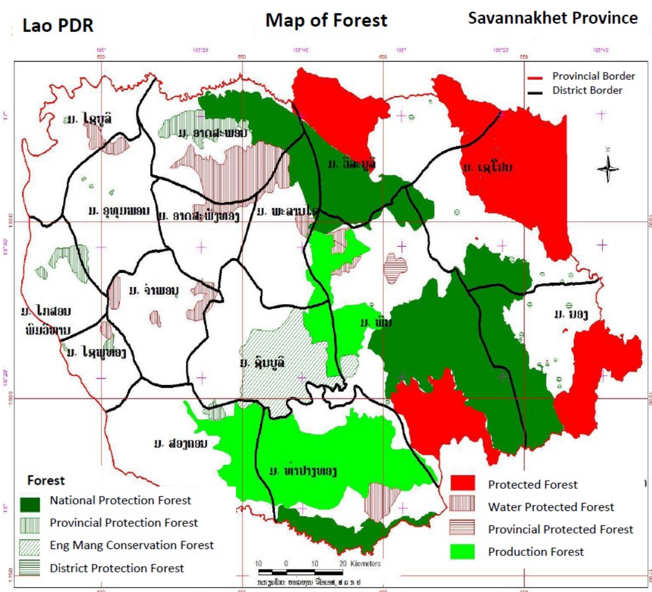
## 3.1 Forests in Savannakhet—dry dipterocarp forests

A disproportionately high amount of DDF (roughly 50 percent, or 607,000 ha) is found in Savannakhet. DDF occurs as open stands and is generally found in places with laterite, shallow soils characterized by a hard pan, with trees being relatively small—a maximum stand height of 25 meters. In the rainy season, these soils are prone to flooding, while in the dry season they are susceptible to droughts. Due to seasonal droughts, these forests undergo a periodic forest fire regime. Consequently, most of the tree species in the DDF are drought- and fire-resistant (Bunyavejchewin 1983). The majority of the species belong to the *Dipterocarpaceae* family, with the most common species being *mai chik (Shorea obtusa), mai koung (Dipterocarpus tuberculatus), mai hang (S. siamensis),* and *mai sat (D. obtusifolius)*.

Due to slow growth rates and a stunted appearance, limited research and conservation efforts have focused on DDFs. Consequently, their value is poorly understood. Lacking information to the contrary, policy makers place limited value on the services they provide. These forests are therefore at risk of being lost to the conversion to agricultural concessions and other land use changes.

There are different forest classifications in Savannakhet, including the main classifications found in Lao PDR: National Protection Forest and Production Forests. In addition, there are provincial, district, and conservation forests (see Figure 2). In some of these classifications, there are also village forests.

Figure 2: Map of land and forest classifications in Savannakhet Province




Source: PAFO.

# 3.2 Agriculture in Savannakhet

Agriculture is the main productive sector in Savannakhet Province. A study by IUCN and NERI (2011) specified that in 2009–10 this sector contributed 49 percent of the total production value of the province. This was followed by the service and industry sectors, which contributed 26 percent and 24 percent, respectively. The economic trends in Savannakhet indicate a growing share of revenue generated from the industry and services sectors in comparison to agriculture. In the province, traditional subsistence agriculture is declining while agriculture as an industry is growing. In the five years leading up to 2011, the agricultural sector averaged a growth rate of 7 percent a year (Savannakhet PDPI, as cited by IUCN and NERI 2011), even as the share of agriculture in provincial revenue declined. In Savannakhet, agriculture remains an important source for livelihoods for households, although traditional agricultural practices are being replaced.

Estimates indicate that 90 percent of the population is actively engaged in rice cultivation, although productivity varies greatly within the area. The province is predominantly characterized as a wet-season lowland rice-cultivating area that meets a quarter of the country's rice needs. Most rice sales come from the districts of Chumphone, Songkhone, and Sayabouri (ACIAR 2012).

## 3.3 Land use change in Savannakhet

Land use change in southern Lao PDR during the 1980–90s was somewhat different from the rest of the country, with just a 3 percent decrease in total forest cover (Vongsiharath 2006). In the case of DDF, the total forest cover actually increased slightly over the last two decades (Vongsiharath 2006). These effects are attributed by Vongsiharath (2006) as being a result of the larger area under protected forest status in the southern half of the country.

Despite the apparent success in forest conservation achieved up to the early 2000s in southern and central Lao PDR, recent national economic objectives have increased pressure for natural resource extraction and land conversion. Several authors have documented the growing pressure on forests in the country due to a demand from neighboring countries (particularly Vietnam, Thailand, and China) for timber and for edible and medicinal NTFPs, as well as growing external investments in the conversion of land to rubber and timber plantations (Vongsiharath 2006; Robichaud et al. 2009; Hodgdon 2010; Barney and Canby 2011). The demand for land concessions in Savannakhet Province has been particularly high since the completion of the second Lao-Thai Friendship Bridge in 2006, connecting the province directly to major markets in Thailand (IUCN and NERI 2011).

According to an IUCN and NERI study (2011) of concessions in Savannakhet based on data from 2009, over 20 foreign companies were operating in industrial agriculture and plantation forestry, particularly for the development of eucalyptus, acacia, rubber, sugarcane, and cassava plantations (see Table 3). The four largest concession holders in the province are:

- Birla Lao Company, Indian, with concessions on 41,000 ha for eucalyptus plantations
- Mitr Lao Sugar Company, Thai, with a sugar factory in Sayabouli District with concessions on around 10,000 ha for sugarcane plantations
- Savan Sugar Company, Thai, with a sugar factory in Phin District and concessions on 12,000 ha for sugarcane plantations
- Lao Thai Hua, Vietnamese, with concessions on 10,000 ha for rubber plantations

It should be noted that a significant proportion of the concessions allocated may not yet be cleared of existing forest or be under large-scale cultivation. As of 2009, the greatest areas under cultivation were sugarcane (9,620 ha), eucalyptus (7,223 ha), and rubber (5,929 ha).

### Table 3: Area and productivity of top five industrial crops in Savannakhet Province, 2009

| Description | Concessions (ha) | Concession length (years) | Surveyed (ha) | Successful survey (ha) | Cleared (ha) | Growing area (ha) | Productivity (t/ha) |
|---|---|---|---|---|---|---|---|
| Rubber | 26,651 | 30-49 | 17,536 | 13,120 | 9 | 5,929 | NA |
| Cassava | 12,508 | 20-30 | 7,100 | 1,761 | 2,100 | 2,100 | 8 |
| Eucalyptus | 41,672 | 15-70 | 148,168 | 30,410 | 7,230 | 7,230 | NA |
| Sugar Cane | 22,000 | 30-40 | 25,523 | 13,158 | 9,984 | 9,620 | 56 |
| Acacia | 40,025 | 40 | 30,925 | 24,471 | 460 | 312 | NA |

Source: IUCN and NERI 2011.

# 4. Study Approach

## 4.1 Study sites

Three study sites with contrasting scenarios in terms of access to forests and land for rice were selected in order to analyze how the loss of access to forests and land affect households' reliance on ecosystem services and their ability to buffer shocks (including those from climate change). The villages were in DDF lands of Savannakhet Province and were selected in collaboration with the provincial and district authorities.

- **The first village, labeled the Participatory Sustainable Forest Management (PSFM) village**, is situated in the northern part of Sonbouli District. Part of its forestland lies within the Dong Kapho National Production Forest Area, and this community is enrolled in a donor-financed project on participatory sustainable forest management.
- **The second village, labeled the eucalyptus village**, is situated in Palanxay District. Part of its land has been allocated to a concession of the Birla Company for the establishment of eucalyptus plantations.
- **The third village, labeled the sugarcane village,** is also situated in Palanxay District. Part of its forestland has been allocated to a concession of the Savan sugar company for the establishment of sugarcane plantations.

The 2005 census data available for our case study communities and demographic data from household surveys reveal that the sugarcane village (1,139 individuals) is twice the size that of the eucalyptus (529 individuals) or PSFM villages (689 individuals) (see Table 4). In terms of household composition, however, the two concession villages have mean household sizes and mean numbers of adult labor roughly one-fourth smaller than in the PSFM village.

### Table 4: Key village demographics

| Human Capital | PSFM | Eucalyptus | Sugarcane |
|---|---|---|---|
| | village | village | village |
| *A: whole village* | | | |
| Population 2005* | 567 | 339 | 897 |
| Population 2012** | 689 | 529 | 1,139 |
| Percent pop. growth/yr. *,** | 3.1 percent | 4.7 percent | 3.9 percent |
| No. households** | 85 | 85 | 179 |
| Avg. household size** | 8.1 | 6.2 | 6.4 |
| percent women* | 50 percent | 50 percent | 54 percent |
| percent men* | 50 percent | 50 percent | 46 percent |
| *B: interviewed sample* | | | |
| No. household sampled | 12 | 12 | 12 |
| Avg. household size | 7.5 | 5.8 | 5.9 |
| Avg. adult labor/household | 4.5 | 2.9 | 2.8 |

* National Census 2005

** Village headman's registry

Interestingly, the average annual population growth rates in the three villages indicate an inverse relationship with household size. Whereas the PSFM village has the largest mean household size, its population growth rate is the lowest, while the village with the smallest mean household size (eucalyptus) has the highest growth rate. All of these growth rates are well above the national and provincial average growth rates, both of which stand at 2 percent (IUCN and NERI 2011). While methodological differences between a census and village leaders' quantifications may artificially increase the estimates of current populations, local stakeholders do indicate that the eucalyptus village, in particular, has received a significant amount of immigration from surrounding communities. This, however, does not seem to explain the relatively high population growth rate in the sugarcane village.

Between the three case study villages, the 2005 census suggests that the largest proportion of adult labor migrants (relative to available labor) left the sugarcane concession village (roughly 20 percent of the total labor force) (see Table 5). This is the village in which almost all land not currently used for small-scale agriculture has been taken up by the concession, leaving little forest for collection of NTFPs and livestock grazing. The data are likely underestimates of the current situation, as the impacts of forest conversions for concessions have become more significant over the last decade.

Table 5: Estimates of labor emigration to Thailand

| Village | No. of persons | Labor force | Percentage | Migrants | Percent of Labor Migrated |
|---|---|---|---|---|---|
| PSFM | 567 | 383 | 67 | 30 | 8 |
| Sugarcane | 897 | 597 | 67 | 120 | 20 |
| Eucalyptus | 399 | 248 | 67 | 10 | 4 |

Source: 2005 Census.

# 4.2 Methodology

## 4.2.1 Data collection methods

This study uses an integrated socioecological systems approach to analyze the impacts of different land and forest policy decisions on both local livelihood resilience and the supply of ecosystem services. However, as DDF (and the livelihoods derived from them) are among the least understood or studied forest types in the country, only a limited amount of secondary data were available to conduct an economic valuation of the costs and benefits of different land uses. To augment the available secondary data, some primary data were collected and stakeholder consultations were held.

Stakeholder consultations and workshops

A series of consultations were held with key technical and policy experts. The consultations, through workshops, involved national, provincial, and district stakeholders representing a range of institutions at the DoF headquarters and the provincial headquarters of the PAFO-Forestry section in Savannakhet.[19]

19. During these workshops, the objectives of the research were shared, and valuable inputs were provided by stakeholders, including the PAFO selection of the key case study sites to be analyzed by the project team.

A detailed presentation of preliminary findings was shared with the government and World Bank staff involved with the Forest Investment Program for their feedback. Preliminary research findings were shared with district and provincial stakeholders in a workshop held in Savannakhet to obtain feedback. The draft report was also shared with key national stakeholders for feedback.

## VILLAGE-LEVEL DATA COLLECTION

The data collection was conducted in April, when there are relatively few demands on stakeholders' time for agricultural activities; however, the turnout differed significantly between villages.[20] Whereas the PSFM village turned out with over 80 people, split roughly between men and women, in the eucalyptus village roughly 26 women and 12 men attended, and in the sugarcane village 12 men and 12 women attended.

The primary modes of village-level data collection revolved around household socioeconomic surveys and Participatory Rapid Appraisal (PRA) methods conducted in focus groups. In each village the data collection took place over the course of two days. All households were asked to detail their income sources, both cash and non-cash sources. There was a valuation of ecosystem provisioning services that are purchased or sold by households.

## HOUSEHOLD SOCIOECONOMIC SURVEY

Village leadership was asked to assist with wealth ranking of all stakeholders present. Accordingly, each household was assigned to one of three wealth or income categories (poorer, middle, and wealthier). Village leadership put households into the three "classes" based on a general perception of well-being. Each income group was then subdivided into gendered groups, who then participated in the PRA focus group discussions. The wealth ranking allowed an exploration of the socioeconomic differences within communities and the differences in how households have access to and use resources and income.

Individuals randomly selected from the focus group in each income group were invited to participate in the household socioeconomic survey. The survey covered a number of thematic areas, including demographics, livelihoods, income sources, assets, and food security. As part of the socioeconomic survey, an attempt was made to estimate the adequacy of rice within the household. This included a quantification of rice grown, bought, sold, consumed, and borrowed over the course of a year. Where possible, two members of each gender group were invited to participate. However, in the eucalyptus village, all surveys were completed by women. In total, four household surveys were completed for each of three income groups in each of three villages.

## FOCUS GROUP DISCUSSIONS

The focus group discussions used an abbreviated version of the Program on Forests' poverty-forest linkages toolkit.[21] Focus groups from each income and gender category were asked to estimate key sources of cash and non-cash household income by ranking and to estimate how much of each resource came from the different land use types (paddy, DDF, and mixed deciduous forest). These data highlight the variety of non-cash income sources, especially those derived from the dry forest. This exercise did result in a significant divergence from the results from the household surveys. A summary of these differences is discussed in the report. The differences cannot be explained adequately based on the available data. Accordingly, in this report these results are primarily used to qualify or support the conclusions from the socioeconomic survey.

In addition, participatory mapping exercises on community resources were conducted with both men and women stakeholder groups, providing research team members with a better contextual understanding of how different sources of cash and non-cash income are distributed spatially across the landscape. These exercises also highlighted significant differences in the amount of distinct types of local environmental knowledge.

20. The respective District Agricultural and Forestry Office (DAFO) had notified the communities of the intended date and time of the research team's arrival and requested that the villagers assemble for a day-long meeting and data collection activity. The research teams were accompanied in the village by representatives of PAFO and DAFO.
21. The toolkit is available at www.profor.info/node/3.

### 4.2.2 Climate change scenario modeling of changes in ecosystem services

Climate change modeling was also part of the methods used to gauge potential impacts of future climate change scenarios on a range of ecosystem services at both near-term (2030) and longer-term (2080) time horizons. The specific methods used for analyzing climate change scenarios and the impacts on ecosystem services are briefly described here. (A more detailed description is found in Rafanoharana, Locatelli, and Russell 2012.)

The climate change projections for 2030 and 2080 were based on the TYN SC 2.03 dataset developed by the Climate Research Unit at the University of East Anglia (Mitchell et al. 2003).[22] This dataset establishes a global historical baseline of climate variables for the period 1951–2000 and of 16 possible climate change projections resulting from four global climate models (GCMs)[23]—CGCM2, CSIRO2, HadCM3, PCM—under four different greenhouse gas emissions scenarios—A1FI, A2, B1, B2. The four emissions scenarios that were considered reflected different global development pathways, with unique combinations of predicted economic growth, technological innovation, economic equity, and environmental quality.

The development paths are projected to result in a greater or lesser increase in average global temperature and sea level. Due to the unpredictability of global development trajectories and their characteristics, all 16 scenarios are presented throughout the analysis. Recent evidence, however, suggest that even with significant efforts to mitigate climate change, adaptation strategies should take particular note of the implications for ecosystems services presented by the higher emissions scenarios (A2 and A1FI).

The Lund-Potsdam-Jena dynamic global vegetation model (Smith et al. 2001; Sitch et al. 2003) was used to identify the possible impacts of climate change within the study area based on a range of hydro-climatic variables. The process-based model uses key ecosystems such as vegetation growth, mortality, carbon allocation, and resource competition. The primary outputs from this analysis represent how baseline and future climate scenarios are likely to interact with soil type and $CO_2$ to result in different levels of the following three key ecological processes: net primary productivity (NPP), runoff, and fire incidence.

In addition to the modeling of climate change impacts on this range of specific ecosystem processes, the baseline and projected levels in temperature and precipitation are used to model the types of vegetation that are likely occur in any given area. Globcover[24] land cover maps for 2005 and 2009 were used to derive the historical land cover change in Lao PDR.

The Integrated Model to Assess the Global Environment (IMAGE) version 2.2 data were used in this study in order to develop scenarios from the combination of the impacts of climate change and land use change for short-term (2030) and long-term (2080) projections. Long-term scenarios for the Southeastern Asia region from the IMAGE 2.2 dynamic integrated assessment model were used. Historical data for the 1765–1995 period are used to initialize the carbon cycle and climate system. IMAGE simulations cover the 1970–2100 period.

The historical climatic and ecosystem services baselines used cover the entirety of Lao PDR and its neighbouring regions. However, the modeled projections of climate change and specific impacts on a range of ecosystem services in the future are specific to central Savannakhet Province.

22. The data are publicly available at www.cru.uea.ac.uk/cru/data/hrg/timm/grid/TYN_SC_2_0.html.
23. It should be mentioned that there are additional GCMs; however, these four were identified as state-of-the-art by the IPCC (2001) in the Third Assessment Working Group 1 Report.
24. Data source: ESA / ESA Globcover Project, led by MEDIAS-France/Postel; see postel.mediasfrance.org/en/PROJECTS/Preoperational-GMES/GLOBCOVER.

## 4.3 Data Analyses

There are three main parts to the data analysis. The first part examines the potential impact of climate change, the second is a vulnerability analysis, and the third involves an economic analysis. The vulnerability analysis brings together how climate change, natural climate variability, and non-climatic factors influence the degree of sensitivity, exposure, and adaptive capacity of the smallholder agricultural system. The vulnerability of the system in turn is based on the potential impacts of these factors. The economic analysis estimates future benefit provision under the different forest resource access conditions in order to quantify the economic value of forests for households.

In order to conduct the analyses, it was necessary to estimate the economic value of the ecosystem services, assess the contribution of livestock assets to resilience, and gauge the level of food security and nutritional diversity of the household. This section provides brief descriptions of how these assessments were done.

The value of ecosystem provisioning services was estimated using market prices of actual goods and proxies as appropriate.[25] The direct market pricing estimated the value of agricultural and forest products that were sold and consumed by the household. For the latter, the valuation was feasible when the quantity of products consumed in the household was known.[26]

Regulatory services were also considered. A conservative value of the watershed regulatory services was estimated as 25 percent of the value of the annual rice production. The value of carbon was estimated based on the carbon content from Pukkala (2005) and a conservative carbon credit of $4.8/ton.

All data are presented in terms of the value of annual benefits accruing (or potentially accruing) to local stakeholders.

### 4.3.1 Contributions of livestock assets to resilience

The approach used to represent the contribution of livestock to households' resilience to shocks compared the value of livestock owned to the total annual cash income of each household. This measure was regarded as being more relevant than the absolute cash value of the livestock themselves, as this ratio relates the market value of cattle directly to the household's relative cash versus non-cash income requirement. Therefore, the value can be viewed as a proxy for sensitivity to market pressures.

### 4.3.2 Household food security and nutritional diversity

Food security and nutritional diversity were also determined based on the total per capita consumption of rice within each household compared with the average actual rice consumption, which in Lao PDR is estimated at 160 kg/person and in most neighboring countries is about 120–140 kg/person. It should be noted that, with respect to rice, purchase and sale prices differ:

- Rice is usually sold after harvest (November-December) in a non-milled state (called *khao peuak*) at a rate of KIP 2,000/kg.

25. Often economic valuations and cost-benefit analyses of ecosystem services represent the values in terms of a total economic value. This approach was not suitable in this case study for numerous reasons, including the high level of uncertainty regarding the accuracy of current datasets and the range of land use change and climate change scenarios projected for the future.
26. The following market prices were used: for the estimate of the overall value of dry forest provisioning services for fodder, the total market value of cattle and buffaloes sold in the village and the relative contribution of each land use type and area in the village in providing forage; for the estimate of the value of NTFPs, the annual estimated sale or market equivalent value of all NTFPs consumed and sold; and for the estimate of the value of timber use for house construction, the average value of the two species used.

- Rice is usually purchased during the lean months (April-June) prior to the next harvest in milled form (called *khao san*) at a rate of KIP 5,000/kg.
- In terms of nutritional value, 1 kg of *khao san* is equal roughly to 1.5 kg of *khao peuak*.

In addition to self-sufficiency in the staple (rice), the relative amounts of NTFPs consumed and purchased by households were compared as an indication of nutritional diversity.

### 4.3.3 Shortcoming of the methodology

The household survey was implemented in order to try to represent some of the livelihood differences, and the different reliance on several ecosystem services as well as additional sources of income and expenditure, between household types and villages. The limited household sample in each village wealth category (N=4) and non-randomized sampling design means that the results cannot be statistically representative of these groups and should be interpreted in conjunction with other data sets available. Wherever the survey results appear to indicate the presence of significant trends and differences, these should be taken as hypotheses and points of departure for future, more detailed, and necessary research investments.

Differences in villages or income groups similarly cannot be viewed as statistically representative of their income or the whole village, but their larger sample size (N=12) suggests that where trends are significant, these results are more credible. In addition, a certain amount of certainty regarding the larger trends is provided by methodological triangulation using stakeholder interviews, limited participant observation, participatory focus group discussions, and validation of major trends during village stakeholder feedback sessions.

One of the main challenges in the methodology for this study was collecting reliable community information of the use and sale of NTFPs. While an attempt has been made to do so through the survey, the focus group data indicate that these data may significantly underestimate these values.

The team attempted to obtain first-hand data on costs and production from the respective concession companies involved in each village, but neither company was willing to be interviewed or share information with the team. Therefore, all analysis on ecosystem services comes from secondary data. Regardless, these data would not have been very representative of what the sectors could achieve over time, as both concessions were only established a few years ago. Therefore the "comparative" analysis of ecosystem services between different land use types should be seen as illustrative rather than definitive.

Both the household and most of the secondary data sources are based on data collected in single snapshots of time or single locations. Where data are collected in a single location, the valuation may be skewed by any range of variables specific to that location but that may not be representative of the mean (that is, poorer-than-average soils and drainage, stronger-than-average local leadership, worse-than-average company-village relationships, and so on). Where the data are collected over a single season, year, or even growing cycle (three years for sugarcane), the benefits reaped from the collection of NTFPs or the returns on investment may similarly be skewed by a range of short-term variables: unseasonably warm or cool weather, flash floods, delays in availability of fertilizer, high incidence of insect pests or fungal infections, and so on).

# 5. Climate Change in the Region

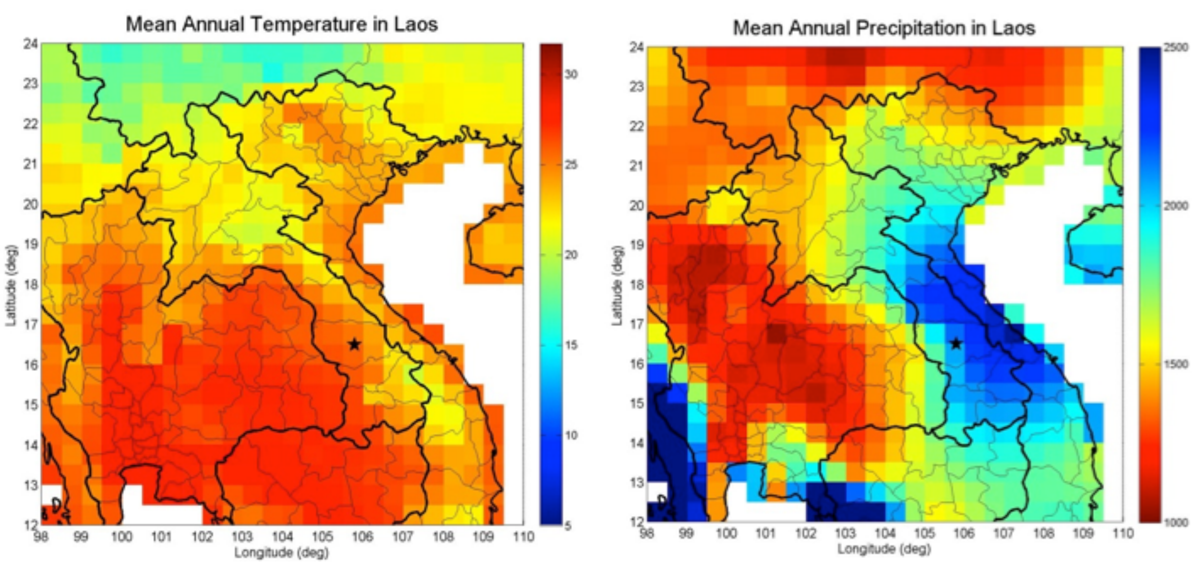
This summary of impacts from climate change is drawn from Rafanoharana et al. (2012), which is a detailed analysis done as part of this study. As described in the methodology section, the analysis examined climate change scenarios and their impacts on ecosystem services in Savannakhet, Lao PDR.

## 5.1 Historical and future projected climate conditions

Overall, the climate in Lao PDR can be described as tropical monsoonal with a mean yearly temperature of 18ºC and distinct wet and dry seasons.

The mean annual temperature distribution suggests a strong correlation with elevation gradients (see Figure 3). Consequently, the more mountainous northern region and, to a lesser degree, the Annamite Range[27] along the country's eastern and southern borders represent areas with lower mean annual temperatures. The Annamite Range and central and southern Lao PDR in general receive the greatest amount of rainfall.

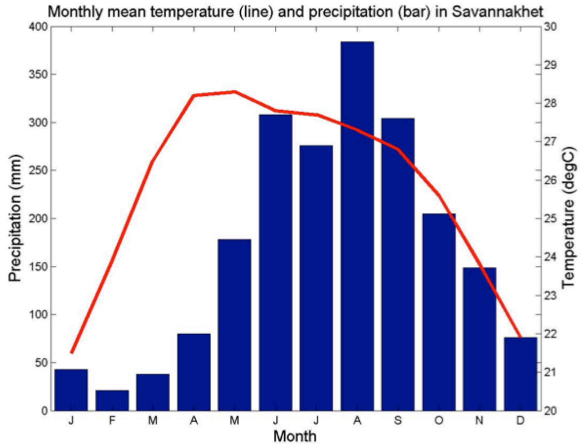
Figure 3: Current mean annual temperature and precipitation in Lao PDR (star: Savannakhet)




Historical rainfall patterns and temperature patterns in Savannakhet Province illustrate largely unimodal distributions (see Figure 4). The highest rainfall occurs during the southwest monsoon rainy season (May to October) and reaches peak levels in August. The average annual precipitation in Savannakhet is 2,061 mm/year, with a monthly range between 21 mm (February) and 384 mm (August). The mean temperature in Savannakhet is 26°C, with a range between 21.5°C (January) and 28.3°C (May).

27. Xai Phou Luang (□□ □□□□) in Lao.

Figure 4: Current monthly mean temperature and precipitation in Savannakhet Province




Source: Rafanoharana, Locatelli, and Russell 2012.

Based on this historical baseline of data, the team modeled 16 climate change scenarios (combining four global climate models and four emissions scenarios) to assess the likely impacts of climate change in the country in general and in Savannakhet Province in particular over the 2030 and 2080 time horizons. Reflecting national trends, from a mean annual baseline temperature of 26°C, by 2030 the mean annual temperature in Savannakhet is expected to increase by within a range of 0.6°C (PCM.B1) and 1.4°C (HAD3.A1FI). Similarly, by 2080 the mean annual temperature increase is expected to range between 1.1°C (PCM.B1) and 4.7°C (HAD3.A1FI).

Future precipitation trends are uncertain, with a range of relative changes in 2080 from –10 percent to +11 percent, with 4 scenarios showing a decrease and 12 an increase. These trends are consistent with the ones reported in other studies (Lefroy, Collet, and Grovermann 2010; Eastham et al. 2008; Johnston et al. 2009), with some differences in amplitudes due to the climate models and scenarios used.

Uncertainties about future precipitation have major implications for the uncertainties on the impacts of climate change on ecosystem services and livelihoods. Given the uncertainties about other drivers of future changes in ecosystem services (particularly land use change and ecosystem degradation from harvesting), impact studies are challenged by the high uncertainties of the results (Kandlikar, Risbey, and Dessai 2005). However, some decisions may provide adaptation benefits under a wide range of climate scenarios, and flexible and adaptive strategies can be developed that are more likely to be robust to uncertainty (Dessai and Wilby 2011).

## 5.2 Projected impacts of climate change on ecosystem services

The climate change scenarios project an increase in vegetative growth or NPP in Savannakhet Province. It should be noted that the proportional impact on rice growth in paddies is likely to be more significant than that in DDF forests, as growth is limited by soil depths. The expected impact on rice production in paddy fields is a net increase in primary productivity of 1.4–12 percent by 2030 and of 14–53 percent by 2080. These findings are consistent with other studies (Lefroy, Collet, and Grovermann 2010; Jintraet and Chinvanno 2012).[28]

28. The benefits of $CO_2$ decline with higher levels of warming should be noted. However, due to limited information on the rate of decline, this was not accounted for in the analysis. Accordingly, the gains mentioned in terms of NPP may only partially materialize.

The seasonal rainfall patterns in the longer-term projections indicate uncertainty regarding the amount of rainfall and runoff during June. This is a critical period in the agricultural production calendar, when farmers transfer rice plants from nurseries to paddies and when the predictability of water levels is particularly important. Crop failure is a risk whenever there is a major interruption in rainfall or a sudden overabundance.

Based on a modeling of Holdridge ecological life zones,[29] the overall increase in temperatures is likely to contribute to a general qualitative shift in vegetative composition toward plant species that are more adapted to drier conditions. This should not, however be confused with a transition toward dry dipterocarp forests, as these trees are more accurately characteristic of specific soil conditions than they are of temperature per se.

Few data are available on the impact of climate change on livestock productivity in DDFs. Livestock graze on natural Arundinaria grasslands, which are resistant to droughts but are low in productivity. Preliminary research on replacing the natural grasslands with improved, drought-resistant pasture species seems to be a promising adaptation strategy (Hacker, Novaha, and Phengvichith 1998). However, little research exists in the country on the dry forest contexts. Therefore, much remains to be understood on how such technologies can be implemented by extension agents and communities.

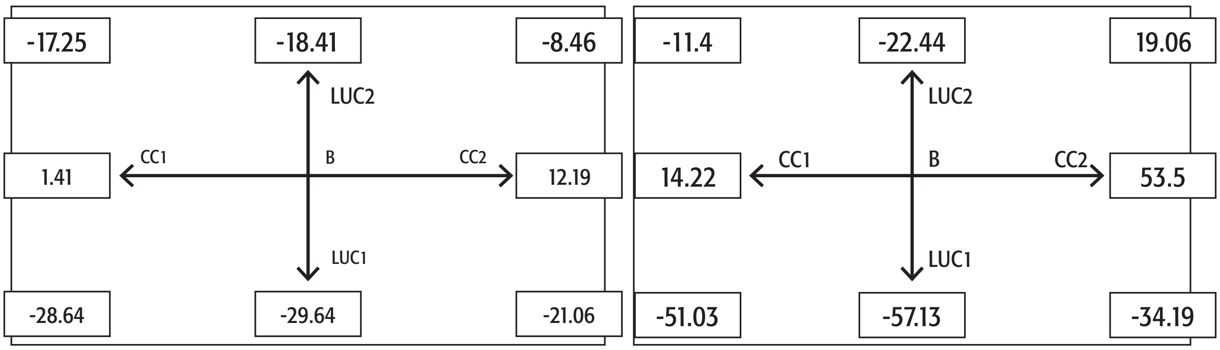
## 5.3 Projected impacts of land use change on ecosystem services

Overall, using the IMAGE 2.2, this study found that policy and economic drivers of land use change are likely to significantly outweigh any impacts from climate change on forest productivity. When climate and land use scenarios are combined, forest production is expected to decrease in 2030 under any scenario. Even with a positive impact of climate change on ecosystem productivity in 2030 (up to +12 percent), total ecosystem production can decrease because of land use change (–1 percent in the worst scenario and –8 percent in the best scenario). The combined analysis of climate and land use scenarios shows that land use change is a more important driver of production than climate change in the short term (2030). In the longer term (2080), climate change appears to have as much effect on production as land use, although uncertainties are higher in 2080 than in 2030. (See Figure 5.)

This corresponds with the general perception among stakeholders that land use change is the key challenge to be addressed to tackle deforestation and degradation of DDFs.

29. First developed by Holdridge in 1947, this is a simple bio-climatic model that describes the suitability of vegetative classes based on precipitation and temperature. These "life zones" are presented as "humidity provinces" (Holdridge 1947). Based on this model, any alterations in distributions of rainfall and temperature under future climate change scenarios can be expected to result in qualitative shifts from one life zone to another.

## Figure 5: Extreme scenarios of impacts on NPP forests for climate and land use change projections for 2030 and 2080




Change in NPP compared to the baseline (B) for two contrasting climate scenarios (CC1 - HAD3.B2A and CC2 - CSIRO2.B1A in 2030; CC1 - CGCM2.A2A and CC2 - CSIRO.A1A in 2080) and two contrasting land-use change scenarios (LUC1 - IMAGE.B2 and LUC2 - IMAGE.B1 in 2030) in 2030 (left) and (LUC1 - IMAGE.A2 and LUC2 - IMAGE.B1) in 2080 (right) in areas with natural vegetation

Several (not all) scenarios of the policy and economic drivers of land use change project an inflection point around 2050, resulting in a gradual recovery in forest production levels, but they offer limited guidance due to the range in forest productivity projections in the long term (2080). When policy/economic and climatic drivers of forest productivity are combined, the range of outcomes spreads from a net loss of productivity of up to 51 percent to a net increase of productivity of 19 percent (in relation to historical baseline levels). Despite the spread, a conclusion is that while climate change could improve rice production, policy makers cannot expect the same easy wins with respect to forest conservation. For the latter, policy and economic drivers have to be addressed in order for any gains from climatic drivers to be felt.

# 6. Livelihood Vulnerability Analysis

The livelihood vulnerability analysis examines the exposure, sensitivity, and adaptive capacity of households. This section presents the livelihood portfolio of households in the three different villages and also the context of land use change. The analysis helps gauge the exposure and sensitivity of household livelihoods to climate change and land use change. The data include sources of cash and non-cash income, land use history, and information on the potential climate change, based on the climate models described earlier. The data are from household surveys, focus group discussions, and interviews with key stakeholders. The livelihood vulnerability analysis also includes an assessment of the adaptive capacity of households.

## 6.1 Exposure

In a vulnerability analysis, exposure is measured using climate change metrics. In the modeling described earlier, climate change scenarios are anticipated to result in an increase in vegetative growth or net primary productivity in Savannakhet Province. In contrast, the seasonal rainfall patterns in the longer-term projections indicate uncertainty regarding the amount of rainfall and runoff during June, an important time in the agricultural production calendar.

## 6.2 Sensitivity

Household sensitivity is informed by the social, economic, spatial, political, and cultural conditions associated with the household. This subsection covers some of the key conditions.

### 6.2.1 Economic and financial sensitivity

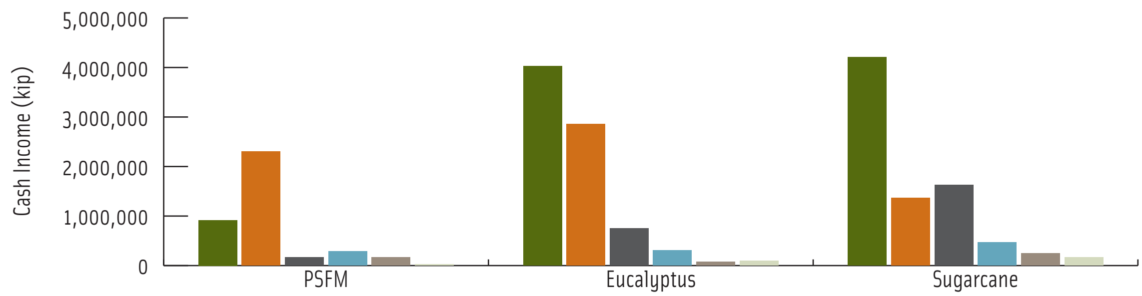
#### PRIMARY SOURCES OF CASH INCOME

Across all three villages, the three main sources of income are labor (45 percent), livestock sales (32 percent), and remittances (11 percent) (see Figure 6). Together, these top three income sources account for 90 percent of household income. The average annual incomes in the two concession villages are between $1,015 to $1,029, approximately double the average annual household cash incomes in the PSFM village ($484) (see Table 6). A partial explanation for this difference is the proximity of the concession villages to markets and the labor opportunities created by concessions. The average income estimated for the PSFM village may be higher than indicated as a result of the underestimation of volumes and values of NTFPs sold by inhabitants. Evidence from focus group discussions reinforces this point, indicating a larger actual contribution from NTFPs than elicited through the survey.

## Table 6: Household cash income in three dry forest villages, Savannakhet, 2012

| Household Cash Income | Poor | Middle | Rich | Average |
|---|---|---|---|---|
| PSFM Village (kip) | 1,041,750 | 2,062,250 | 8,430,000 | 3,873,833 |
| Eucalyptus Village (kip) | 3,842,500 | 7,037,500 | 13,476,500 | 8,118,833 |
| Sugarcane Village (kip) | 4,302,000 | 5,343,500 | 10,157,500 | 8,077,000 |
| Average (kip) | 3,062,083 | 4,814,417 | 10,688,000 | 6,689,889 |

## Figure 6: Overview of household cash income across three case studies




| | | | | | | |
|---|---|---|---|---|---|---|
| Labor | 917,500 | 24% | 4,025,000 | 50% | 4,206,250 | 52% |
| Livestock | 2,306,250 | 60% | 2,861,667 | 35% | 1,362,500 | 17% |
| Remittances | 166,667 | 4% | 752,500 | 9% | 1,625,000 | 20% |
| Forest Products | 291,750 | 8% | 304,667 | 4% | 469,083 | 6% |
| Agriculture | 166667 | 4% | 75,000 | 1% | 247,500 | 3% |
| Others | 25,000 | 1% | 100,000 | 1% | 166,667 | 2% |

A second difference between the PSFM and concession village economies was the primary source of income. In the PSFM village, livestock were an important source (60 percent). In the concession villages, labor was the most important source (eucalyptus village: 50 percent, sugarcane village: 51 percent). In concession villages, a rise in income from livestock sales results from selling off livestock reserves in response to a shortage of forests for forage rather than the annual sale of surplus livestock. Accordingly, this source of income is expected to diminish in subsequent years. Both livestock and forest products can be considered as ecosystem values derived from forestland (with livestock requiring biomass from forests for feed). Across all three villages, they provide approximately 38 percent of average household income. The range is from 68 percent in villages with intact forests to 23–39 percent in villages where significant areas have been lost to concessions.

The third difference is the contribution of wage labor to income of households in concession villages. From stakeholder interviews, wage labor is increasingly replacing the sale of NTFPs as a source of cash to make everyday purchases. Stakeholders, however, observed that although the abundance of NTFPs is declining, they remained a source of income throughout the year. In contrast, opportunities for wage labor are limited in the area and dependent on factors beyond the control of households, and often opportunities are not available when they are most needed.

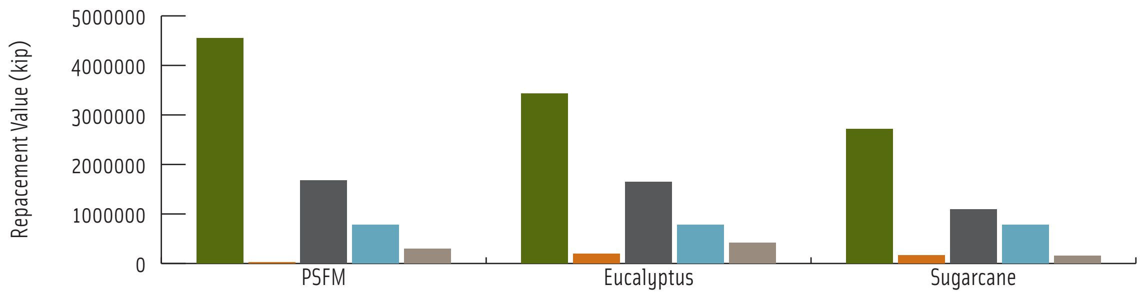
In all three communities, income from forest products is modest (approximately 6 percent). NTFP sales, however, provide more income sources to middle-income and wealthy households as a result of their access to major markets. Average cash income from NTFPs is greater in concession villages than in the PSFM village. Two explanations for this are the regulatory restrictions on households that are not part of PSFM villages legally selling timber and the consumption of NTFPs as an integral part of rural economic strategies, and arguably cultures, irrespective of income distinctions. The latter is corroborated with findings from other studies (Foppes 2011; WFP 2008).

It should be noted that there are differences between the contributions to income from various sources depending on the methodology used to elicit the information. The cash contributions of NTFPs were particularly divergent in the PSFM and sugarcane villages. In addition, there are significant differences in the income contributions from labor in middle and wealthier households of the eucalyptus village and across all households of the sugarcane village. Likewise, if any households engage in illegal logging, this revenue stream is seldom reported.

## HOUSEHOLD NON-CASH INCOME

Non-cash income, defined as all products produced on farm or collected from the wild, that are consumed within the household is highest in the PSFM village. These are calculated based on replacement values at local market prices (see Figure 7).

Figure 7: Overview of household non-cash income across three case studies



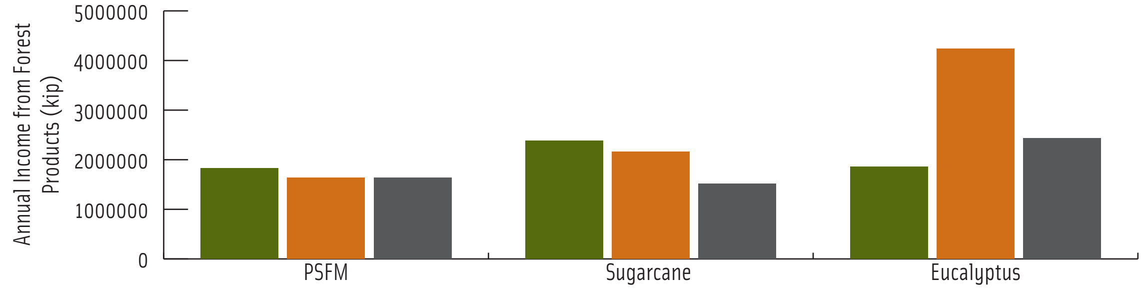

| | | | | | | |
|---|---|---|---|---|---|---|
| Rice consumption | 4,555,833 | 62% | 3,432,500 | 53% | 2,720,417 | 55% |
| Other crops | 29,167 | 0% | 201,250 | 3% | 167,917 | 3% |
| NTFPs | 1,678,833 | 23% | 1,644,875 | 25% | 1,090,625 | 22% |
| Timber | 784,000 | 11% | 784,000 | 12% | 784,000 | 16% |
| Firewood | 300000 | 4% | 417,500 | 6% | 157,500 | 3% |

The largest source of non-cash income across all three villages is rice consumption, representing 57 percent of all non-cash income generated. The PSFM village households consume more rice on average than the other villages. In addition, notable amounts of NTFPs are consumed in all three villages, representing on average 23 percent in the PSFM and eucalyptus concession villages. Third, timber for construction contributes on average 13 percent to non-cash income per household per year.[30]

In terms of forest, non-cash contributions (for example, from NTFPs, timber, and fuelwood) to different wealth categories was approximately the same across all household wealth classes. The cash equivalent value ranged between $185/year and $300/year. The outlier was the middle-income households in the eucalyptus village, which received the equivalent of approximately $530/year. In terms of the percent contribution to non-cash income, forest resources were the most important for the lower-income households in the eucalyptus village. Middle-income and poor households in the PSFM and eucalyptus villages obtained about half of their non-cash contributions from forest resources and the rest from subsistence rice production (see Figure 8). Despite the accounts of a shortage of NTFPs in the eucalyptus village, it appears that the poorest households (those that have very limited rice production for subsistence use and do not own livestock) are dependent on forest products for their livelihoods and food intake.

30. Due to the infrequency of house construction (on average every seven years) and the limited numbers of households sampled, these data could not be collected in the household survey and are rather based on key stakeholder interviews. All households are assumed to construct houses on roughly the same periodicity, thereby gaining the same non-cash value.

Figure 8: Non-cash income from forests by wealth class in three villages




| | | | | | | |
|---|---|---|---|---|---|---|
| Poor | 1832500.00 | 0.47 | 2381625.00 | 0.78 | 1856500.00 | 0.40 |
| Middle | 1637750.00 | 0.51 | 2157625.00 | 0.37 | 4239125.00 | 0.61 |
| Wealthy | 1637750.00 | 0.18 | 1512750.00 | 0.23 | 2437500.00 | 0.30 |

## CONTRIBUTIONS OF NTFPS FROM FOCUS GROUPS

The study engaged income-category-segregated and gender-segregated stakeholder focus groups in participatory ranking exercises on the importance of various sources of income. All groups attributed a higher importance to the contributions of NTFPs to household cash and non-cash resources than they did in the individual household surveys.

The summary tables from the gender- and economic-class-segregated focus group discussions in one community (the PSFM village) are shown in Tables 7 and 8. All gender and income groups indicated that forest products provide at least half of their cash income, although women attributed slightly more to NTFPs than men did. The largest contribution was from the sale of frogs and snails, followed by mushrooms and insects.

Table 7: NTFP contributions to total household cash income in PSFM village

| | Cash Income Ban Alang | Poor | Middle | Wealthy | All | Men | Women | Both |
|---|---|---|---|---|---|---|---|---|
| A | Forest Products | 54% | 56% | 54% | 55% | 51% | 57% | 54% |
| 1 | Mushrooms | 11% | 9% | 11% | 10% | 10% | 12% | 11% |
| 2 | Frogs and snails | 14% | 20% | 14% | 16% | 11% | 18% | 14% |
| 3 | Insect Products | 11% | 9% | 11% | 10% | 10% | 11% | 11% |
| 4 | Bamboo and rattan shoots | 6% | 9% | 6% | 7% | 4% | 7% | 6% |
| 5 | Wild vegetables | 2% | 4% | 2% | 3% | 0% | 4% | 2% |
| 6 | Kisi damar resin | 6% | 5% | 6% | 6% | 9% | 2% | 6% |
| 7 | herbal medicines | 1% | 0% | 1% | 1% | 3% | 0% | 1% |
| 8 | Timber for house building | 3% | 0% | 3% | 2% | 3% | 3% | 3% |

Source: PSFM village PRA discussions.

Similar to the importance attributed to forest products in the household data, participants indicated that forests contribute on average 52 percent to total non-cash household income (see Table 8). The poorer households attributed a significantly greater proportion (67 percent) of their non-cash household income to forests than wealthier households did (36 percent). Firewood, bamboo/rattan shoots, frogs, and snails were ranked highest by all household groups, while mushrooms and insect are more important to poorer households. Women and men do not seem to value these resources very differently. This points to the diversity within forest income that influences the sensitivity of the households.

Table 8: NTFP contributions to total household non-cash income in PSFM village

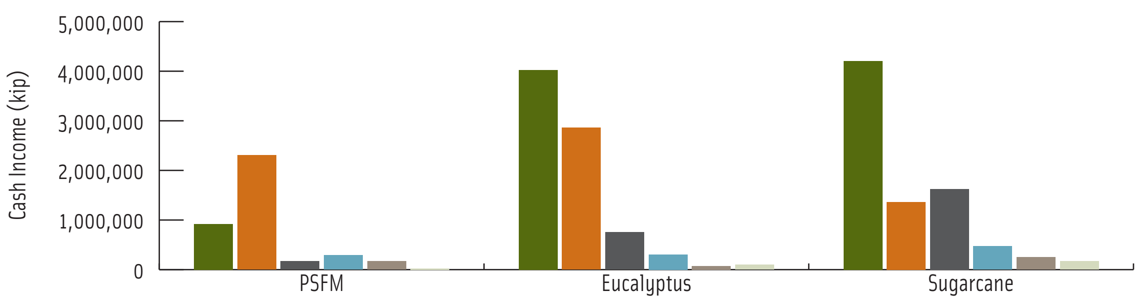
| | Non-Cash Income | Poor | Middle | Wealthy | All | Men | Women |
|---|---|---|---|---|---|---|---|
| A | Forest Products | 67% | 53% | 36% | 52% | 56% | 47% |
| 1 | Mushrooms | 8% | 5% | 3% | 5% | 7% | 4% |
| 2 | Frogs and snails | 9% | 8% | 8% | 8% | 9% | 8% |
| 3 | Insect Products | 8% | 4% | 0% | 4% | 5% | 3% |
| 4 | Bamboo and rattan shoots | 12% | 8% | 10% | 10% | 11% | 9% |
| 5 | Wild vegetables | 7% | 5% | 7% | 6% | 8% | 4% |
| 6 | Firewood | 11% | 14% | 8% | 11% | 10% | 12% |
| 7 | Timber for house building | 12% | 11% | 0% | 7% | 7% | 8% |

Source: PSFM village PRA discussions.

## HOUSEHOLD EXPENDITURES

An overview of household expenditures highlights some similarities and differences between the three community case studies and wealth categories. On average, poorer households spend around 73 percent of their income on food, with little left for other uses. Middle-income and wealthy households spend between 30 and 39 percent and spend more on household, production, social, and health costs (see Figure 9). The condition of poorer households is underscored by their low availability of income per year (4.3m Kip, or $541), and their overall greater expenditure on food suggests a clear lack of self-sufficiency in food production from either agricultural or forest sources.

Figure 9: Household expenditures by wealth group in three villages

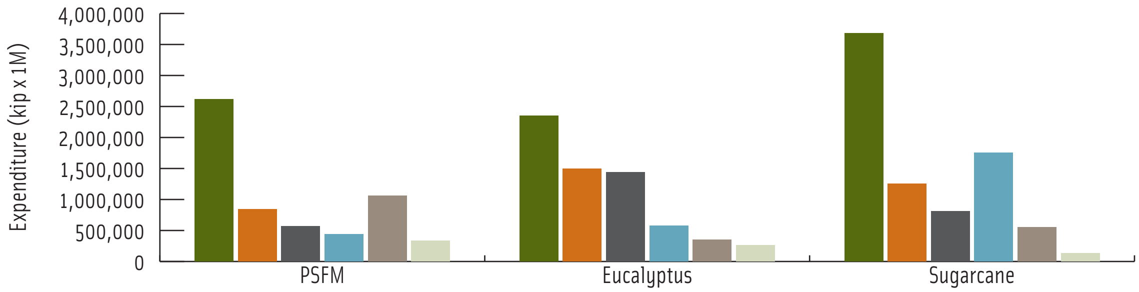



| | PSFM | | Eucalyptus | | Sugarcane | |
|---|---|---|---|---|---|---|
| Food | 3,371,667 | 73% | 2,608,462 | 30% | 2,409,808 | 39% |
| Household | 401,583 | 9% | 1,750,769 | 20% | 1,196,615 | 19% |
| Production | 91,667 | 2% | 1,585 | 18% | 939,231 | 15% |
| Social | 326,667 | 8% | 1,615,385 | 18% | 638,462 | 10% |
| Health | 191,667 | 7% | 797,692 | 9% | 835,385 | 13% |
| Schooling | 41,667 | 1% | 400,769 | 5% | 234,615 | 4% |

PSFM and sugarcane village households spend roughly 45 percent on food. The average eucalyptus village household spends a little less (38 percent) on food but spends more on household and production-activity related expenditures (see Figure 10). Whereas the PSFM community spends more than the others on education, the sugarcane village spends the most on social events,[31] suggesting that if there were a need to reallocate money to other expenditure categories it would be possible.

31. Note: This is not skewed by any marriages, as none took place in the last year in any household sampled.

## Figure 10: Household expenditures by village




| | | | | | | |
|---|---|---|---|---|---|---|
| Food | 2,619,375 | 45% | 2,354,167 | 36% | 3,677,917 | 45% |
| Household | 845,417 | 14% | 1,498,000 | 23% | 1,251,167 | 15% |
| Production | 572,500 | 10% | 1,442,500 | 22% | 811,667 | 10% |
| Social | 441,667 | 8% | 575,000 | 9% | 1,751,667 | 21% |
| Health | 1,058,333 | 18% | 350,000 | 5% | 555,000 | 7% |
| Schooling | 334,167 | 6% | 262,500 | 4% | 133,333 | 2% |

## BALANCING HOUSEHOLD CASH INCOME AND EXPENDITURES

A review of the total household cash income and expenditures across the three villages and wealth groups is provided in Table 9. The average household in the PSFM and sugarcane villages earns less than it spends, as do the poorer and middle-income households, suggesting a notable level of sensitivity to changes in economic conditions.

## Table 9: Cash incomes and expenditures in three villages and wealth groups

Balance between average household cash income and expenditures over three villages

| Income/Expend. | PSFM | Eucalyptus | Sugarcane | Average | |
|---|---|---|---|---|---|
| Cash Income | 3,873,833 | 8,118,833 | 8,077,000 | 6,689,889 | 836 |
| Expenditures | 5,871,458 | 6,482,167 | 8,180,750 | 6,844,792 | 856 |
| Balance | -1,997,625 | 1,636,667 | -103,750 | -154,903 | -19 |
| US$ (yr 2012) | $(250) | $205 | $(13) | $(19) | |

Balance between household cash income and expenditures between wealth groups in three villages

| Income/Expend. | Poor | Medium | Rich | Average | |
|---|---|---|---|---|---|
| Cash Income | 3,091,250 | 5,806,538 | 9,865,846 | 6,689,889 | 836 |
| Expenditures | 4,324,917 | 8,708,462 | 6,254,115 | 6,844,792 | 856 |
| Balance | (1,233,667) | (2,901,923) | 3,611,731 | (154,903) | (19) |
| $ | $(154) | $(363) | $451 | $(19) | |

## OVERALL ECONOMIC AND FINANCIAL SENSITIVITY

Using data collected as part of the detailed household income and expenditures, the sensitivity of total cash and non-cash income was calculated by determining the percentage of the total income that was dependent on natural resources that are vulnerable to climate change (directly, as a source of cash and non-cash income) and indirectly (as an input to another source of income, such as livestock). The findings are presented in the Table 10.

Table 10: Share of total income dependent on natural resources and expenditures directly related to food purchases and food production (agricultural inputs) in three villages and wealth categories*

| | Poor | Medium | Rich | Average |
|---|---|---|---|---|
| **PSFM Village** | | | | |
| Total Sensitivity | 86 | 95 | 86 | 90 |
| Direct Sensitivity | 93 | 90 | 62 | 74 |
| Indirect Sensitivity | 7 | 10 | 38 | 26 |
| Expenditure | 63 | 40 | 45 | 48 |
| **Eucalyptus Village** | | | | |
| Total Sensitivity | 62 | 60 | 73 | 65 |
| Direct Sensitivity | 92 | 90 | 52 | 77 |
| Indirect Sensitivity | 8 | 10 | 48 | 23 |
| Expenditure | 1 | 26 | 19 | 15 |
| **Sugarcane Village** | | | | |
| Total Sensitivity | 42 | 73 | 54 | 59 |
| Direct Sensitivity | 100 | 74 | 94 | 80 |
| Indirect Sensitivity | 0 | 26 | 6 | 20 |
| Expenditure | 83 | 70 | 46 | 66 |

* The expenditure categories included are those for buying rice, meat, fish and other food as well as expenditures on agricultural inputs.

## 6.2.2 Land use change

Each village has a different land use history.

**The PSFM village** is inhabited by villagers who identify closely with the Brou ethnicity. The village was established well before 1832, and villagers have lived in this location throughout the last century. More recently, this village has also been involved in both the Lao-Swedish Joint Forest Management project (JFM) and the Finnish-Lao Forest Management and Conservation Program (FOMACOP)/PSFM projects.

A small proportion (346 ha) of the total village forestlands (2,709 ha) falls within the Dong Kapho Production Forest Area (supported by the PSFM project). However, several impacts of the PSFM and the JFM and FOMACOP projects[32] apply to the village lands overall. At the community level, stakeholders have a greater understanding of the rationale for sustainable forest management, and this applies to a certain degree throughout its forest areas.

The government does not issue land concessions in villages associated with the production forest areas, strengthening the resolve of the community to reject the frequent requests for land from outside investors and reducing concerns of land conversion. In the PSFM community, each household is estimated to have access to an average of 17.23 ha of DDF land (see Table 11).

32. The JFM project ran from 1991 to 1995; the FOMACOP project ran from 1995 to 2001. FOMACOP evolved into SUFORD and the current PSFM project.

## Table 11: Available land per household in the PSFM village

| Land Use Category | Lao Name | Area (ha) | Area/hh (ha) |
|---|---|---|---|
| village use forest | pa somsai | 833 | 9.8 |
| land reserved for agriculture | din hae kasikam | 631 | 7.43 |
| **Total Dry Forest Area** | **pa kok** | **1,465** | **17.23** |
| regeneration forest | pa feun fu | 432 | 5.08 |
| state production forest | pa palit | 346 | 4.08 |
| holy forest | pa mahaesak | 71 | 0.84 |
| burial forest | pa sa | 8 | 0.09 |
| **Total Mixed Deciduous Forest** | **pa pasom** | **858** | **10.09** |
| paddy field | na deum | 277 | 3.26 |
| Total agricultural land | din kasikam | 277 | 3.26 |
| wetland | din beung | 54 | 0.64 |
| built up area | din beung | 27 | 0.32 |
| river bodies | mae nam | 22 | 0.26 |
| roads | sen tahng | 6 | 0.08 |
| **Total others** | **din eun** | **110** | **1.29** |
| **Total** | | **2,709** | **31.87** |

The inhabitants of **the eucalyptus village** belong to the Lao Xouay ethnicity, although some community leaders claim to regard their ethnicity as belonging to the largest national grouping of ethnicities (the *Lao loung*). According to local and district officials, the village was officially relocated from its original location on the banks of the Xaha River to its present location two years ago. The relocation was indicated as necessary to give the villagers access to a new power line brought in by the government and to provide more room for population and paddy expansion. Villagers have received limited gains from the utility line routing, although a newly established sawmill located in the middle of the village has access to power. The government has indicated the intention to establish a "focal area" market at this site.

In 2006, the Indian-owned Birla pulpwood company received the concession to convert roughly 311 ha (one-third) of this village's territory into eucalyptus plantation. Unfortunately, the plantation management did not adequately assess or respect existing land use patterns in the delineation of its concession boundaries, resulting in significant adverse impacts on local livelihoods. An estimated 68 ha of existing paddy fields were appropriated by the company, representing 28 percent of the total village paddy in use (see Table 12). In addition, an unknown amount of land that was formally registered by villagers for future generations' paddy expansion (known as *chap chong din*[33]) as well as non-claimed standing (predominantly) DDF areas were bulldozed for inclusion in the plantation. In total, 246 ha of forest were converted, or roughly 33 percent of the total village forestlands. This has resulted in a range of conflicts between the villagers and the company, based on the local law enforcement's documentation of over 40 cases.

33. These are forested lands that are claimed by individuals for future development into paddy, for which the individuals pay land taxes to the district government.

## Table 12: Paddy and forest converted to eucalyptus in eucalyptus village

| Land Use Category | area (ha) | % of total |
|---|---|---|
| Total land area of the village | 977.45 | 100% |
| Total land remaining for villagers | 664.01 | 68% |
| **Paddy** | | |
| Original paddy area | 241.09 | 25% |
| Paddy converted to Eucalyptus | 67.58 | 7% |
| Remaining paddy area | 173.51 | 18% |
| Share of paddy lost | | 28% |
| **Forest** | | |
| Original forest area | 736.36 | 75% |
| Forest converted to Eucalyptus | 245.86 | 25% |
| Total area planted to Eucalyptus | 313.44 | 32% |
| Remaining forest area | 490.5 | 50% |
| Share of forest lost | | 33% |

The residents of **the sugarcane village** belong to the Katang ethnicity, an ethnicity that is closely related in language, physical features, and upland farming settlement locations to the Xouay of the eucalyptus village. However, this village has undergone a significant reorganization during recent years, as five villages were merged into two new administrative units. In addition, a sugarcane concession was established on village lands.

The Savan Sugar Company engaged actively with the community in order to avoid expropriating either paddies currently in use or the lands identified by the community as being registered as *chap chong din*. While the concession has not been burdened by any significant amount of conflicts with the community, the impact of the concession on livelihoods is more notable than in the eucalyptus village. The sugarcane concession has taken up almost all the remaining forestland available to the community, leaving villagers with very little forest for livestock to graze in or for the collection of NTFPs.

No village map or map of the concession was available. However, based on the land holdings under *chap chong din* registry and the number of cattle owned by the sampled households, the average area of grazing land that is available per head of livestock appears to be around 0.43 ha, suggest an enormous pressure on the resources base.

The three case studies represent quite different land use and forest endowment contexts. The PSFM village is relatively isolated from major markets and roads, has three times the land area, and retains a significant proportion of its land (62 percent) under forest cover. In this community, each individual has a larger mean area under rice cultivation, as well as larger amounts of *chap chong din* for paddy.

In contrast, the two concession villages are located close to the major east-west highway that connects this province directly with the capital as well as markets in Vietnam and Thailand. Households in these villages have much smaller land holdings (both in terms of paddy and *chap chong din*). The eucalyptus village retains roughly 62 percent of its village lands as communal forest and 14 percent of the land under chap chong din forest cover. In the sugarcane village, only 35 percent of the forest cover remains and most of this is under chap chong din (and, therefore, is likely to be converted in the future).

The climate change modeling described earlier concludes that land use change can undermine any positive gains from climate change and compound any potential negative impacts. Ongoing land use change and current social conditions suggest that the small agricultural households in the sugarcane and eucalyptus villages are likely to be relatively more sensitive to climate change than households in the PSFM village.

# 6.3 Adaptive capacity

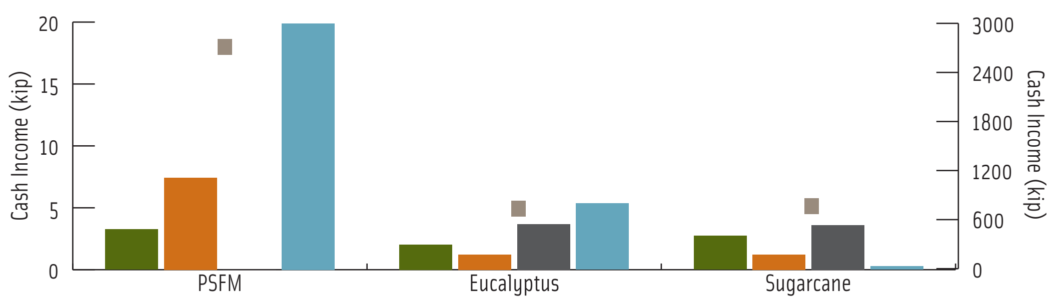
Adaptive capacity in the context of smallholder agriculture is often considered a function of economic resources, access to technology, information and skills, access to infrastructure, and the strength of local institutions and level equity. This section uses the data collected to reflect the adaptive capacity of the households sampled in the three villages, with a focus primarily on their economic resources.

## 6.3.1 Contribution of land to adaptive capacity

The data collected in this study did not allow for a complete analysis of all household assets. The availability of paddy for rice cultivation, the household claims to land for future agricultural expansion, and access to additional communal forests, however, allow for some general comparisons to be made. Figure 11 indicates the average amount of paddy available to each household.

The PSFM village households have both the largest average area of paddy under cultivation (3.26 ha) as well as the highest amount of forestland reserved as *chap chong din* (7.43 ha). In contrast, the average eucalyptus village household retains only 2.04 ha of paddy and 1.23 ha of *chap chong din*. The sugarcane village households similarly own an average of 2.73 ha of paddy and 1.23 ha of reserve forest, although in this case most of this forest has actually been claimed as *chap chong din* and can be expected to be converted soon.

Figure 11: Total land area available per household in three case study communities




| | PSFM | Eucalyptus | Sugarcane |
|---|---|---|---|
| Paddy (ha/hh) | 3.26 | 2.04233 | 2.73 |
| Reserved land (ha/hh) | 7.43 | 1.23 | 1.23 |
| Concession land lost (ha/hh) | 0 | 3.69 | 3.61 |
| Communal Forest (ha/hh) | 19.89 | 5.36 | 0.28 |
| Total Village land (ha) | 2,709.00 | 737.05 | 766.61 |

## 6.3.2 Contribution of livestock to adaptive capacity

Livestock assets are the main source of savings for rural households in Lao PDR. Livestock can be sold for cash in times of need (flooding or illness). The value of livestock assets can be compared to the annual income of households, as a measure of self-sufficiency or resilience in times of crisis. When comparing livestock ownership across the three villages, significant differences are noted (see Table 13).

Overall, the PSFM village owns roughly 46 percent more livestock than the eucalyptus village and 80 percent more than the sugarcane village. Interestingly, the middle-income households across the three villages own relatively similar numbers of livestock (the means for each village are within 12 percent of the overall mean). In contrast, the differences among the poor in the three villages is notable, with the eucalyptus village owning 200 percent and the sugarcane village own less than 5 percent than the mean.

One way of representing the relative contributions of livestock to households' adaptive capacity or resilience to shocks is to compare the value of livestock owned to the total annual cash income of each household. In the PSFM village, the value of large livestock was on average comparable to 43 months or 3.6 years of total household income. In the concession villages, where households' reliance on income is higher overall, livestock assets represent 12–14 months of income. While there are certainly disparities between household groups, the livestock equivalent in income is similar among the poorest households in the PSFM village (1.4 years), the mean wealthy households in the eucalyptus village (1.3 years), and the mean wealthy households in the sugarcane village (1.7 years). The poorer households in the sugarcane village have almost no livestock buffer.

### Table 13: Contribution of livestock assets to household resilience

| livestock assets | poor | | middle | | wealthy | | average | |
|---|---|---|---|---|---|---|---|---|
| | Kip | $ | Kip | $ | Kip | $ | Kip | $ |
| PSFM village | 1,487,500 | 186 | 6,878,750 | 860 | 33,362,500 | 4,170 | 13,909,583 | 1,739 |
| Eucalyptus village | 3,695,000 | 462 | 7,721,250 | 965 | 17,210,000 | 2,151 | 9,542,083 | 1,193 |
| Sugarcane village | 81,250 | 10 | 6,066,250 | 758 | 17,102,500 | 2,138 | 7,750,000 | 969 |
| average | 1,754,583 | 219 | 6,888,750 | 861 | 22,558,333 | 2,820 | 10,400,556 | 1,300 |
| **total HH cash income** | | | | | | | | |
| PSFM village | 1,041,750 | 130 | 2,062,250 | 258 | 8,655,000 | 1,082 | 3,873,834 | 484 |
| Eucalyptus village | 3,842,500 | 480 | 7,037,500 | 880 | 13,476,500 | 1,685 | 8,118,833 | 1,015 |
| Sugarcane village | 4,302,000 | 538 | 5,343,500 | 668 | 10,157,500 | 1,270 | 8,077,000 | 1,010 |
| average | 3,062,083 | 383 | 4,814,417 | 602 | 10,763,000 | 1,345 | 6,689,889 | 836 |
| **livestock/income** | | | | | | | | |
| PSFM village | 143% | | 334% | | 385% | | 359% | |
| Eucalyptus village | 96% | | 110% | | 128% | | 118% | |
| Sugarcane village | 2% | | 114% | | 168% | | 96% | |
| average | 80% | | 186% | | 227% | | 191% | |
| **HH resilience (years)** | | | | | | | | |
| PSFM village | 1.4 | | 3.3 | | 3.9 | | 3.6 | |
| Eucalyptus village | 1 | | 1.1 | | 1.3 | | 1.2 | |
| Sugarcane village | 0 | | 1.1 | | 1.7 | | 1 | |
| average | 0.8 | | 1.9 | | 2.3 | | 1.9 | |

While the poorer and middle-income households in the eucalyptus village and the middle-income households in the sugarcane village own reasonable livestock buffers, qualitative interviews with stakeholders indicate that availability of forage and water sources in these communities is a concern. At present, the sugarcane village relies on the permeability of village boundaries to enable their livestock to graze in neighboring village areas, as the concession has converted all communal forestlands. The only forage left in their village is on lands that have been claimed for future development or expansion of paddy (*chap chong din*).

In the case of the eucalyptus village, the potential of losing additional village lands to concessions is resulting in large-scale privatization of the remaining communal forests into chap chong din plots. As chap chong din plots progressively become fenced and converted for other uses, the use of livestock as a source of resilience is likely to be rapidly eroded in the coming years.

### 6.3.3 Household food security and nutrition as a proxy for resilience

Glutinous rice, the dietary staple of all three villages, comes from rainfed paddies. The average actual rice consumption in Lao PDR is estimated at 160 kg/peson, and in most neighboring countries it is about 120–140 kg/person. The recommended norm of rice per person is not known. An analysis of rice production and consumption (see Table 14) indicates that all the households have more rice than is consumed on average per person. As expected, the wealthier households consume much more rice than the poorer and middle-income households do. The wealthier households in the PSFM village consume quantities of rice that are lower than those consumed by the wealthier households in the two concession communities. In the concession communities, middle-income households consume less rice than the poor households do. However, food security in these villages does not depend on greater access to land alone.

Table 14: Food security—Rice consumption across three communities

| Village | Wealth group | Area of rice paddy | Rice produced kg/ha | Consumed rice purchased kg/capita | Actual consumption kg/capita |
|---|---|---|---|---|---|
| PSFM | Poor | 0.36 | 1,040 | 18 | 319 |
| | Middle | 0.37 | 1,290 | 13 | 332 |
| | Wealthy | 0.17 | 1,317 | 11 | 360 |
| Eucalyptus | Poor | 0.53 | 1,547 | 9 | 360 |
| | Middle | 0.32 | 1,640 | 7 | 297 |
| | Wealthy | 0.79 | 1,690 | 18 | 558 |
| Sugarcane | Poor | 0.70 | 2,208 | 11 | 322 |
| | Middle | 0.29 | 2,333 | 6 | 290 |
| | Wealthy | 0.38 | 2,500 | 18 | 596 |
| Average | | 0.44 | 1,391 | 15 | 404 |

Across the three villages, access to paddy is not correlated with income. In contrast, rice yields per hectare are correlated with income within each village, though in the case of the eucalyptus village, middle-income and wealthy households have roughly the same yields. Based on stakeholder discussions as well as the household interviews, it is clear that wealthier households in the concession villages invest greater capital in agricultural inputs (both labor and fertilizer).

In addition to inter-household differences in yield, there are significant differences in rice yields among the villages. Stakeholder discussions in the concession villages suggest an increased use of inorganic fertilizers. In contrast, households in the PSFM village are attempting to raise yields mainly through collection and application of natural fertilizers.

These disparities are not, however, reflected in the consumption of NTFPs (primarily mushrooms, rattan, bamboo shoots, insects, frogs, and snails). Stakeholders in poorer households consume roughly the same amount (expressed in cash equivalent) of NTFPs across the three villages ($21–33/year), and in both the PSFM and sugarcane villages the poor consume more NTFPs than wealthier households do (see Table 15). In addition, while middle-income households have the largest rice deficit, they consume more than twice the amount of NTFPs as other households.

In the sugarcane village, NTFP consumption is negatively associated with income. Considering that that the availability of communal forestland is almost reduced to nil and that income is closely correlated with claims to chap chong din, the inverse relationship between income and NTFP consumption suggests that very little of the forestland has been converted and that these claims to *chap chong din* do not present a hindrance to other people's access for the collection of NTFPs.

Table 15: Food security—NTFP consumption across three communities

| Village | Income group | Area of forest (ha/capita) | Consumption of wild foods | |
|---|---|---|---|---|
| | | | (kip/capita) | ($/capita) |
| PSFM | poor | 2.59 | 198,000 | $ 24.75 |
| | middle | 2.56 | 510,581 | $ 63.82 |
| | wealthy | 2.45 | 40,122 | $ 5.02 |
| Eucalyptus | poor | 0.81 | 171,429 | $ 21.43 |
| | middle | 1.02 | 495,262 | $ 61.91 |
| | wealthy | 1.08 | 219,769 | $ 27.47 |
| Sugarcane | poor | 0.19 | 264,568 | $ 33.07 |
| | middle | 0.20 | 181,232 | $ 22.65 |
| | wealthy | 0.36 | 101,667 | $ 12.71 |
| Average | | 1.05 | 238,988 | $ 29.87 |

The results raise the question of whether the wealthier households with more food security (in terms of caloric intake) have the same levels of nutrition as the poorer and middle-income households. While food security is seemingly not the greatest concern in these communities, it will be a cause for concern to both caloric intake and nutritional diversity among poorer and middle-income households, as natural population growth and loss of forests to concessions and paddy will combine to reduce the supply of NTFPs for all. All three communities also express concerns regarding the limited availability of land suited for conversion to paddy as well as to support livestock or NTFP consumption needs.

According to stakeholders living in the concession villages, some seasonal nutritional impacts are already being felt, highlighting how annual estimates of cash incomes frequently mask the seasonality of food and cash insufficiency. Concession stakeholders indicate that they previously paid for small household purchases through cash raised from the sale of NTFPs collected throughout the year. Unfortunately, with the increasingly limited per capita amount of forest available and the intermittent availability of labor opportunities, households indicate greater seasonal food insecurity.

In addition, when asked what kinds of food they purchase, most stakeholders indicate that they cannot afford to replace the NTFPs that they had previously consumed on a regular basis through purchases. Instead of the diversity of frogs, snails, fish, insects, small birds, and mammals that they would previously have consumed throughout the year, households are increasingly reliant on the purchase of chicken, pork, and salted tuna. Furthermore, they indicate that they seldom purchase vegetables to replace those no longer available to them.

Evidence from the three case studies, for the interviewed households, on the sensitivity and adaptive capacity to climate change provides a good indication of how forests are and could contribute to enhancing the resilience of smallholder agriculture households. In the PSFM village, household incomes are directly sensitive to climate change. However, the large area of land with limited pressure for conversion to other purposes enables the households to buffer their level of income and financial sensitivity in two ways: with adequate grazing areas and through the consumption and sale of NTFPs (to augment their food security and for use as fuelwood and production into charcoal).[34] Because of the large land area in the PSFM village, which is relatively secure from conversion, the households' resilience strategy relies heavily on livestock and NTFPs. People also are able to minimize seasonal variations in food security by using NTFPs as a backup during these times. Surveyed households, however, mentioned the dwindling supply of NTFPs.

In the eucalyptus and sugarcane villages, while the specific conditions are slightly different, it is noteworthy that in both cases a notable portion of the income of the sampled poor and medium-level households is directly sensitive to climate change. These households, in contrast to the PSFM households, do not have ready access to forestlands or additional lands for paddy production. (For example, in the eucalyptus village 28 percent of paddy land and 33 percent of forestland was converted; in the sugarcane village, while land conversion did not result in the loss of existing paddy land, it has taken up much of the forest that used to be in place.) In the sugarcane village, the limited enforcement of boundaries may explain how several of the interviewed households are still able to rely on NTFPs to buffer themselves against climate shocks that affect their level of food security.

The primary impacts of land use changes on stakeholder resilience in the selected rice farming communities relate to the loss of access to forests for NTFPs and fodder for livestock. Livestock are an asset that households use to enhance their resilience against shocks. Farmers in these areas attribute rice production largely to the capacity of dry forests to absorb and regulate flows of water (Fujita 2000). In most DDF areas, rice production is mainly practiced in shallow depressions suffering marked drought and flood regimes that are a function of direct rainfall intensity.

It is also important to point out that most households do not have enough income, even with labor opportunities, to match their expenditures. The financial status of these households constrains their ability to change their grazing practices and adopt stall feeding in order to maintain livestock as part of their "resilience portfolio." The households' income stream also constrains access to other forms of insurance against climate shocks.

In summary, in the sampled households, forests play an important role in resilience to major shocks in order to overcome periodic shortfalls in income and food supplies. The resilience of households is higher in the PSFM area than in areas where land use change has reduced access to forests and additional lands for paddy.

34. More than 90 percent of households rely on fuelwood (primarily firewood and charcoal) for cooking and heating. A study from 2012 indicates that consumption of firewood in the rural areas averaged about five kilograms per day per family. This represents over 2 million tons of firewood consumed annually (source: www.biomass-asia-workshop.jp/biomassws/10workshop/download-file_10th_biomass-asia-workshop/5_AUG_13/15.%20Mr.Bounchanh%20Douangvilay,%20REMI,%20Country%20report%20Lao%20PDR.pdf).

# 7. Values of the Ecosystem Services of Dry Dipterocarp Forests

Due to limited data availability, this case study does not apply economic analysis to compare the cost effectiveness of a resilience strategy that includes forests for grazing livestock (that is, a strategy that includes an EBA approach) with alternative resilience strategies that are culturally appropriate and implementable. In place of this approach, the analysis estimates benefits to households from forest ecosystem services that are represented based on their harvesting value on an annual basis. The assessment of the value of ecosystem services provides an indication of the costs that need to be accounted for when deciding on land use changes (including the cost of undermining smallholder agricultural households' resilience strategy).

## 7.1 Valuation of provisioning services

The optimal stocking density of livestock in the dry forest context of Southeast Asia has been estimated by Zola and Fraser (2012) as 5.4 ha/head. The PSFM village is the closest measurement for a sustainable livestock provisioning service in this context. In the other communities, stakeholders allude to allowing their livestock to graze on the lands of neighboring villages, which cannot be used for an accurate calculation of a sustainable ecosystem service.

Based on stakeholder focus group activities and discussions, different land categories in the PSFM village were ranked for their relative importance in providing fodder to livestock. Stakeholders indicate that livestock rely on forestland and that rice paddies only provide nutrients during the two months of the year immediately following the rice harvest. In comparing the amount of forest (both communal and current chap chong din) and the numbers of livestock registered by village leaders, the respective stocking densities in the three villages surpassed what would be considered as a sustainable level (3.5 ha/animal): PSFM (2.5 ha/animal), eucalyptus (1.5 ha/animal, from pre-concession 4.3 ha/animal), and sugarcane (0.43 ha/animal).

Through a multiplication of the total market value of cattle and buffaloes sold in the PSFM village in 2011 (approximately KIP 155,660,131, or roughly $19,458) and the relative contribution of each land use type and area in the village in providing forage,[35] the overall value of dry forest provision services for fodder come to $63.60/ha (see Table 16). While paddy does provide a significant value in fodder as well, it cannot replace forest, as this supply is only available for 1–2 months immediately following the rice harvest. In this community, stakeholders indicate that the mixed deciduous forests have little forage to offer and are not grazed very much by livestock.

35. Villagers in the PSFM village estimate that for grazing, their cattle depend for 10 out of 12 months on the DDF forest and for the remaining months they rely on the paddy fields in the beginning of the dry season.

### Table 16: Values of livestock per hectare for three land use types in the PSFM village

| Livestock values | Dry forest | Mixed Deciduous Forest | Paddy | Total |
|---|---|---|---|---|
| Total livestock sold (kip) | 129,197,908 | - | 26,462,222 | 155,660,131 |
| Total livestock assets (kip) | 745,201,667 | | 152,631,667 | 897,833,333 |
| Land area (ha) | 1,465 | 778 | 277 | 2,520 |
| Value of livestock sales per ha (kip) | 88,214 | - | 95,490 | 61,767 |
| Value of livestock sales per ha ($) | $11.03 | $- | $11.94 | $7.72 |
| Value of livestock assets per ha (kip) | 508,812 | - | 550,778 | 356,268 |
| Value of livestock assets per ha ($) | $63.60 | $- | $68.85 | $44.53 |

A calculation of the annual estimated sale or market equivalent value of all NTFPs consumed and sold indicates that DDFs provide a higher value ($4.19/ha), almost two-thirds of the value of the paddy based on the value of rice sold and consumed (see Table 17).

### Table 17: Values of annual NTFPs sold from three land use types in the PSFM village

| Non-Timber Forest Values | DDF | MDF | Paddy | Total |
|---|---|---|---|---|
| NTFPs consumed (kip) | 40,356,997 | 13,004,498 | 11,206,040 | 64,567,535 |
| NTFPs sold (kip) | 8,722,062 | 2,190,934 | 3,580,684 | 14,493,681 |
| Total NTFP value (kip) | 49,079,059 | 15,195,432 | 14,786,724 | 79,061,215 |
| Total land area (ha) | 1,465 | 778 | 277 | 2,520 |
| Value NTFPs consumed (kip/ha) | 27,555 | 16,707 | 40,437 | 25,621 |
| Value NTFPs sold (kip/ha) | 5,955 | 2,815 | 12,921 | 5,751 |
| Value of all NTFPs per ha (kip/ha) | 33,510 | 19,521 | 53,359 | 31,372 |
| Value NTFPs consumed ($/ha) | $3.44 | $2.09 | $5.05 | $3.20 |
| Value NTFPs sold ($/ha) | $0.74 | $0.35 | $1.62 | $0.72 |
| Value of all NTFPs ($/ha) | $4.19 | $2.44 | $6.67 | $3.92 |

A limited amount of timber harvesting is permitted from the PSFM forest for construction purposes. Two primary types of timber are harvested from DDFs for house construction: *mai koung (D. tuberculatus)* for the supporting posts on which houses are elevated and *mai chik (S. obtusa)* for floor and walls. There are several other common species of *Dipterocarpacae*, with their own uses. However, given the limited data available on the amounts of each tree species found in these forests, an average value of the two species above is used to derive an estimated value of the DDF provision of timber of $6.91/ha.[36] This compares with the average value of a mixed-deciduous forest of $36–145/ha (see Table 18).

36. This low value is a significant reason why most foresters assess a very limited value to DDFs.

### Table 18: Value of timber resources in three land use types in the PSFM village

| Timber values | DDF | MDF | Paddy | Total |
|---|---|---|---|---|
| Timber volume (m3/ha) | 19 | 20 -80 | 5 | 12 |
| Average timber price ($/m3) | $40.00 | $200.00 | $20.00 | $246 |
| Total Timber value ($/ha) | $760 | $4000-16,000 | $100 | $2,953 |
| Annual value ($/ha) * | $6.91 | $36-145 | $1 | $26.85 |

* Based on 110 year rotation cycle

The limited value of DDFs for timber is further reduced by the poor soil conditions that constrain tree growth. Based on a detailed inventory and a calculation of growth rates in DDFs in Savannakhet Province by Pukkala (2005), it is estimated to take over a century for the two species just mentioned to reach a harvestable width (roughly when they attain a diameter at breast height of 25cm) (see Table 19).

### Table 19: Time needed to grow to harvestable size for three dominant species in DDFs in Savannakhet

| Key DDF species | | Average | Growth | No years to | No years |
|---|---|---|---|---|---|
| Lao Name | Scientific Name | DBH (cm) | cm/ 5yrs | average DBH | to DBH=25 |
| Mai koung | *Dipterocarpus tuberculatus* | 26 | 1.2 | 108 | 104 |
| Mai chik | *Shorea obtusa* | 28.7 | 1.1 | 130 | 114 |
| Mai sat | *Dipterocarpus obtusifolius* | 23.3 | 1.04 | 112 | 120 |
| | Average | 26 | 1 | 117 | 113 |

Source: Pukkala, 2005.

Through key stakeholder interviews, a rough estimate was obtained in the PSFM village for the consumption of timber for household construction (see Table 20). The actual off-take represents a value of $3.75/ha of forest per year. This is much lower than the value that could be obtained if the forest were harvested in a sustainable way, as noted in Table 18 ($6.91 for DDF and $36–145 for mixed-deciduous forest). This would seem to indicate that present levels of legal village harvesting of timber for house construction are very modest.

### Table 20: Villagers' estimate of annual consumption of timber for house construction in the PSFM village

| Actual Timber Off-take | Values |
|---|---|
| No Households per year | 7 |
| Volume of wood needed/hh (m3) | 30 |
| Local price kip/m3 | 320,000 |
| Total value kip/year | 67,200,000 |
| Total value $ | $ 8,400 |
| Value $/ha of forest | $ 3.75 |

In addition to harvesting timber for construction and furniture making, a significant amount is harvested for firewood. Although communities near the major highway appear to be very actively involved in the production of charcoal (particularly for export to Vietnam), the distance from the PSFM village (which this valuation is based on) to such markets makes charcoal production financially unviable because of the transportation costs. Based on the market values of firewood reported, the average provisioning service values of firewood from DDF and mixed-deciduous forests are $1.09/ha and $2.05/ha, respectively (see Table 21).

Table 21: Values of firewood per hectare from three land use types in the PSFM village

| Firewood values | DDF | MDF | Paddy | Total |
|---|---|---|---|---|
| Annual value of fuelwood consumption (kip) | 12,750,000 | 12,750,000 | | 25,500,000 |
| Land area (ha) | 1,465 | 778 | 277 | 2,520 |
| Value per ha (kip) | 8,706 | 16,380 | - | 10,119 |
| **Value per ha ($)** | **$1.09** | **$2.05** | **$-** | **$1.26** |

As with most communities located next to a major forest under government management, it can be assumed that there is some under-reporting of the amount of both timber and firewood harvested.

## 7.2 Valuation of regulating services

In terms of the regulating services that are provided by the DDF, these forests provide a range of services that are less visible. While they are not typically located on very steep slopes, in which the erosion and flood control functions of forests may play a larger role, the loss of DDFs would result in some alteration of base hydrological flow and siltation of existing fields. Therefore a conservative valuation of the watershed regulatory services has been calculated at 25 percent of the value of the annual rice production, resulting in a total DDF valuation of $26.31/ha (see Table 22).

Table 22: Watershed regulatory values of dry forests, calculated as 25 percent of total rice production value in the PSFM village

| Rice values and erosion values | DDF | MDF | Paddy | Total |
|---|---|---|---|---|
| Rice consumed in whole village ($) | | | $48,406 | $48,406 |
| Rice sold in whole village ($) | | | $1,771 | $1,771 |
| Land area | 1,465 | 778 | 277 | 2,520 |
| Value of rice consumed ($/ha) | | | $174.67 | $174.67 |
| Value of rice sold per ha ($/ha) | | | $6.39 | $6.39 |
| Total value of rice per ha ($/ha) | | | $181.06 | $181.06 |
| **Erosion values (25 % of rice production)** | **$26.31** | **$13.98** | **$4.98** | **$45.27** |

## 7.3 Valuation of Co-benefits

Finally, it must be underscored that in addition to the ecosystem services for which tentative valuations of their contributions to local stakeholder resilience are calculated here, DDFs a host of additional ecosystem services to a wide range of stakeholders at various scales.

One form of potential co-benefit for which tentative markets already exist (but whose value as applied to the country's DDF have not actually been realized in the marketplace) is that of the international market price for the trade in carbon credits. Based on estimations of carbon content for Savannakhet's DDFs (Pukkala 2005) and a conservative carbon credit of $4.80/ton, over the course of their 110-year harvest rotation cycle, DDFs could potentially contribute a net annualized value of $3.55/ha (see Table 23).

Table 23: Value of DDFs in terms of potential carbon credit

| Carbon values | DDF | MDF | Paddy | Total |
|---|---|---|---|---|
| carbon content (tons C/ha) | 22.20 | 54.50 | 6.92 | 0.00 |
| carbon content (tons CO2/ha) | 81.46 | 200.02 | 25.40 | 0.05 |
| Carbon value, price= $4.8 /ton CO2 ($/ha) | $390.99 | $960.07 | $121.90 | $133.79 |
| Total Carbon value whole area (1,465 ha) | $572,636 | $747,320 | $33,782 | $1,353,738 |
| carbon asset per year (110 yr cycle, $/ha) | $3.55 | $8.73 | $1.11 | $4.46 |

In addition, for a range of ecosystem services estimations of monetary values in this context are not possible given the data available, representing areas for future research. In addition, in some cases the calculation of a monetary value may not be desirable for moral or cultural reasons. Some of the ecosystem services for which no data are available include:

- Provision of drinking water for livestock consumption
- Provision of habitat for biodiversity in general, as well as the flora and fauna involved in natural pest regulation, barriers to the spread of diseases, and the provisioning of honey and pollination services for many plants, both domesticated and not
- Soil micronutrient uptake
- Microbial diversity for soil health
- Local temperature and climate regulation during heat waves that protect humans, livestock, and a range of plants used by humans
- Cultural and religious values
- Recreational and aesthetic values
- Genetic diversity values
- Medicinal values

## 7.4 Total value of DDF ecosystem services

To summarize, ecosystem services provide an immediate and measurable source of annual returns to households through the sale and/or replacement values for livestock, NTFPs, firewood, construction materials, and domestic water supplies. The value of current estimated annual income in the PSFM village from these provisioning services amounts to roughly $20.66/ha (see Table 24). In addition, when adding a conservative estimation of the contributions of DDF forests to regulation of the water supplies and erosion control for agricultural production, the total value of known, quantifiable ecosystem services is estimated to amount to $46.97/ha.

Table 24: Economic values of dry forest ecosystem services as annual returns to the PSFM village

| Dry Forest Ecosystem Services Annual returns | kip/ha | $/ha |
|---|---|---|
| Livestock sales | 88,214 | $ 11.03 |
| NTFP sales and consumption | 33,510 | $ 4.19 |
| Timber for house construction | 24,000 | $ 3.00 |
| Firewood consumption | 8,706 | $ 1.09 |
| Domestic water use | 10,857 | $ 1.36 |
| ***Total value provisioning services*** | ***165,288*** | ***$ 20.66*** |
| Erosion control (25 percent of rice production) | 210,455 | $ 26.31 |
| ***Total value regulatory services*** | ***210,455*** | ***$ 26.31*** |
| **Actual contribution to HH income** | **375,743** | **$ 46.97** |
| Potential from timber sales (110 yr. cycle) | 55,273 | $ 6.91 |
| Potential annual carbon value | 28,435 | $ 3.55 |
| ***Total option values*** | ***83,708*** | ***$ 10.46*** |
| **Overall potential value** | **459,451** | **$ 57.43** |

In Table 12, some option values or co-benefits are indicated that result from the conservation of this resource (the potential for sustainable off-take on a 110-year rotation length and the value of the standing carbon on the global carbon credit trading market). However, two of these ecosystem services can be regarded as "assets" that communities can use and sell or trade in times of emergency. As such, the DDF ecosystem provides an important safety net, as discussed earlier. The total of DDF ecosystem asset sale value in the PSFM village amounts to $824 per ha (see Table 25). If carbon markets pick up and Lao PDR advances in being able to trade carbon on either the voluntary or (if created) compliance market, there could be opportunities to also sell carbon assets.

Table 25: The value of dry forest ecosystem services as livelihood assets in the PSFM village

| Dry Forest Ecosystem Services as Assets | kip/ha | $/ha |
|---|---|---|
| Timber | 6,080,000 | $ 760 |
| Livestock assets | 508,812 | $ 64 |
| **Total ecosystem assets value** | **6,588,812** | **$ 824** |
| Carbon assets | 3,127897 | $ 391 |
| ***Total ecosystem and carbon asset values*** | ***9,716,709*** | ***1,215*** |

## 7.5 Benefits from concessions

Despite requests for interviews and data sharing with the respective concession managers in Savannakhet, the research team, with the support of the PAFO representative, was unable to obtain primary data on actual economic viability or growth rate in the concession. Therefore the estimation of benefits is based on secondary sources of data.

According to an assessment of the Lao Plantation Authority (LPA) project of a smallholder eucalyptus plantation in another DDF context in Savannakhet Province (funded by the Asian Development Bank), the projections on the return on investment of the eucalyptus village were well below the range expected (see Table 26) and did not break even when calculated over a seven-year rotation (LPA 2005). In fact, the actual yield was less than 25 percent of the lower end of the range of projected yield and less than 10 percent of the most optimistic projection.

From the team's qualitative observations of the Birla Lao concession, the plantation is likely to achieve reasonable yields, in line with the lower end of the ADB-LPA projections. At the same time, it must also be underscored that the community received very little compensation for the loss of these forestlands and the consequent decreases in NTFP and livestock fodder supplied or forgone for future agricultural expansion.

### Table 26: Economic values of eucalyptus plantations on former DDF soils

| Economics of Eucalyptus planted on Dry Dipterocarp soils | ADB LPA project Eucalyptus yields | | | Birla Lao |
|---|---|---|---|---|
| | foreseen low | foreseen high | actual | foreseen yield |
| Mean annual increment m3/y/ha | 10 | 24 | 2.28 | ? |
| price $/ton | $27 | $27 | 27 | ? |
| gross income value $/ha/yr | $270 | $648 | 61.48 | ? |
| total income over 7yrs | $1,890 | $4,536 | 430.37 | ? |
| production costs | $493 | $493 | 493 | ? |
| Net profit over 7 years | $1,397 | $4,043 | -62.63 | ? |
| Net income per year | $200 | $578 | -8.95 | ? |

In 2010, the sugarcane company employed about 7,000 people per day during the harvest period and 4,200 people in the maintenance period, mostly as day wage workers. The company also adopts contract farming schemes for sugarcane production in Savannakhet. About 1,194 households have joined in the company's scheme.[37] Households that have land and do not want to sell it can partner with the company through contract farming arrangements. The arrangement also gives households access to more land for growing, maintaining, and harvesting sugarcane, although the cost of preparing the site, growing, and maintaining the area is borne by the landowners (IUCN and NERI 2011).[38]

An IUCN and NERI study (2011) found that the households surveyed that were involved with the scheme were unable to pay off the debt they incurred for sugarcane production based on the price paid by the company (the debt was on average $2,424). Independent farmers also found that it was difficult to make a revenue from sugarcane production.

Regardless of scale, sugarcane cultivation on DDF soils appears to be underperforming due to poor growth rates and crop pests, which has led the small-scale landowners to give up entirely. Based on expert inputs considering what Thai

37. In an IUCN and NERI case study area in Savannakhet Province, more than 60 households (roughly 13.5 percent of all households) had signed up for this arrangement (IUCN and NERI 2011).
38. Sources: www.unpei.org/sites/default/files/e_library_documents/Lao_ESEA_Sugar_Plantations_Saravan_Province_2011.pdf

farmers across the border require in order to reach their "break-even point," the yields would need to at least double for either Lao farmers or concessions to be able to succeed. Table 27 shows that Lao farmer A and the Lao concessions invested close to the same amount of money in their production system. Given the returns, either the white leaf pest or the soils in the Savannakhet examples are particularly problematic. In addition, different sugarcane producers may get significantly different prices for their product.

Beyond wage labor, there is no systematic compensation scheme for workers or households who have been injured or lost access to their resources. There also was no evidence in the literature of benefit-sharing arrangements between local communities and the company.

## Table 27: Economics of sugarcane farming on former DDF soils***

| Sugarcane values | Lao farmer a* | Lao farmer b* | Lao concessions** | Thailand farmers** |
|---|---|---|---|---|
| yield history | yr 1: 70 t/ha; yrs 2 and 3 failed | yr 1: 50 t/ha; yr 2: 25 t/ha; yr 3 failed | problems with "white leaf" disease | "break-even point" around 1100 baht/ton |
| avg yield/yr over 3 yrs (tons/ha) | 23 | 25 | 33 | 59 |
| price baht/ton | 609 | 609 | 1,000 | 1,200 |
| gross income baht/ha | 14,219 | 15,234 | 33,000 | 70,800 |
| average costs (baht/ha) | 56,250 | 39,375 | 64,900 | 64,900 |
| net profit (baht/ha) | (42,031) | (24,141) | (31,900) | 5,900 |
| net proft (kip/ha) | (11,208,333) | (6,437,500) | (8,506,667) | 1,573,333 |
| net profit ($/ha) | (1,401) | (805) | (1,063) | 197 |

*** Calculation of the economic viability of sugarcane in DDF soils comes from a combination of data from two landowners from nearby villages in Phalanxay District who had attempted to cultivate sugarcane and from data collected from other sugarcane concessions in Lao PDR and Thailand. The difference between small-scale farmers' costs was due to the fact that Farmer B used "free" family labor.

Detailed information on payments for the establishment of concessions was not readily available (partly because payments are negotiated with different levels of government, and none of these are recorded centrally). IUCN and NERI (2011) found that the company contributes to the government budget through taxes and concession fees. The company's accumulated contribution from 2007 until the end of 2009 is estimated to be nearly $1.6 million, corresponding to about 0.06% of government budget or to about 0.7% of Savannakhet Province's budget during the same period (see Table 28). This is not considered a very substantial contribution to government revenues. All of these taxes and concessions go directly to the central government; funds are then allocated to the provinces through the Ministry of Finance.

## Table 28: Contribution of Mitr Lao Sugar to central government budget (for total area—extends beyond Savannakhet)

| Year | Amount (dollars) |
|---|---|
| 2007* | 61,310 |
| 2008 | 737,839 |
| 2009 | 764,409 |
| Total | 1,563,559 |

* In 2007 the company started to grow sugarcane and established a sugar factory about 60 kilometers north of the Savannakhet provincial center.

## 7.6 Summary of impacts of concessions and PSFM programs on the provision of ecosystem services

The economic benefits from concessions are illustrative at best. Lacking access to data from the actual concessions in question, it is challenging to assess the total benefits from concessions with any accuracy.

With respects to the valuation of ecosystem services and the rural livelihoods based on them, it is evident that dry dipterocarp forests are undervalued and that often the loss of benefits derived from DDFs are not accounted for when considering land use options. Our analysis also reveals that the income and employment benefits gained by the surveyed households are often lower than the value of the ecosystem services these households derive from DDFs; this includes the value of the provisioning services (food, fodder, and timber) and the regulatory services (watershed hydrological service protection). In addition, there are the potential values from carbon credits that could help to encourage community support for forest conservation programs.

The loss of access to DDFs also results in households losing their primary source of savings—livestock —which would otherwise help them weather crop failures and other shocks. It is difficult to quantify to what degree the losses of DDFs reduce agricultural production and health through the loss of reliable hydrological flows and erosion regulation, but the impacts are certainly witnessed by stakeholders.

The conversion of DDFs should be considered relatively irreversible. The slow growth rates in DDF soils implies that it takes a long time for DDFs to recover. Estimates indicate that on average DDF trees in Savannakhet require over 100 years to attain a minimum commercially harvestable diameter. Therefore, the negative long-term impacts on ecosystem services and livelihoods need to be internalized in any costs and benefits (that is, the economic cost of approximately $57/ha). Furthermore, were the land to be restituted to local communities, the poor and middle-level smallholder households who have sold their livestock assets may be unable to benefit from the regained access to sources of fodder.

# 8 Key Messages for Decision Makers

**Climate change impacts (excluding extreme events) could potentially generate an increase in net primary productivity in the next 20–50 years.**

Climate change forecasts have a notable degree of uncertainty. Nevertheless, they are helpful in predicting a range of impacts. An analysis of past and projected climate trends in 2030 through 2080 for Savannakhet Province, involving a comparison of 16 global climate change scenarios with a 30-year historical climate baseline (1961–90), found the following:

- Temperatures are uniformly expected to increase, by 0.6–1.4°C by 2030 and by 1.1–4.7°C by 2080.
- The baseline for average annual rainfall was 2,061 mm/year, and projections of future changes from this baseline ranged between –60.18 and +78.72 mm/year in 2030 and between –202.71 and +219.08 mm/year in 2080.

The expected impact of climate change on paddy field rice production is a net increase in primary productivity of 1.4–12.2 percent by 2030 and of 14–53 percent by 2080. These findings are consistent with other studies (Lefroy, Collet, and Grovermann 2010; Jintrawet and Chinvanno 2012), and their range is indicative of the significant uncertainty in projections. As a caveat, these projections are based on overall annual measures of production, but they may mask significant impacts of exposure to greater variability of rainfall, particularly at the start of the growing cycle. They also do not account for the decline in the benefits of greater $CO_2$ concentrations as temperature increases.

There are few data on the impact of climate change on livestock productivity. Preliminary research on replacing the natural grasslands with improved, drought-resistant pasture species seems to be giving promising results as a potential adaptation strategy to climate change (Hacker et al. 1998).

**Land use change (forest conversion to plantation concessions) can undermine any gains in net primary productivity from climate change gains.**

The negative impacts of forest conversion and land use change more broadly are likely to counteract any potential short- to medium-term benefits from climate change. Furthermore, there is evidence that conversion of forests to plantations and agricultural concessions has notable social and environmental impacts. In Lao PDR, forests provide important ecosystem services to society and the environment, ranging from direct benefits from harvestable timber and NTFPs to indirect benefits such as the regulation of water and climate.

On the whole, stakeholders at all levels express low levels of concern about climate change. They are much more preoccupied with the ongoing changes in land use and their effects on local livelihoods.

**Forest ecosystems such as dry dipterocarp forests are often undervalued and poorly understood.**

Dry dipterocarp forests provide local stakeholders with a range of ecosystem services—most importantly, fodder for livestock and other NTFPs for consumption and sale. DDFs in Lao PDR also provide habitats for several engendered wildlife species, such as the Elds deer (Panolia eldii). However, the benefits from DDFs remain poorly documented. This study found that there are ecosystem benefits that need to be better studied and estimated to facilitate optimal planning and decision making. The cost of losing these benefit is seldom accounted for in land use decisions, including those that determine the allocation of concessions.

Ecosystem services from DDFs can buffer smallholder agricultural households from shocks resulting from climate change. Loss of forestland reduces the feasibility of maintaining livestock resources, which are a key source of resilience. For the households surveyed in this study, the value of livestock they owned was equivalent to 3.6 years of average annual household cash income in the PSFM village. This compared with 1.2 years in the eucalyptus village and 1.0 years in the sugarcane village. This illustrates the key role of livestock as a source of savings and/or as a safety mechanism during times of crisis. Villagers estimated that their large livestock depend on natural stands of Arundinaria grass in DDFs for 80 percent of their grazing requirement. Loss of forestland directly reduces their livestock-based resilience. Elevated livestock sales in the eucalyptus village are thought to be a result of the loss of forest grazing land.

**The impact of land use change (resulting from issuance of concessions) on DDFs needs to be better understood.**

Dry dipterocarp forestlands in the south of Lao PDR, where large tracts of land are being allocated to foreign companies, are increasingly targeted for conversion to commercial plantations. This forms part of the national government's attempt to leverage its land resources to attract foreign direct investment. DDFs cover 13 percent of Lao PDR's total forest estate and represent a unique vegetative ecotype spanning parts of Souteast Asia. DDFs are characteristic of shallow soils that are prone to flooding in the rainy season, to periods of extreme drought in the dry season, and to frequent exposure to wildfires (Bunyavejchewin 1983). Consequently, DDFs have very slow growth rates and take roughly 100 years to grow to a commercially valuable size (diameter of roughly 25 cm) and are therefore regarded as a less important source of timber compared with other forest types (Pukkala 2005).

The impact of land use change on the ecosystem services provided by DDFs needs to be better understood to ensure that the relative irreversibility of DDF conversions does not result in climate "maladaptation" by limiting the adaptation options for stakeholders dependent on DDFs in the future.

**Change in access to forests can force local communities to adopt unsustainable coping strategies to counter the adverse impacts of climate and land use change.**

Local communities have developed a number of strategies to cope with land use changes, some of which could also be applied to changes in climate change. The key coping strategies include:

- Privatization of communal land, aimed at the conversion to paddy land
- Working harder as hired labor to earn income to buy food, reducing the ability to produce food
- Migration of young people (mostly girls) to Thailand, exposing them to risks of human trafficking
- Arbitration in conflicts with companies to obtain compensation for land lost to concessions

Unfortunately, most of these strategies constitute a deterioration of livelihood conditions, not an improvement. In addition, it must be stated that future expansion of the area under rice cultivation through the conversion of individually owned plots of DDF is likely to be limited in reducing vulnerability. While climate change may be expected to raise the productivity of existing paddy fields, the success rate of these new conversions is likely to be limited, as these are mostly located on the top of ridges in the topography, where soils are very shallow and prone to droughts.

**A forest-based and ecosystem-based adaptation approach can offer a viable and effective resilience strategy to climate and land use change for smallholder agricultural households.**

Natural DDFs are important for managing and maintaining water soil resources that underpin the entire rural economy. They provide a key source of resilience as grazing land for livestock, which constitute the bulk of local savings capital. For local small-scale farmers, livestock in DDF represent a key source of resilience to all kinds of potential shocks and help compensate them for the risks of rainfed rice farming on drought-prone shallow soils. Access to DDFs is also modified by small-scale DDF conversions, partly motivated by local concerns of losing village land to concessions. This pressure to privatize and convert remaining DDFs would be reduced if local communities could obtain tenure security over communal forestland. A more comprehensive approach to enhancing resilience is ecosystem-based adaptation, which might include the following elements:

**Reducing exposure to climate variability and external shocks**

- Invest in water storage and utilization infrastructures for irrigation and drinking water.
- Involve the community in the restoration of forests to bring more water back to streams and wetlands.
- Involve the community in restoration of forest cover to reduce the impacts of longer hot periods on local climate and biodiversity.
- Create alternative employment opportunities.

**Reducing sensitivity to climate variability and external shocks**

- Apply an integrated village land use planning strategy that sets aside sufficient land for the maintenance of livestock herds and for some expansion of small-scale agriculture.
- Ensure community access to a range of ecosystems within the DDF landscape, ranging from the highest ridges, most sensitive to drought and erosion, to the lower strata, which have deeper soils and are more resilient to drought and erosion.

**Enhancing adaptive capacity**

- Adopt more-intensive systems for animal feeding to reduce the area of land needed for livestock.
- Adopt more-intensive rice cultivation systems, including more-intensified use of organic and inorganic fertilizers.
- Improve access to better education to improve the quality and likelihood of gaining off-farm employment.

The revenue and expenditure information of the surveyed households suggests that some of the options for enhancing adaptive capacity may require public funds.

A key conclusion of this study is that Lao PDR should invest in improving the understanding of the values of DDF ecosystem services and incorporating these in all decision making and planning around the conversion of DDF land. National partners should also explore ways to include these values in land use planning processes while improving land use planning, designing drought-resilient livestock and agricultural systems, and enforcing rules on forest protection more effectively.

Adaptation strategies and strategies to build resilience among smallholder poor agricultural households should be based on EBA approaches that, in coordination with more conventional measures to enhance resilience, could minimize the loss of natural assets and promote their sustainable and participatory management.

# Annex 1

## Case Study: PSFM Village

### Analysis of household vulnerability

The caveats associated with this analysis of case studies and the vulnerability among households must be (repeatedly) underscored lest they are overlooked. Cognizant of the potential biases involved, all conclusions in terms of relative drivers and characterizations of vulnerability or resilience should most appropriately be regarded as hypotheses to be tested.

A detailed overview of sources of cash and non-cash income by household income (wealth) category is provided in this Annex. The discussion before the detailed Table focuses on the overarching trends and key patterns observed.

### Household sources of cash income

In the PSFM village, stakeholder assessments of income categories are closely aligned with measures of total cash income. While the middle and wealthy groups report earning on average roughly double the amount of cash of the poorer group, the highest-income group reports cash earnings over 800 percent that of the poorer households.

Across all PSFM village households surveyed, annual sales of livestock appear to be the overwhelmingly largest source of household cash income (60 percent) followed by income from labor (24 percent) and the sale of forest products (8 percent). However, when differentiated by income categories, this pattern generally only holds true for middle and wealthy income groups. For poor households, remittances are by far the largest source of income (48 percent), followed by livestock (25 percent) and forest product sales (19 percent).

Interestingly, the sale of forest resources contributes less to middle categories than to either the poor or the wealthy, and in absolute terms it provides wealthy households with double the amount of income that it does to poor households.

### Total household income (cash plus non-cash)

As was the case with cash incomes, in the PSFM village household income categories are closely correlated with absolute values of non-cash income from agriculture. In terms of proportional contributions to income in the PSFM community, non-cash income accounts on average for roughly two-thrids of the total household income, with 70 percent and 30 percent coming from rice cultivation and forest products gathered, respectively.

However, the middle-income group consumed four times as much food from the forest than the poor households did. Overall, middle and wealthy households consumed roughly the same value of self-cultivated or gathered foods, both consuming more than twice the amount of lower-income households. Nevertheless, non-cash income sources represent the vast majority of poorer and middle-income households finances (contributing 75 percent and 81 percent, respectively), with roughly one-third to half coming from forest resources.

Wealthier households rely roughly equally on cash versus non-cash income, and only 10 percent of the non-cash income comes from forest product consumption. However, in absolute values the amounts of forest products gathered are only roughly 20 percent below that of the poorer households.

Overall, the differences in total household income among the income groups remains quite significant, although less so than the initial assessment of cash income would indicate. With an average total income estimated around $2,131, wealthy households earn almost four times the total income of poor households ($521) and roughly 60 percent more than the middle-income group ($1,340).

## Household cash income vs. expenditures

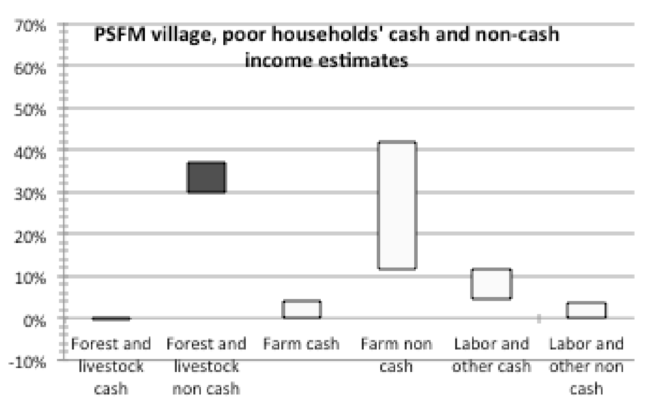
The three greatest sources of expenditures cited by both middle and wealthier income households were to purchase rice, hire labor, and pay for health care. None of the poorer households can purchase labor, and so their top three expenditures go to rice, health care, and agricultural inputs.

In completing a balance sheet based on reported household cash income and expenses (see Table A), it would appear that most poorer and middle-income households are unable to make ends meet. Based on qualitative data, however, this does not accurately reflects the quality of life of these households. Meanwhile, the wealthiest households would essentially break even, with no savings to show for their efforts.

In addition to the possibility of human error in data collection, however, and potential aberrations due to the small sample size, data collected using the PROFOR poverty assessment participatory group exercises suggest that both cash and non-cash incomes from non-timber forest products (NTFPs) and rice harvesting may be greatly underestimated by the surveys (see Annex 4). In the PSFM village, the greatest amount of variance related to the poorer and middle-income households' estimates of the relative contributions of cash income came from the sale of forest/livestock products and non-cash income from on-farm resources. The results from the poorest households are shown here for illustration (see Figure A).

This study cannot fully explain these differences. However, the former might be explained in part by the difficulty in estimating the values and amounts of NTFPs that may be sold frequently, but intermittently, in differing quantities and at different market values. Nevertheless, given the balance sheet conclusions just described, these results may suggest a significantly greater benefit derived from these resources and therefore a significantly greater ecosystem service value of dryland diptercarp forests.

## Figure A: Illustration of divergence between PSFM village data sources




Source: Household survey and PRA.

## Table A: PSFM village—Detailed household income and expenditures

| SUFORD village | Cash Income per Household (kip/year) | | | | | Cash Income per Household (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Labor | 75,000 | 552,500 | 2,125,000 | 917,500 | $ 115 | 7% | 27% | 25% | 24% |
| Livestock | 265,000 | 936,250 | 5,630,000 | 2,306,250 | $ 288 | 25% | 45% | 65% | 60% |
| Remittances | 500,000 | - | - | 166,667 | $ 21 | 48% | 0% | 0% | 4% |
| Forest | 201,750 | 73,500 | 600,000 | 291,750 | $ 36 | 19% | 4% | 7% | 8% |
| Agriculture | - | 500,000 | - | 166,667 | $ 21 | 0% | 24% | 0% | 4% |
| Others | - | - | 300,000 | 25,000 | $ 3 | 0% | 0% | 3% | 1% |
| **Total Cash Income** | 1,041,750 | 2,062,250 | 8,655,000 | 3,873,833 | $ 484 | 100% | 100% | 100% | 100% |
| US$ (yr 2012) | $ 130 | $ 258 | $ 1,082 | $ 484 | | | | | |
| | | | | | | | | | |
| **SUFORD village** | **Non-Cash Income per Household (kip/year)** | | | | | **Cash Income per Household (%)** | | | |
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Forest (NTFP & firewood) | 1,048,500 | 4,257,000 | 853,750 | 1,978,833 | $ 247 | 34% | 49% | 10% | 30% |
| Agriculture | 2,080,000 | 4,400,000 | 7,537,500 | 4,585,000 | $ 573 | 66% | 51% | 90% | 70% |
| Total | 3,128,500 | 8,657,000 | 8,391,250 | 6,563,833 | $ 820 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 391 | $ 1,082 | $ 1,049 | $ 820 | | | | | |
| | | | | | | | | | |
| **SUFORD village** | **Household Cash and Non-Cash Income (kip/year)** | | | | | **Cash/Non-Cash Income(%)** | | | |
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Cash income | 1,041,750 | 2,062,250 | 8,655,000 | 3,873,833 | $ 484 | 25% | 19% | 51% | 37% |
| Non cash income | 3,128,500 | 8,657,000 | 8,391,250 | 6,563,833 | $ 820 | 75% | 81% | 49% | 63% |
| Total | 4,170,250 | 10,719,250 | 17,046,250 | 10,437,667 | $ 1,305 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 521 | $ 1,340 | $ 2,131 | $ 1,305 | | | | | |
| | | | | | | | | | |
| **SUFORD village** | **Household Cash Income and Expenditures (kip/year)** | | | | | **HH Cash Income/Expenditures ($)** | | | |
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Cash Income | 1,041,750 | 2,062,250 | 8,655,000 | 3,873,833 | | $ 130 | $ 258 | $ 1,082 | $ 484 |
| Cash Expenditures | 3,676,250 | 7,685,833 | 8,431,458 | 5,871,458 | | $ 460 | $ 961 | $ 1,054 | $ 734 |
| Balance | (2,634,500) | (5,623,583) | 223,542 | (1,997,625) | | $ (329) | $ (703) | $ 28 | $ (250) |
| | | | | | | | | | |
| **SUFORD village** | **Livestock Assets per Household (kip)** | | | | | **Livestock Assets/HH ($)** | | | |
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Livestock Assets | 1,487,500 | 6,878,750 | 33,362,500 | 13,909,583 | | $ 186 | $ 860 | $ 4,170 | $ 1,739 |
| | | | | | | | | | |
| **SUFORD village** | **Expenditures in kip per Household Category** | | | | **Expenditures in %** | | | | |
| TYPE OF EXPENDITURE | poor | middle | wealthy | average | poor | middle | wealthy | average | |
| Rice buying expenditures | 1,512,500 | 1,732,500 | 2,478,125 | 1,907,708 | 41% | 23% | 29% | 32% | |
| Hiring labor | - | 1,500,000 | 1,500,000 | 392,500 | 0% | 20% | 18% | 7% | |
| Social events | 250,000 | 300,000 | 300,000 | 441,667 | 7% | 4% | 4% | 8% | |
| Health expenditures | 675,000 | 1,375,000 | 1,375,000 | 1,058,333 | 18% | 18% | 16% | 18% | |
| Clothes | 161,250 | 875,000 | 875,000 | 645,417 | 4% | 11% | 10% | 11% | |
| Meat and fish buying | 100,000 | 400,000 | 400,000 | 441,667 | 3% | 5% | 5% | 8% | |
| Other food buying | 127,500 | 400,000 | 400,000 | 270,000 | 3% | 5% | 5% | 5% | |
| Electricity bills and appliances | - | - | - | - | 0% | 0% | 0% | 0% | |
| Kitchen utensils | 150,000 | 400,000 | 400,000 | 200,000 | 4% | 5% | 5% | 3% | |
| School expenses | 100,000 | 183,333 | 183,333 | 334,167 | 3% | 2% | 2% | 6% | |
| Agricultural inputs | 600,000 | 520,000 | 520,000 | 180,000 | 16% | 7% | 6% | 3% | |
| Marriage price | - | - | - | - | 0% | 0% | 0% | 0% | |
| Contribution to savings fund | - | - | - | - | 0% | 0% | 0% | 0% | |
| TOTAL HH EXPENDITURES | 3,676,250 | 7,685,833 | 8,431,458 | 5,871,458 | 100% | 100% | 100% | 100% | |
| TOTAL HH CASH INCOME | 1,041,750 | 2,062,250 | 8,655,000 | 4,302,000 | 0% | 0% | 0% | 0% | |
| BALANCE | (2,634,500) | (5,623,583) | 223,542 | (1,569,458) | 0% | 0% | 0% | 0% | |

# Annex 2

## Case Study: Eucalyptus Village

### Analysis of household vulnerability

The caveats associated with this analysis of case studies and the vulnerability among households must be (repeatedly) underscored lest they are overlooked. Cognizant of the potential biases involved, all conclusions on relative drivers and characterizations of vulnerability or resilience should most appropriately be regarded as hypotheses to be tested.

A detailed overview of sources of cash and non-cash income by household income category is provided in this Annex. The discussion before the detailed Table focuses on the overarching trends and key patterns observed.

### Household sources of cash income

This community's classification of household income categories is correlated with measures of total cash income. The mean levels of cash income across the three groups appears have a very "normal" distribution, with the middle income earning ($899) on average 87 percent more than the poor ($480), and 85 percent less than the wealthy households ($1,663). Looking at the overall sources of cash income across the Eucalyptus Village households surveyed, income from labor is the largest source of household cash (50 percent) followed by income from the sale of livestock (35 percent) and remittances (9 percent).

In terms of the distribution of sources of cash by income category, the correlation between increasing income from labor and livestock sales can be noted, but there is an inverse relationship with importance of income from remittances and overall diversity of sources of cash income. A major difference between middle and wealthy income households is the amount of income received from the sale of livestock, as wealthy households earn between 9 and 16 times the amount earned by poor and middle-income households, respectively. Conversely, though not comparable in absolute terms, middle-income households earn 8 percent of their cash income from the sale of forest products—roughly four times the absolute value earned by lower-income and higher-income households.

### Total household income (cash plus non-cash)

This community's household income categories also correspond closely with the overall amounts of non-cash income received from forests and farms. However, mirroring the middle class's greater sale of NTFPs, this class also consumes two to three times the amount of NTFPs consumed by wealthier or poorer households, respectively. Interestingly, when combining the values of NTFPs sold and consumed, the poor also gain significantly less value ($154) than the wealthy ($225). In addition, poorer and middle-income households consume roughly half as much rice as wealthier households.

Overall, the contributions of non-cash income have a slightly leveling effect on overall household income distributions across the community, with the middle class "earning" ($1,667) 74 percent more than the poor ($959), and 65 percent less than the wealthier households ($2,552).

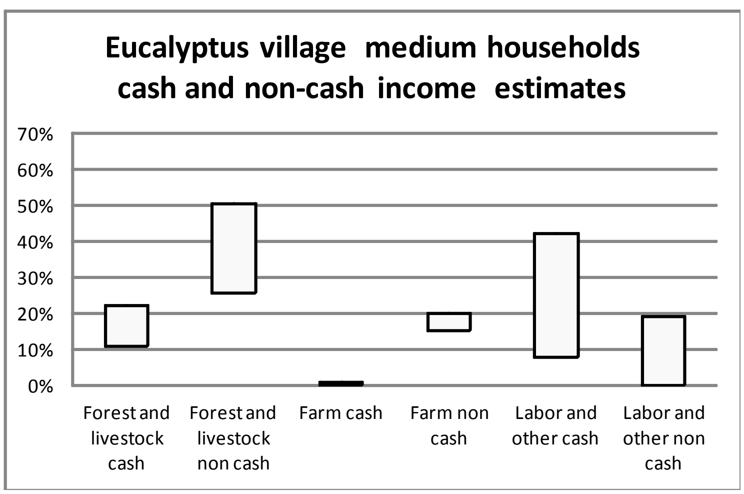
## Household cash income vs. expenditures

In this village, the amount of expenditures for the purchase of rice—while the single largest expenditure overall (29 percent)—declines with income category, with the wealthiest households being fully rice self-sufficient. This would make sense, given the much higher consumption of agricultural produce by the wealthiest households and their greater investment in agricultural inputs.

Why do the lowest and highest income group households have roughly the same amount of expenditures, while the middle-income group had twice their level of expenditures (see Table B)? It cannot be interpreted whether this is due to human error in the data collection process with respect to this middle category. If the data for the poorer and wealthier household categories are correct, the poorer households balance is roughly 18 percent below income, while the wealthy households would earn or consume twice the amount of resources that they spend.

As was the case in for the PSFM community, these results are somewhat confounded by significant differences between perceived contributions from different livelihood activities between the household survey and PRA exercises. As with the PSFM village, poorer household estimates of non-cash income from forests and farms display a significant divergence between data sets, while the middle-income group displays the greatest divergence across cash and non-cash sources of income (see Figure B). These differences cannot be adequately resolved with the available data.

Figure B: Illustration of divergence among eucalyptus village data sources




Source: Household survey and PRA.

## Table B: Eucalyptus village—Detailed household income and expenditures

| **Eucalyptus village** | **Cash Income per Household (kip/year)** | | | | | **Cash Income per Household (%)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Labor | 2,125,000 | 4,650,000 | 5,300,000 | 4,025,000 | $ 503 | 55% | 65% | 40% | 50% |
| Livestock | 455,000 | 830,000 | 7,300,000 | 2,861,667 | $ 358 | 12% | 12% | 55% | 35% |
| Remittances | 1,100,000 | 707,500 | 450,000 | 752,500 | $ 94 | 29% | 10% | 3% | 9% |
| Forest | 162,500 | 601,500 | 150,000 | 304,667 | $ 38 | 4% | 8% | 1% | 4% |
| Agriculture | - | 105,000 | 105,000 | 75,000 | $ 9 | 0% | 1% | 1% | 1% |
| Others | 0 | 300000 | 0 | 100000 | $ 13 | 0% | 4% | 0% | 1% |
| **Total Cash Income** | 3,842,500 | 7,194,000 | 13,305,000 | 8,118,833 | $ 1,015 | 100% | 100% | 100% | 100% |
| US$ (yr 2012) | $ 480 | $ 899 | $ 1,663 | $ 1,015 | | | | | |

| **Eucalyptus village** | **Non-Cash Income per Household (kip/year)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Forest (NTFP & firewood) | 1,856,500 | 4,239,125 | 2,437,500 | 2,844,375 | $ 356 | 40% | 61% | 31% | 44% |
| Agriculture | 2,760,000 | 2,683,750 | 5,457,500 | 3,633,750 | $ 454 | 60% | 39% | 69% | 56% |
| Total | 4,616,500 | 6,922,875 | 7,895,000 | 6,478,125 | $ 810 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 577 | $ 865 | $ 987 | $ 810 | | | | | |

| **Eucalyptus village** | **Household Cash and Non-Cash Income (kip/year)** | | | | | **Cash/Non-Cash Income(%)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Cash income | 3,842,500 | 7,194,000 | 13,305,000 | 8,118,833 | $ 1,015 | 45% | 51% | 63% | 56% |
| Non cash income | 4,616,500 | 6,922,875 | 7,895,000 | 6,478,125 | $ 810 | 55% | 49% | 37% | 44% |
| Total | 8,459,000 | 14,116,875 | 21,200,000 | 14,596,958 | $ 1,825 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 1,057 | $ 1,765 | $ 2,650 | $ 1,825 | | | | | |

| **Eucalyptus village** | **Household Cash Income-Expenditures (kip/year)** | | | | | **HH Cash Income/Expenditures ($)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Cash Income | 3,842,500 | 7,194,000 | 13,305,000 | 8,118,833 | | $ 480 | $ 899 | $ 1,663 | $ 1,015 |
| Cash Expenditures | 4,675,000 | 10,350,000 | 4,421,500 | 6,482,167 | | $ 584 | $1,294 | $ 553 | $ 810 |
| Balance | (832,500) | (3,156,000) | 8,883,500 | 1,636,667 | | $ (104) | $ (395) | $ 1,110 | $ 205 |

| **Eucalyptus village** | **Livestock Assets per Household (kip)** | | | | | **Livestock Assets/HH ($)** | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Livestock Assets | 3,695,000 | 7,721,250 | 17,210,000 | 9,542,083 | | $ 462 | $ 965 | $ 2,151 | $ 1,193 |

| **Eucalyptus village** | **Expenditures in kip per Household Category** | | | | **Expenditures in %** | | | |
|---|---|---|---|---|---|---|---|---|
| TYPE OF EXPENDITURE | poor | middle | wealthy | average | poor | middle | wealthy | average |
| Rice buying expenditures | 3,295,000 | 1,937,500 | - | 1,744,167 | 1 | 19% | 0% | 27% |
| Hiring labor | - | 3,600,000 | 725,000 | 1,441,667 | - | 35% | 16% | 22% |
| Social events | 400,000 | 425,000 | 900,000 | 575,000 | 0 | 4% | 20% | 9% |
| Health expenditures | 75,000 | 500,000 | 475,000 | 350,000 | 0 | 5% | 11% | 5% |
| Clothes | 375,000 | 650,000 | 525,000 | 516,667 | 0 | 6% | 12% | 8% |
| Meat and fish buying | 180,000 | 380,000 | 650,000 | 403,333 | 0 | 4% | 15% | 6% |
| Other food buying | 175,000 | 270,000 | 175,000 | 206,667 | 0 | 3% | 4% | 3% |
| Electricity bills and applia | - | 1,540,000 | 209,000 | 583,000 | - | 15% | 5% | 9% |
| Kitchen utensils | 100,000 | 660,000 | 435,000 | 398,333 | 0 | 6% | 10% | 6% |
| School expenses | 75,000 | 387,500 | 325,000 | 262,500 | 0 | 4% | 7% | 4% |
| Agricultural inputs | - | - | 2,500 | 833 | - | 0% | 0% | 0% |
| Marriage price | - | - | - | - | - | 0% | 0% | 0% |
| Contribution to savings fun | - | - | - | - | - | 0% | 0% | 0% |
| TOTAL HH EXPENDITURES | 4,675,000 | 10,350,000 | 4,421,500 | 6,482,167 | 1 | 100% | 100% | 100% |
| TOTAL HH CASH INCOME | 3,842,500 | 7,037,500 | 13,476,500 | - | 1 | 68% | 305% | 0% |
| BALANCE | (832,500) | (3,312,500) | 9,055,000 | (6,482,167) | (0) | -32% | 205% | -100% |

# Annex 3

## Case Study: Sugarcane Village

### Analysis of household vulnerability

The caveats associated with this analysis of case studies and the vulnerability among households must be (repeatedly) underscored lest they are overlooked. Cognizant of the potential biases involved, all conclusions relating to relative drivers and characterizations of vulnerability or resilience should most appropriately be regarded as hypotheses to be tested.

A detailed overview of sources of cash and non-cash income by household income category is provided in this Annex. The discussion before the detailed Table focuses on the overarching trends and key patterns observed.

### Household sources of cash income

Stakeholder assessments of income categories in this community are closely aligned with measures of total cash income, and the distribution of cash income falls between the other case studies in terms of how skewed it is. As was the case in the Eucalyptus village, income from labor seems to be the largest source of household cash income (51 percent). However, whereas the reliance on labor income increased with income category in the Eucalyptus village, this relationship is reversed in the sugarcane village, where fully 89 percent of cash income comes from labor. Across the village, labor is followed by income from remittances (20 percent) and the sale of livestock (17 percent).

Diversification of sources of cash income is closely correlated with income. Among the poorer households, sale of labor accounts for 89 percent of cash income, with the remainder coming from the sale of forest products. Meanwhile the middle-income group's income from labor and livestock sales are quite close (46 percent and 37 percent, respectively), followed by forest product sales (10 percent). Among the wealthier households, remittances, labor, and livestock provide the top three sources of cash income (38 percent, 29 percent, and 19 percent, respectively) and indeed, only these wealthier households received any income from remittances.

In this village, the poorer households own very few cattle and do not report selling any. Although middle and wealthier households earn roughly the same amount of income from cattle sales ($170), this represents almost a third of the total middle-class cattle holdings, while it only represents around 11 percent of the livestock owned by the wealthier households, suggesting either that these households had a greater need for capital the preceding year or that there is some disproportionate pressure on middle-income household to sell off livestock due to a shortage of forage overall.

The loss of most of this community's forest area warrants the introduction of several caveats in the interpretation of these data. The relatively low contribution of forest product sales to household cash income across income groups (6–10 percent) is described by villagers as being due to an absolute shortage of available forest and the overexploitation of most fauna species. Yet it is interesting that in absolute terms the wealthiest households earned roughly twice the amount of NTFPs as did the poor, where most forest products gathered appear to be consumed within the home.

## Overall household income (cash plus non-cash)

In addition to bearing a strong relationship with cash income, this community's classification of income groups also bears a strong correlation with increased rice consumption and reduced consumption of forest foods. However, in contrast with the other case studies, there is no clear relationship between income and relative contribution of cash vs. non-cash income, with the wealthier households receiving a greater proportion (67 percent) of their total income from non-cash sources than did the poor (63 percent) and the middle group (51 percent).

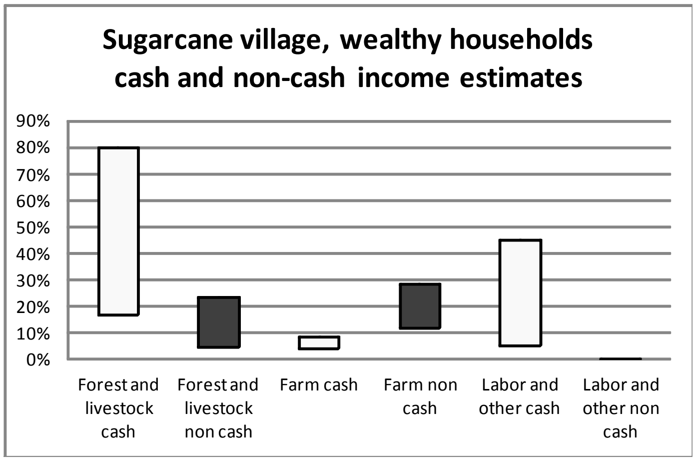
In this community, consumption of forest products is of greatest importance to the poorest households, where it contributes 70 percent of non-cash income (roughly twice in actual volume of forest foods consumed by the wealthy), although in absolute terms the middle-income households consume roughly 85 percent the amount of poorer households. Conversely, wealthier and middle income households consume over five to six times as much rice as poorer households. Upon inclusion of non-cash income sources, the total household income increases to wealthy ($1,931), middle ($1,281), and poor ($778).

## Household cash income vs. expenditures

Upon asking stakeholders about household expenditures, the single greatest source of expenditures for each of the three income classes was for the purchase of rice, amounting to roughly 95 percent (poor), 68 percent (middle), and 15 percent (wealthy) of the total cash annual household cash resources. Among the middle and poorer households, social events were cited second, while the wealthy cited the purchase of other foods almost as highly as their purchase of rice. Third for each group were purchase of clothing (poorer) and utility bills (middle); only the wealthy cited any significant cost incurred to the hiring of labor.

In completing a balance sheet based on reported household cash income and expenses, poorer and middle-income households' expenditures outweigh sources of cash and non-cash income, while wealthier households reported an average 12 percent surplus. Most remarkably, however, focus group discussions in all income categories indicated particularly large disparities in the perceived contributions from the sale of forest products in addition to cash income from labor (see Figure C and Table C ).

## Figure C: Illustration of divergence among sugarcane village data sources




Source: Household survey and PRA.

## Table C: "Sugarcane village"—Detailed household income and expenditures

| Sugarcane village | Cash Income per Household (kip/year) | | | | | Cash Income per Household (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Labor | 3,493,750 | 2,393,750 | 3,025,000 | 4,206,250 | $ 526 | 89% | 46% | 29% | 51% |
| Livestock | - | 1,925,000 | 1,962,500 | 1,362,500 | $ 170 | 0% | 37% | 19% | 17% |
| Remittances | - | - | 3,900,000 | 1,625,000 | $ 203 | 0% | 0% | 38% | 20% |
| Forest | 308,250 | 524,750 | 632,500 | 469,083 | $ 59 | 8% | 10% | 6% | 6% |
| Agriculture | - | - | 637,500 | 247,500 | $ 31 | 0% | 0% | 6% | 3% |
| Others | 500,000 | 500,000 | - | 166,667 | $ 21 | 13% | 10% | 0% | 2% |
| **Total Cash Income** | 3,944,500 | 5,253,500 | 10,352,500 | 8,234,500 | $ 1,029 | 100% | 100% | 100% | 100% |
| US$ (yr 2012) | $ 493 | $ 657 | $ 1,294 | $ 1,029 | | | | | |

| Sugarcane village | Non-Cash Income per Household (kip/year) | | | | | Cash Income per Household (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Forest (NTFP & firewood) | 1,597,625 | 1,373,625 | 728,750 | 1,248,125 | $ 156 | 70% | 28% | 14% | 30% |
| Agriculture | 680,000 | 3,621,250 | 4,363,750 | 2,888,333 | $ 361 | 30% | 72% | 86% | 70% |
| Total | 2,277,625 | 4,994,875 | 5,092,500 | 4,136,458 | $ 517 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 285 | $ 624 | $ 637 | $ 517 | | | | | |

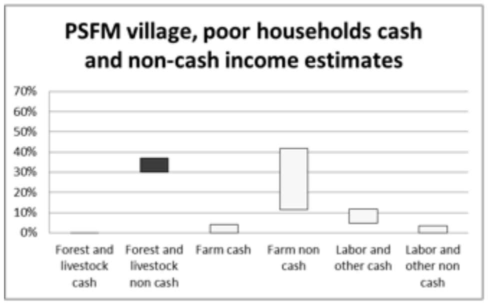
| Sugarcane village | Household Cash and Non-Cash Income (kip/year) | | | | | Cash/Non-Cash Income(%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | $ | poor | middle | wealthy | average |
| Cash income | 3,944,500 | 5,253,500 | 10,352,500 | 8,234,500 | $ 1,029 | 63% | 51% | 67% | 67% |
| Non cash income | 2,277,625 | 4,994,875 | 5,092,500 | 4,136,458 | $ 517 | 37% | 49% | 33% | 33% |
| Total | 6,222,125 | 10,248,375 | 15,445,000 | 12,370,958 | $ 1,546 | 100% | 100% | 100% | 100% |
| US$ (2102) | $ 778 | $ 1,281 | $ 1,931 | $ 1,546 | | | | | |

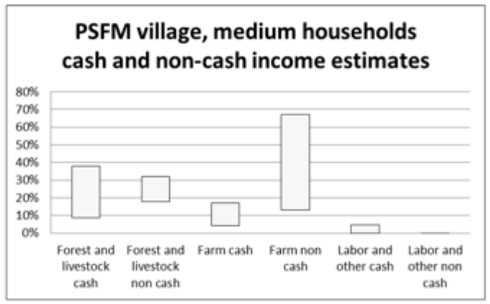
| Sugarcane village | Household Cash Income-Expenditures (kip/year) | | | | | HH Cash Income/Expenditures ($) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Cash Income | 3,944,500 | 5,253,500 | 10,352,500 | 8,234,500 | | $ 493 | $ 657 | $ 1,294 | $ 1,029 |
| Cash Expenditures | 5,223,500 | 5,578,500 | 8,973,750 | 8,180,750 | | $ 653 | $ 697 | $ 1,122 | $ 1,023 |
| Balance | (1,279,000) | (325,000) | 1,378,750 | 53,750 | | $ (160) | $ (41) | $ 172 | $ 7 |

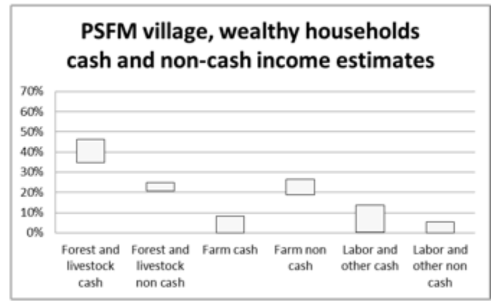
| Sugarcane village | Livestock Assets per Household (kip) | | | | | Livestock Assets/HH ($) | | | |
|---|---|---|---|---|---|---|---|---|---|
| Wealth category | poor | middle | wealthy | average | | poor | middle | wealthy | average |
| Livestock Assets | 81,250 | 6,066,250 | 17,102,500 | 7,750,000 | | $ 10 | $ 758 | $ 2,138 | $ 969 |

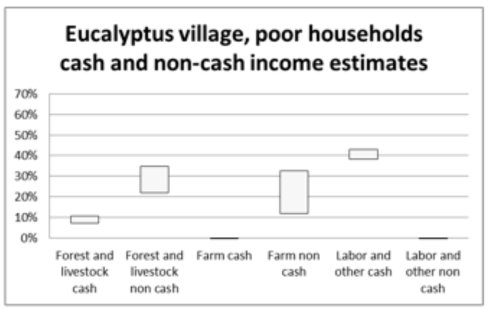
| Sugarcane village | Expenditures in kip per Household Category | | | | Expenditures in % | | | |
|---|---|---|---|---|---|---|---|---|
| TYPE OF EXPENDITURE | poor | middle | wealthy | average | poor | middle | wealthy | average |
| Rice buying expenditures | 4,065,000 | 3,640,000 | 1,482,500 | 2,367,500 | 78% | 65% | 17% | 29% |
| Hiring labor | - | 25,000 | 1,125,000 | 458,333 | 0% | 0% | 13% | 6% |
| Social events | 330,000 | 850,000 | 875,000 | 1,251,667 | 6% | 15% | 10% | 15% |
| Health expenditures | 125,000 | 200,000 | 865,000 | 555,000 | 2% | 4% | 10% | 7% |
| Clothes | 250,000 | 200,000 | 600,000 | 516,667 | 5% | 4% | 7% | 6% |
| Meat and fish buying | - | 60,000 | 831,250 | 573,750 | 0% | 1% | 9% | 7% |
| Other food buying | 135,000 | 85,000 | 1,415,000 | 736,667 | 3% | 2% | 16% | 9% |
| Electricity bills and appliances | 103,500 | 278,500 | 877,500 | 540,333 | 2% | 5% | 10% | 7% |
| Kitchen utensils | 65,000 | 65,000 | 167,500 | 194,167 | 1% | 1% | 2% | 2% |
| School expenses | 25,000 | 50,000 | 300,000 | 133,333 | 0% | 1% | 3% | 2% |
| Agricultural inputs | 125,000 | 125,000 | 435,000 | 353,333 | 2% | 2% | 5% | 4% |
| Marriage price | - | - | - | 500,000 | 0% | 0% | 0% | 6% |
| Contribution to savings fund | - | - | - | - | 0% | 0% | 0% | 0% |
| TOTAL HH EXPENDITURES | 5,223,500 | 5,578,500 | 8,973,750 | 8,180,750 | 100% | 100% | 100% | 100% |
| TOTAL HH CASH INCOME | 4,302,000 | 5,343,500 | 10,157,500 | 3,842,500 | 82% | 96% | 113% | 47% |
| BALANCE | (921,500) | (235,000) | 1,183,750 | (4,338,250) | -18% | -4% | 13% | -53% |

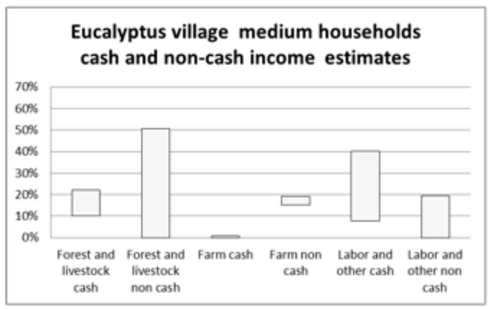
# Annex 4. Range of estimated cash and non-cash income values

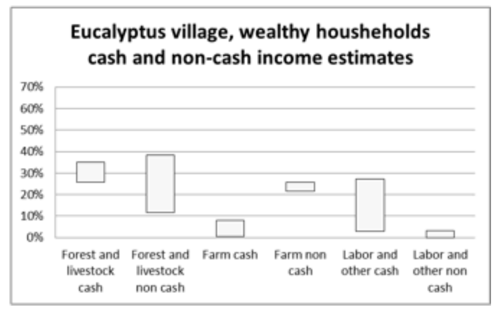


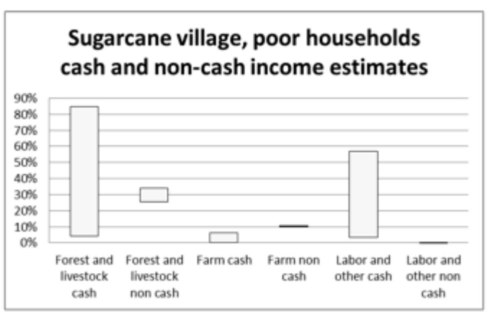



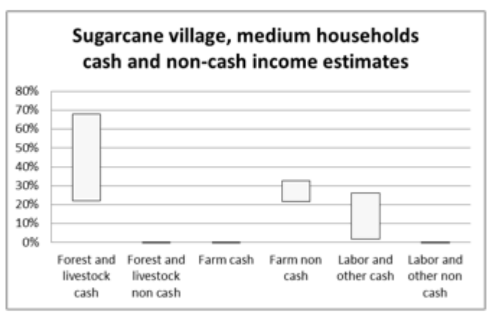



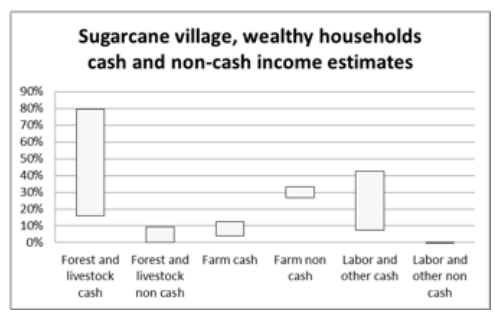




Sources: Household survey and PRA exercises.

# Annex 5. Market Prices for Primary NTFPs Collected in Case Study Communities, Savannakhet Province, April 2012

| *Lao Name* | *Scientific Name* | *Price (kip/kg)* |
|---|---|---|
| **A: Mushrooms** | | |
| het bot | Lentinus polychrous | |
| het poh | Astraeus hygrometricus | 50,000 |
| het langoh | Amanita spp. | 25,000 |
| het pouak | Termitomyces spp. | 30,000 |
| **B: Frogs, snails and other water animals** | | |
| kob khakam | Rana sp. | 20,000 |
| kiet na | Rana lymnocharis | 10,000 |
| eung | Kaloula pulchra | 20,000 |
| **C: Insect products** | | |
| meng kaeng | Stink bugs of Tesseratoma papillosa | 50,000 |
| khai mot daeng | red ant eggs of Oecophylla smaragdina | 30,000 |
| chak chang | cicads of Orientopsaltria sp. | 50,000 |
| **D: Bamboo and rattan shoots** | | |
| nor lan | | 2,000 |
| nor san | | 2,000 |
| nor kasen | | 1,000 |
| vai | rattan: Calamus spp. | 500 |
| **D: Wild vegetables and fruits** | | |
| pak wan | Melientha suavis | 50,000 |
| dok kachiao | Curcuma sp. | 10,000 |
| pak kadone | Barringtonia spp. | 5,000 |
| mak kamphom | Emblica officinalis | 8,000 |
| **E: Tree exudates** | | |
| ki si | dammar resin from Shorea obtusa | 4,000 |
| **F: Timber and firewood species** | | |
| koung | Dipterocarpus tuberculatus | |
| sat | Dipterocarpus obtusifolius | |
| hang | Shorea siamensis | |
| chik | Shorea obtusa | |
| tiu | Cratoxylon formosum | |
| daeng | Xylia xylocarpa var. kerrii | |
| seuak | Terminalia spp. | |

# Annex 6: Key Policies Affecting Forests and Concessions

| Policy | Implementing agency | Goals relating to dryland diptercarp forests |
|---|---|---|
| **Forestry Strategy 2020** | Department of Forestry | **Restoring forest cover** to 65 percent by 2015, 70 percent by 2020 |
| | | **Subdivides forest estate** into three categories:<br>• Conservation in PAs<br>• Sustainable Forest Management in production forest areas<br>• Plantations elsewhere |
| **Seventh National Socio-Economic Development Plan (2011–15)** | Ministry of Planning and Investment, Ministry of Industry and Commerce, Ministry of Energy and Mines | **National 8 percent economic growth annually**<br>• GDP per capita at least $1,700<br>• Exit Least Developed Country by 2020<br>• Reduce poverty to 19 percent of population and 11 percent of households by 2015 |
| | | **Foreign investment in land:** $8–8.75 billion between 2011 and 2015, including establishing 500,000 ha of tree plantations by 2020 |
| | | **Develop hydropower:** 10 additional large dams to produce 5,015 MW |
| | | **Develop mining/processing:** copper plates (86,200 t/yr.), gold bars (6 t/yr.), coal (728,000 t/yr.), copper ore (298,000 t/yr.), and gypsum (600,000 t/yr.) |
| **Labor and Employment Strategy** | Ministry of Labor and Social Welfare | **Provide labor:** agriculture sector (2.29 million), processing, industry and construction (226,000), service (739,000) |
| **Agricultural Sector Strategy** | Ministry of Agriculture and Forestry | **Food security:** produce rice equivalent to 4 million tons, at 3.9 tons per hectare on average |
| | | **Cash crop production for income generation:** expand maize production to 150,000 hectares, produce coffee at more than 553,000 tons |
| | | **Livestock production for consumer markets:** produce meat at 32 kg/person/year, aquatic products (fish, frogs, shrimp) at 22 kg/person/year, produce 120,000 cattle for export |
| **Land Policy** | Land Department in Ministry of Natural Resources and Environment | **Equitable land use planning:** create detailed land management plans at macro and micro levels, and land use plans in villages and village-clusters (Kumbans) across the country |
| | | **Land titling for tenure security and tax collection:** issue 1 million land titles, achieve a threefold increase in land revenue (5 percent of the national revenue). |
| **National Strategy on Climate Change** | Ministry of Natural Resources and Environment | **Reduce carbon emissions (NAMAs):** only one NAMA developed for the transportation sector: target reduction of 440,000 t $CO_2$ for 2013–20 |
| | | **Climate Adaptation (NAPAs):** not yet developed |
| **Decentralization Policy** | Prime Minister's Office, Ministry of the Interior | **Decentralization of services:** through establishment, resettlement around rural trade focal areas |
| **Renewable Energy Development Strategy 2020** | Ministry of Energy and Mines | **Production of 205 million liters of biodiesel by 2020,** roughly requires approximately 400,000 ha of jatropha |

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