DRIVERS OF DEFORESTATION AND FOREST DEGRADATION IN NAMKADING NATIONAL PARK OF LAOS

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SUMMARY

Understanding the drivers of deforestation and forest degradation in the Namkading National Protected Area, Laos is important for introducing appropriate technique and policy interventions. Here, we applied GIS and satellite imagery to map deforestation and forest degradation areas in the reserve and identified the drivers and its driving factors by analyzing the local perceptions using questionnaire surveys, group discussions, and field observations. The results indicated that deforestation areas decreased by 61,98 hectares. And forest degradation area increased by 732,13 hectares between 2015 and 2019. We found direct drivers of forest deforestation and forest degradation in the protected area are unsustainable harvest of forest products, uncontrolled forest fire and agricultural expansion. The main indirect drivers are poverty, high demand of timber products in international markets, and ineffective law enforcement in Laos particularly in Borlikhamxay. Our analysis indicates that deforestation and forest degradation are caused by wood furniture producers, agricultural practitioners, charcoal makers, land migrants, firewood collectors, and subsistent farmers. Based on group discussions showed that some activities could be introduced to mitigate these drivers such as implementing the law enforcement related to forestry, selection of alternative income generation for local community live in and surrounding the Namkading National Protected Area along with the provision of environmental education to reduce the driving factors to deforestation and forest degradation and support the sustainable forest resource management of this protected area in the long-term.

Keywords: agricultural expansion, drivers of deforestation, forest degradation, Namkading National Park, uncontrolled forest fire.

1. INTRODUCTION

Deforestation and forest degradation (D&FD) are major global environmental problems and trying to solve them because large areas of forest cover are being lost on a daily basis. Many developing countries are facing these issues, especially in Lao People's Democratic Republic (hereby Laos). The deforestation and forest degradation and environmental issues are being discussed and have raised attentions at numerous environmental conferences on measures to combat their impacts.

According to the Food and Agriculture Organization (FAO, 2019) and current Lao Forestry Law (LFL), (LFL, 2019) defined deforestation as the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 percent threshold, while forest degradation is defined as the changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services. Simply put, while deforestation denotes the loss of forest caused by human actions. On the other hand, forest degradation refers to reduction in the quality of goods and services provided by the forest. Laos's forests are of great importance in a number of aspects. They provide lots of functions and services that support the livelihoods and ecosystem processes. Forests provide a multiple services such as shelter, habitats, fuel, food, fodder, fiber, timber, medicines, security and employment, providing clean freshwater, storing carbon and cycling nutrients, and helping to stabilization the global climate (Ministry of Agriculture and Forestry (MAF), (MAF, 2020). At present, the diversity of many protected areas with ineffective management and their quality of forest covers in Laos are slowly changing due to human activities. Particularly, Namkading National Protected Area (NKD-NPA) in Borlikhamxay Province, central Laos.

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This protected area covers approximately 168,550 ha, is mainly native evergreen and mixed deciduous forests which accounts for 84% of the total area. Unfortunately, the forest areas in the reserve have been deforested, degraded and reduced. Since 2015–2020, the deforestation area was estimated about 2,689 ha (Bakham Chanthavong et al, 2021).

Generally, there are several causes of D&FD and these causes vary from one country and region to another. They are related to multi-factors which are cross-cutting. Beside the forestry sector, they are also linked to other sectors - sociopolitical, economic, demographic etc. Hence, the solutions to the causes of D&FD should be holistic. There are several known causes of D&FD in NKD-NPA. However, understanding and analyzing the causes is complicated. Therefore, this study aims to analyze the trends of the forest areas in the NKD-NPA as well as provide an understanding of the direct and indirect causes of D&FD from 2015 to 2020. The results of this study might also support the decision making by protected area management authorities and sustainable natural resource management in the protected area, Laos.

2. RESEARCH METHODOLOGY

2.1. Study area

This study was conducted in Namkading National Protected Area was one of the original 18 National Biodiversity Conservation Areas of Laos, established in 1993 by decree 164/PM. It situated in the southwestern part of the Borlikhamxay Province, central Laos. It is one of the most globally significant natural ecosystems of the country (Hallam & Hedemark, 2013). This protected area covers an area of 169.000 ha, with an altitudinal gradient from 138 m in the lowlands to 1514 m at the summit of Mount Phou Pa (Hallam & Hedemark, 2013). The vegetation is diverse along this gradient, containing lowland evergreen forest, mixed deciduous forest, grasslands, wetlands and limestone karst (Strindberg et al., 2007; Hallam & Hedemark, 2013). Whereas the vertebrate fauna, including at least 43 species of mammals, 234 species of birds and 21 species of reptiles, has been well documented in the area (IEWMP, 2006; WCS, no date), very limited studies of the flora (Electrowatt, 1995; Hwang et al., 2015; Souladeth et al., 2017) have been made as in the other areas in Laos (Rundel, 1999; Newman et al., 2007).

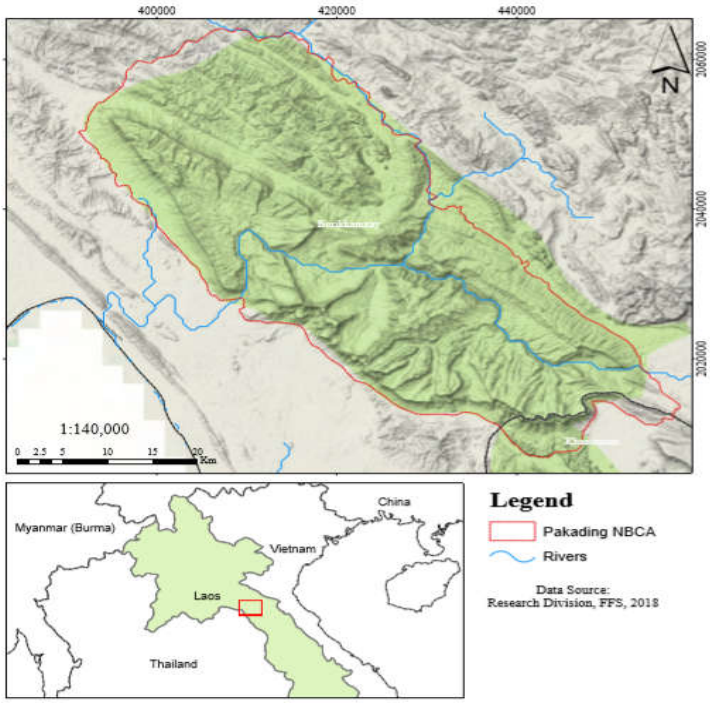

Figure 1. The Study Area: Namkading National Protected Area, Lao PDR

2.2. Methods

2.2.1. Surveys

The study used both secondary and primary data and information. Data on trends of deforestation and forest degradation over the last 5 years was primarily obtained from interpretation of Sentinel 2 Satellite images. Both qualitative and quantitative methods were used in data analysis.

2.2.1.1. Collection and Analysis of Secondary Data

Secondary data and information were collected by reviewing the relevant literature and documents obtained from Provincial and District Agriculture and Forestry Offices in Borlikhamxai, NKD-NPA offices and other agencies. We also obtained data on community forest and forest encroachment from the Department of Forestry, Ministry of Agriculture and Forestry. Statistical data and information is obtained from District Agriculture and Forestry Offices and village committees.

2.2.1.2. Spatial Analyses of Land Use and Forest Cover Changes

Sentinel 2 Satellite dataset from 2016 and 2019 were used to map deforestation and forest degradation areas for the two periods and analyze the trends in forest area and its condition. The Satellite images were freely downloaded from the Google Earth Engine (GEE). Two scenes were acquired (T48QVF and T48QUF) to cover the entire landscape of the study area.

The image scenes were ortho-rectified with the help of ground control points and a digital terrain model to remove the distortions arising from variations in topography, and then projected into Universal Transverse Mercator 1984 zone 48N (WGS_1984_UTM_Zone_48N) datum. The images were classified through visual interpretation. Due to limitation and time availability for the classification and insufficient ground truth data. The analyses were carried out in GEE and ArcGIS software.

2.2.1.3. Collection and Analysis of Primary Data

We interviewed 100 of the local people, out of 100 the people, 40 were staff officer using questionnaire surveys and field discussion. The interviews and discussion with key experts and stakeholders in Borlikhamxai, two districts (Parkading and Viengthong) as well as village level within the boundary of the NKD-NPA. The formal meeting with staffs from Ministry of Natural Resources and Environment (MONRE), Department of Forestry (MAF) and other government agencies, International Non-governmental organizations (INGOs), and civil society associations based in Borlikhamxai were conducted to facilitate the consultation.

Field surveys were conducted from December 2019 to January 2020. We obtained data from villager's guidance and assistance from the head of villages where appropriate.

Our questionnaire consists of three main categories as follows: (i). Basic information of household in the villages; (ii). Social characteristics of surveyed households and natural forest resources uses patterns by local people; (iii). Contribution of income generation from forest resources use to household income and (iv). The divers of deforestation and forest degradation. All the interviewees were contacted in advance by telephone. After confirmation of willingness to participate in the survey, the field interview was carried out in Lao language.

2.2.2. Data analysis

The questionnaire survey data was entered into Microsoft Excel spreadsheets and analyzed by using the statistical package for the social sciences SPSS 25.0. Each question was treated as a separate variable with some key statistics, including frequency, percentage, average values.

3. RESULTS AND DISCUSSIONS

3.1. Trends in Forest Cover Change and deforestation and forest degradation in the NKD-NPA Landscape (2015-2019)

The NKD-NPA Landscape had a total of 168,550 hectares, about 84% of the landscape area of forest in 2019. There are variations in

forest cover, forest types, and trends in forest cover across the forest types. The landscape area and the forest type showed in table.

Table 1: The landscape area and the forest type of NKD-NPA in 2019

No	Landscape/forest types	Area (ha)	Percentage (%)
1	Mixed Deciduous Broadleaf	73942.89	43.87
2	Evergreen Broadleaf	39777.80	23.6
3	Semi - Mixed Deciduous Broadleaf	28198.42	16.73
4	Forest Plantation	2528.25	1.50
5	Secondary Evergreen Broadleaf	9017.43	5.35
6	Shift Cultivation	7871.29	4.67
7	Water and Wetland	5494.73	3.26
8	Road, building	1719.21	1.02
	Total Landscape	**168550**	**100**

(Sources: The authors surveyed and computing, 2019)

The forests in this reserve are intermixed with settlements and agricultural land, and valued primarily for meeting the livelihood and subsistence needs of the local population. The Mixed Deciduous Broadleaf has around 43.87 %, the Evergreen Broadleaf had 23.6% and the Evergreen Broadleaf had 16.73 percent forest cover in 2019.

An analysis of changes in major forest cover in the landscape for the period 2015-2019 shows that the area under forest remained more or less constant during the period; forest under substantially decreased, and degradation and agriculture area slightly increased (Figure 2, Table 2).

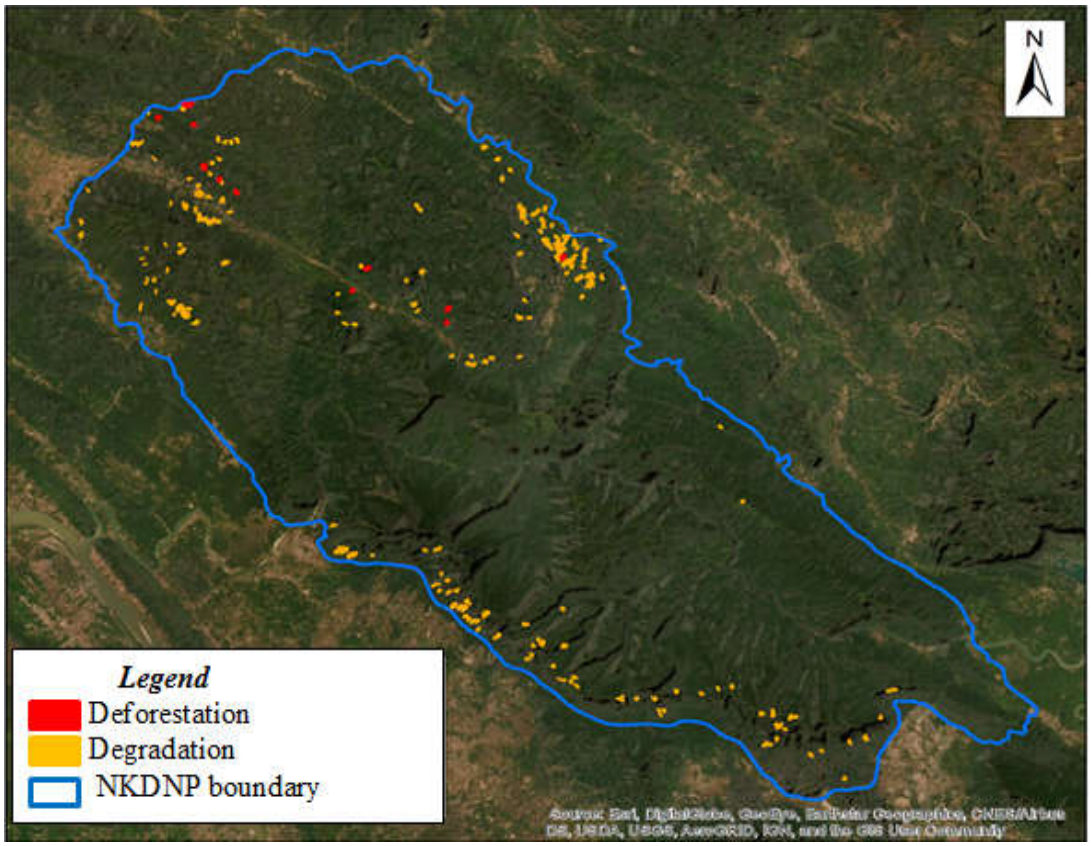

Figure 2. Area under deforestation and forest degradation in NKD- NPA

(Sources: The authors' map, 2019)

Table 2. Area Under Different forest types in NKD- NPA in 2015 and 2019

No	Forest types	Area in 2016 (ha)	Area in 2019 (ha)	Chang in 2019 – 2015 (ha)
1	**Deforestation**	**141919,1**	**141857,1**	**- 61,98**
1.1	Mixed Deciduous Broadleaf	73942,89	73901,53	- 41,36
1.2	Evergreen Broadleaf	39777,80	39768,53	- 9,27
1.3	Semi - Mixed Deciduous Broadleaf	28198,42	28187,07	- 11,35
2	**Forest degradation**	**53312,97**	**54045,1**	**732,13**
2.1	Mixed Deciduous Broadleaf	31056,01	31373,33	317,32
2.2	Evergreen Broadleaf	12331,12	12390,46	59,34
2.3	Semi - Mixed Deciduous Broadleaf	9925,842	10281,31	355,47

(Sources; The authors listed and computing, 2019)

The finding that forest area remained largely unchanged during the period does not mean that there was no forest loss or gain in the landscape. The forest areas under deforestation decreased by 61.98 ha and forest area under degradation increased substantially by 732.13 ha in between 2015 and 2019.

3.2. Drivers of deforestation and forest degradation in the NKD-NPA

Drivers of deforestation and forest degradation in the NKD-NPA can be categorized into two groups. Direct drivers are human activities that originate from human choice of land use, which directly impacts upon forest cover. Underlying causes of deforestation and forest degradation are structural (or systemic) in nature. These can be seen as a complex of social political, economic, technological, and cultural variables that constitute initial conditions in the human-environmental relations. Ty, S., et al. (2011), assessed and clarified 10 drivers of deforestation in Oddar Meanchey Province, namely forest clearing for sales 30%, conversion to cropland 30%, conversion to settlements 10%, fuel-wood gathering 10%, forest fired induced to clean land 5%, hunting inducing forest fires 5%, illegal logging for commercial on sale 5%, timber harvesting for local use 5%, large economic land concessions and timber concession with a very small proportion. To reduce such drivers, any appropriate intervention requires specific assessment in place since its drivers are varied and complicated. Wildlife Conservation Society Lao PDR Program (WCS, 2015), assessed and clarified nine direct drivers and eight underlying indirect drivers of deforestation and forest degradation in Houaphan province. Colin Moore et al, (2011), Investigation of the Drivers of Deforestation and Forest Degradation in Namphui National Protected Area had clarified nine source activities were identified as being responsible for deforestation and forest degradation.

A total of 6 direct and indirect drivers of deforestation and forest degradation have been identified in NKD-NPA. These include: (1) Over and unsustainable harvest of forest products, (2) Uncontrolled forest fire, (3). Agricultural expansion, (4) Poverty, (5). High demand of timber product in the international market, and (6). Ineffective law enforcement in the area.

3.2.1. Directed drivers of Deforestation and Forest Degradation in the NKD- NPA

(i) Over and unsustainable harvest of forest products

According to the forestry law, the local people are allowed to harvest the timber and non-timber forest products in the controlled use zone in sustainable ways. Before 2019, permits are obtained from MAF and trade and transportation of the timber are prohibited in Laos. While Ban Pakading and Ban Parkbuak claim that village allocated forest areas are currently enough to satisfy their timber needs, the Vienghthong villages stated that they satisfy their timber needs from the NKD-NPA. Furthermore, it was mentioned that villagers had to travel increasingly longer distances in order to collect the species they needed.

Although this is not illegal, it is important to know that this driver exists in the Viengthong district. Both villagers and government staff stated that illegal logging occurs in the NKD-NPA on a very limited scale. Illegal logging appears to be financed by outside "businessmen" and assisted by villagers who scout out valuable trees in exchange for a fee. In other cases, villagers may cut more than their allowed MAF quota and sell their excess. According to villagers, felled timber comes from trees with a diameter of about 50 – 60 cm (anything larger is too big to handle), is cut into manageable sizes and then transported out of the forest either by hand or *tuk tuk* due to a lack of suitable roads for trucks. This lack of access for larger vehicles suggests that larger scale illegal logging is not possible via access from village areas (MAFL, 2018).

(ii) Uncontrolled forest fires. Fires are known to have played a role in affecting the ecology of tropical forests in South East Asia, especially in Laos, however, historically this has been primarily limited in extent to open deciduous forests and savannahs. Greater population density has however increased the impact of fire on tropical forests, with repeated burnings causing forest areas to degrade increasing the number of reported fires in closed Semi - Mixed Deciduous Broadleaf and Mixed Deciduous Broadleaf. However, there were some fire also occurred within this NKD-NPA which dominant by new resettlements of local villagers. A total area of 16,923 hectares were detected as forest fires (6,392 hectares of high severity and 10,531 hectares of moderate-high severity classes) within the study dataset. About 2,689 hectares of forest fires were detected within Namkading from March-April, 2018. This includes 841 hectares of high severity and 1,848 hectares of moderate-high severity (Bakham Chanthavong et al, 2021).

Fire was mentioned on several occasions as a factor affecting the quality of the forest in the NKD-NPA. Fires were reported to always be surface fires rather than crown fires. In this regard, this driver can be considered primarily one of degradation, however the long-term degradation of mature forests whose saplings have high fire-driven mortality rates and are quickly out-competed by sapling, seedling can lead to the eventual re-classification of forest from high to low density mixed deciduous forest, until density drops to below the UNFCCC definition of forest cover. By the survey and groups local people discussion, the main ways fire affect the NKD-NPA are the following: (1) Fires are used to prepare agricultural lands for the new planting season. This most often happens during the late months of the dry season (March – May). Windy conditions or poor fire management often cause fires to spread beyond the field boundaries into surrounding fields or forest nearby; (2). Hunters use fire to force animal movement in certain directions and to improve visibility in the forest. There is little incentive for hunters to practice fire management techniques and therefore these fires often burn out of control.

Figure 3. Photos from Field Visits - Uncontrolled forest fires

(Sources: Bakham Chanthavong, 2018)

(iii) Agricultural expansion. Out of 100 people were interviewed, 45 agricultural practitioners. All the agricultural practitioners interviewed during the field trip are involved with agricultural expansion. Agricultural practitioners reported that their main cash-crops were maize and Job's tears about 300 hectares (*Coix lacryma-jobi)*, with some villages planting limited amounts of rubber, sesame and okra. The adoption of cash-crop farming is a recent trend with almost all villages reporting a transition to this form of agriculture within the past five years. Government policy promoting this crop as well as the market demand for these crops and the consequent increase in household income were the main reasons given for this agricultural expansion. This is entirely consistent with the results of the literature review that cited similar reasons for this agricultural expansion. Nevertheless, villagers considered agricultural expansion to have had an overall positive impact on their livelihoods.

The agricultural expansion is visible effects on land-use. These crops require greater amounts of land than upland rice, the primary crop they have replaced, which has been obtained primarily by requesting permission from District Agriculture and Forestry Offices to expand into village forest areas. In some cases, due to the limited capacity of staff at District Agriculture and Forestry Office to enforce land expansion, this has also occurred illegally outside of the allocated village boundary. The agricultural extend is Viengthong district occurred within the NKD-NPA, while in Thongmixai district expansion has tended to be into village forest areas and neighboring village areas.

3.2.2. Indirected drivers of deforestation and forest degradation in the NKD- NPA

(i) Poverty. Poverty can be an underlying cause for many of the direct and indirect drivers of forest degradation and deforestation in the NKD-NPA.

Out of 100 people were interviewed, 35 local officers. According to interviewed local officials, being officially classified as not poor does not necessarily lead to reduced deforestation and degradation in the NKD-NPA by households. In reality, residents in the province observe that people in many parts of the country as well as in the world enjoy better living conditions than what they do, and this observation shapes local people's expectations of an improved living standard. To meet this expectation, most families in the Borlikhamxai try to earn money to build better houses, to support their children to receive a higher educational level and to own items including cars, tractors, motorbikes, trucks, and smart phones. Many families (especially in Bolikhamsai town) also decorate their houses with (expensive) wooden furniture, often made of valuable tree like Mai Long Leng, which provides demand for further logging. Forest resources can also be used unsustainably to increase incomes. For example, farmers use more land area to cultivate agricultural cash crops to meet their demand for more income, leading to greater deforestation and unsustainable land use practices. Local governmental officials at the Bolikhamsai and Viengthong level use the phrase, "it is better die tomorrow than today". This means that they know the future impact of destroying forest on people and environment but they also understand that local people have to rely on the forest resource mainly trees to meet their immediate needs. Many local officials (anonymous) strongly believe that solving the problems of deforestation and forest degradation in the NKD-NPA cannot be achieved until food security and reasonable incomes are provided for people living near forest areas. Until these issues are addressed, forest clearance for food and cash crop production will continue.

(ii) High demand for timber product in the

international markets. International demand for commodities, specifically maize, timber, and some non-timber forest products (NTFPs) is an underlying driver for deforestation and degradation in the NKD-NPA (MAFL, 2018).

There is a large market and demand for hardwood timber in foreign countries, especially for furniture making. In fact trade data suggests that the majority of wood based products are logs and sawn wood, which are predominantly exported to foreign countries Much of this demand, is supplied with illegally logged timber from Laos, especially in areas near to the border likes the NKD-NPA in Borlikhamxai. As mentioned above, it is estimated that more than half, and possibly up to 90% of the total wood harvested in Laos is illegal, and therefore not documented. The demand for some NTFPs from international markets may also be leading to forest degradation in the NKD-NPA. For example, the majority of red mushrooms collected are destined for foreign countries, and interviews revealed that the collection of red mushroom has increased significantly in recent years (2018 – 2019).

(iii) Ineffective law enforcement in Laos. Many of the drivers for deforestation and forest degradation covered in this report are facilitated, or exacerbated, by insufficient or absent enforcement of existing rules and laws related to forest land use. While NKD-NPA areas of forest have various levels of legal protection, deforestation and forest degradation in these areas continues for a number of reasons. In many village, the villagers encroach onto forest land illegally to increase rice production for food consumption, and to grow agricultural cash crops, primarily maize, to increase income. The motivations for clearing land range from insufficient lands for poorer farmers to produce enough food for the year, through to larger scale agricultural ventures aimed at making profits. Regardless of these motivations and requirements of both villagers and law enforcement agencies, there is a general lack of law enforcement of protected forest areas. An added complication is that of conflicting government policies and support. For example, the central government of Laos has a stated policy of returning forest cover to 70% of total land area by the year 2020, including through tree planting. Districts however, promote and support food security through extension and the support of trading which can lead to increased forest clearing for agricultural land. Locking up land in forest plantations can lead to farmers clearing land in other areas, a process known as 'leakage'. Exacerbating this problem is the lack of marketing support to villagers which leads to low agricultural commodity prices being paid to farmers. To make enough money, farmers need to plant larger areas of land than they would need to if they were paid better prices. Higher commodity prices may not necessarily lead to reduced forest clearance, however improved incomes may reduce the pressure for many families to clear more difficult to cultivate or marginal forest areas (MAFL, 2018).

3.3. Suggestion

Based on study on drivers of the deforestation and forest degradation in the NKD-NPA. We suggest that:

- Illegal timber product harvesting and trade violations need to be rigorously punished. The improvement of systematic timber harvest monitoring system by Agriculture and Forestry agencies is needed and the forest inventory of the protected area should be conducted at district and provincial levels.

- Small-scale (about 1000 hectares) forest plantation should be initiated. This should include detailed observations of the species natural habitat and growth factors. Such plantation could also be supported by training on different cultivation techniques and the knowledge of relevant cultivation aspects such as habitat, diseases and other features.

4. CONCLUSIONS

The drivers of the deforestation and forest degradation are considered separately in this study, it is typically the combination and interaction of a number of drivers.

For deforestation, the most important combination of factors is: Agricultural expansion, primarily maize production, linked with pioneering shifting agriculture using fire, and shortened fallow periods. The increase in maize production can lead directly to deforestation as upland maize field expand, and can also facilitate further forest cover loss by displacing upland rice production into new forest areas, and by increasing pressure to reduce fallow lengths. These reduced fallow lengths lead to a net decrease of regenerating fallow forest cover from year to year.

The most important drivers of forest degradation are most likely: Unsustainable wood extraction, through legal and illegal selective logging of high value trees. International demand for commodities, primarily maize for animal feed for foreign markets

Low law enforcement capabilities, leading to illegal timber extraction, poorly enforced conservation and protection forest areas, and the inability of officials to ensure that infrastructure, mining and hydropower projects abide by project conditions and quotas.

Poverty, which can lead to ongoing pressure to clear upland forest areas as poorer families try to produce sufficient rice. Poverty can also lead to illegal activities such as illegal timber and NTFP extraction as households seek additional income sources.

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NGUYÊN NHÂN GÂY MẤT RỪNG VÀ SUY THÁI RỪNG TẠI VƯỜN QUỐC GIA NAM KA ĐING, LÀO

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TÓM TẮT

Hiểu được các nguyên nhân gây mất rừng và suy thoái rừng ở Vườn Quốc gia Nam Ka Đing, Lào là điều quan trọng, giúp cho đề xuất các biện pháp kỹ thuật và thể chế, chính sách tác động. Với việc ứng dụng công nghệ địa không gian và tư liệu ảnh viễn thám trong lập bản đồ mất rừng và suy thoái rừng cũng như điều tra, phỏng vấn người dân địa phương nhằm phân tích, đánh giá xác định nguyên nhân và các tác nhân chính gây mất rừng và suy thoái rừng tại Vườn Quốc gia Nam Ka Đing giai đoạn 2015 - 2019. Kết quả, đã xác định được diện tích rừng bị mất 61,98ha, rừng bị suy thoái 732,13ha. Những nguyên nhân trực tiếp và gián tiếp chính được xác đinh là: Khai thác tài nguyên rừng thiếu bền vững; Cháy rừng thiếu kiểm soát; Mở rộng diện tích đất canh tác nông nghiệp; Đói nghèo; Nhu cầu tiêu dùng đồ mộc tăng cao và Hiệu lực của hệ thống luật pháp về Lâm nghiệp còn hạn chế ở Lào, nhất là ở tỉnh Bolikhamsai. Những tác nhân chính là do số người tham gia sản nghề xuất đồ mộc, người nông dân, những người khai thác gỗ làm than củi, kiếm củi cho đun nấu cũng như những người mưu sinh hàng ngày phục thuộc vào nguồn tài nguyên rừng. Kết quả tham vấn với các bên có liên quan, đã đề xuất một số giải pháp tác động nhằm giảm thiểu, ngăn chặn các nguyên nhân gây mất rừng và suy thoái rừng gồm: Thực thi pháp luật về Lâm nghiệp; Tạo lập và chuyển đổi thu nhập, kết hợp giáo dục, đào tạo nâng cao nhận thức về quản lý bền vững nguồn tài nguyên rừng đối với cộng đồng địa phương sống cạnh Vườn Quốc gia Nam Ka Đing.

Từ khóa: cháy rừng thiếu kiểm soát, mở rộng canh tác nông nghiệp, Nam Ka Đing, nguyên nhân mất rừng, suy thoái rừng.

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