

The Impact of Land Rights on Deforestation in Lao PDR*

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Abstract

The purpose of this study is to examine whether land rights reduces the deforestation in Lao PDR. The authors use the secondary data collected by LECS 5 (Laos Expenditure and Consumption Survey 5), in period 2012-2013, from Lao Statistics Bureau and use 6,020 sample households in Laos. Logistic regression model is used for the analysis. This study finds that household land rights have a negative impact on deforestation (cutting timbers in surrounding forests) and the impact is statistically significant. The authors conclude that land rights of the households have a huge impact on deforestation in Lao PDR. Land use policy-makers should be aware that land rights and land security hugely reduce the deforestation (cutting of timbers of the households) especially rural households. This finding might have significant impacts on reducing deforestation by households in Lao PDR and provide information for further research in this area. It is the first study to investigate the impact of land rights on deforestation (cutting timbers in surrounding forests by households in Lao PDR) in the Faculty of Economic and Business Management, National University of Laos.

Keywords: Land rights; Deforestation, Lao PDR.

Introduction

Forests and trees make crucial contributions to people and the planet especially supporting livelihoods, providing clean air and water, preserving biodiversity and reacting to climate change issue. Forests operate as an important source of food, medicine, and fuel for more than a billion people (FAO, 2018). Forests cover approximately 30 percent of the world's total land area, but they are vanishing at a jumpy rate. Between 1990 and 2016, the world lost 1.3 million square kilometers of forest which is larger than the area of South Africa (National Geographic, 2019). Land is an essential asset for social, political and economic sustainability that generates livelihood, supplies ecosystem services, and stockpiles

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wealth for the rural communities in developing countries around the world (Bogale et al., 2006; Legesse, 2014; Toulmin, 2008).

The cause of deforestation is definitely multifaceted. However, one of the main causes for deforestation is land tenure (Dolisca et al., 2007; Smucker, 1998; Smucker et al., 2002) and gathering fuelwood for cooking or heating is a major factor in deforestation (Tucker, 1999). Empirical studies confirm that tenure security is associated with less deforestation (Robinson et al., 2014; Dolisca et al., 2007; Etongo et al., 2015). Similar findings were obtained for South America (Araujo et al., 2009) and for Sub-Saharan Africa (Damnyag et al. (2012). Numerous studies show that well-defined land rights have the capability to increase natural resource management, agricultural productivity and sustainable development through supplementing or strengthening landholders' confidence (Abdo, 2013; Bogale et al., 2006; De Soto, 2000; Meinzen-Dick, 2014; Wang et al., 2015). And, research by Alston et al. (2000) along the Brazilian Amazon shows that tenure insecurity results in higher rates of forest clearance. In many parts of the developing countries, tenure insecurity increases deforestation due to forest clearance as a first in claiming the land rights (Alston et al., 2000; Myers, 1994).

In addition, some studies demonstrate that the insecure land in developing countries might lead to high inefficiency in land investment, credit accessions, food security and high inefficiency in labor supply (Legesse, 2014; Macours et al., 2010; USAID, 2007). But, the study by Wunder and Verbist (2003) argue that secure land tenure does not always support optimal natural forest management and it has more positive effects on tree planting and agroforestry than on the management of the natural forest. On the other hand, the study of Robinson et al (2014) showed that tenure security is associated with less deforestation. Therefore, the security of land tenure can act as a vital factor in the decision-making of land use (Wannasai and Shrestha, 2008).

Lao PDR is one of the poorest countries in Southeast Asia. However, with mostly mountainous topography and tropical climate, Laos has an endowment of forest and possesses one of the pristine monsoon forests in South East Asia, which the total forest area is estimated about 13.2 million hectares or 57.4 percent of total land area in 2015. Forest resources are crucial to many stakeholders and contribute pivotally to the rural economy in Laos, as they provide ecosystem services, preserve biodiversity and watersheds, and elimination of carbon dioxide.

Although the proportion of land area covered by forests has increased, the forests of Laos are currently encountering multiple pressures and the quality of the forest has continued to rapidly degrade over the past few decades. Based on measurements by the Lao government, deforestation has denuded large areas of Laos since the 1940s, when the national forest cover was over 70 percent of the country's land area. In the 1990s, that number shrank to less than 40 percent (Open Development Laos, 2018).

Very few empirical studies have examined the factors contributing to land degradation, land use and deforestation in Laos. Land Degradation in the Lao PDR was conducted by Lestrelin (2010). Vongvisouk et al. (2019) studied the shifting cultivation stability and change in Laos to examine the impact of shifting cultivation. Contradictory land use plans and policies in Laos especially tenure security and the threat of exclusion was studied by Broegaar et al (2016). Overall, descriptive statistical analysis was mostly used in many studies regarding land security, land use and policy, shifting cultivation, and land

degradation in Laos, but applying econometrics model to assess the impact of land rights on deforestation in Laos is still very rare.

This study attempts to examine the impact of household factors specifically land rights on deforestation in Lao PDR. We use 6020 sample household data collected by LECS 5 (Lao Expenditure and Consumption Survey 5) in 2012-2013 and use the Logistic regression model for the analysis.

The rest of paper is organized as follows: Section 2 gives an overview of forests and deforestation in Laos. Section 3 reviews the literature. Section 4 describes the model. Section 5 describes the characteristics of the sample households. Section 6 provides the empirical results and discussions. Lastly, the concluding remarks are given in the final section.

Overview of forests and deforestation in Lao PDR

Lao PDR is abundant in biodiversity. It is estimated that biological resources contribute over 66 percent to GDP. Moreover, they offer benefits for the rural poor communities as agro-biodiversity is the main source of food, nutrition and income generation. In the area of forestry, some non-timber forestry products (NFTP) such as wild animals, bamboo and rattan shoots, fruits, greens, honey, and others are sold in local markets and some are traded internationally. In addition, non-wood forest products, including edible insects, provide 60 percent of the monetary income of rural villages (FAO, 2019).

Lao PDR is made up three different zones: the northern mountainous region; the central and southern hilly to the mountainous region; and the area around the Mekong River and its tributaries (Somphathilath, 2012). It is a greatly biodiverse country with approximately 172 mammal species, 212 bird species and 8286 higher plant species (IUCN, 2006). Forests in Lao PDR can be clearly classified into the upper mixed deciduous forest, upper dry evergreen forest, and dry dipterocarp forest.

According to the Department of Forestry (DoF), using the national definition of forest of >20 percent tree canopy cover, forest area in 2002 was 9.8 million hectares and 41 percent of the overall land area which declining to 9.5 million hectares and 40 percent of the total land area in 2010 (DOF, 2011). According to the Global Forest Resources Assessment by the United Nations Food and Agriculture Organization (FAO), applying the FAO forest definition of >10 percent tree canopy cover, forest area in 2002 was around 16.4 million hectares and covered 69 percent of the whole land area, and almost 15.8 million hectares and 67 percent of the total land area in 2010. Albeit these figures indicate relatively modest changes between 2002 and 2010 with a loss of 35,000 hectares annually, forest cover is reported to have decreased rapidly in the 10 years prior, between 1992 and 2002, at a rate of 134,000 hectares per year. Additionally, forest quality has worsened and degraded in the last couple of decades, with dense forest falling from 29 percent in 1992 to only 8.2 percent in 2002 and open forest growing from 16 percent to 24.5 percent (FAO, 2010). Deforestation and forest degradation in Lao PDR contributed about 51 million tons to annual CO₂ emissions (DOF, 2010).

Lao comprises of 49 ethnic groups and a large number of sub-groups whose livelihoods range from hunting and gathering to various forms of shifting cultivation in the uplands and wet-rice farming in the plains (King and van de Walle, 2010). In recent years, the economy has grown rapidly, with the average annual GDP growth of more than 7 per cents and reaching 8.4 per cents growth in 2010. The agriculture-forestry sector has contributed crucially in boosting the economy, which accounted for 30.4 per cents of the GDP in 2010 and is the largest contributor to national GHG emission.

Despite a small population, forests in Laos are facing numerous issues driven mainly by slash-and-burn agricultural farming, uncontrolled fires, commercial and illegal logging, and fuelwood collection for cooking, which heavily resulted in the loss of 6.8 per cents of the country's forests between 1990 and 2005. The deforestation rate has increased moderately since the 1990s. Also, forest loss in Lao PDR has driven by development activities such as agricultural expansion, forestry plantations, mining, hydropower, and infrastructure development (Mekong Maps, 2010). These pressures are likely to increase given the country's target for accelerating economic growths.

Literature Review

Dolisca et al. (2007) conducted a study, based on Tobit regression analysis, to examine effects of deforestation, land tenure, and population pressure at Forêt des Pins Reserve in Haiti, by using the annual average area of cleared forest per household as the dependent variable. Using farm-household data collected from 243 households in 15 villages located in and around the reserve, the study found that household size, education level of household head, land tenure regime and farm labor are important factors for land clearing.

By using Tobit model in the analysis, Etongo et al. (2015) examined the impacts of land tenure and asset heterogeneity on deforestation in Southern Burkina Faso. The study analyzed the drivers of deforestation in Ziro province of Southern Burkina Faso by using the area of forest cleared annually as the dependent variable, whereas household characteristics and local institutions (tenure and property rights) were considered as the independent variables. Data were collected through focus group discussions, participant observation, interviews with key informants and from 200 farm households. Tobit regression results confirmed that land tenure insecurity and low agricultural production expressed in the sizes (areas) and ages of farms led to increased deforestation. The significance of tenure insecurity, as a driver of deforestation, indicated that migrants do contribute more to deforestation than the indigenous groups. Greater rights and improved legal status might reduce the rights to limited use granted to migrants.

In a study of Honduras, Godoy et al. (1998) examined the effects of schooling on the clearance of old-growth rain forest through a survey of 101 Tawahka Amerindian households in the Honduran rain forest. The results of tobit, ols, probit, and median regressions found

that each additional year of education lowered the probability of cutting old-growth rain forest by about 4% and decreased the area cut by 0.06 ha/family each year. However, the effect of education on deforestation was non-linear because, with up to 2 years of schooling, forest clearance declined; with between 2 and 4 years of schooling, clearance increased, but beyond 4 years of education, once again, seemed to curb deforestation. Thus, education curbed forest clearance because it is easier for individuals to gain information about new farm technologies from outsiders in order to intensify term production by river banks.

Kubitza et al. (2018) assessed the impact of land property rights and agricultural intensification on deforestation in Indonesia. The data were collected from a panel survey of farm households in Sumatra and survey data were combined with satellite imageries to account for spatial patterns, such as historical forest locations. Results indicated that plots for which farmers hold formal land titles are cultivated more intensively and are more productive than untitled plots. Nevertheless, due to land policy restrictions, farmers located at the historic forest margins often do not hold formal titles. Without land titles, these farmers are less able to intensify and more likely to expand into the surrounding forest land to increase agricultural output. In addition, results showed that forest closeness and past deforestation activities by households were found to be positively associated with current farm size.

Legesse et al. (2018) studied the impacts of land tenure and property rights on reforestation intervention in Ethiopia and the study examined determinants of farmers' decisions to invest in reforestation interventions through focusing on land tenure and property rights. The study found that land security is one of the most significant factors that affect farmers' decision to practice reforestation intervention. In addition, farmers' level of education, family size and training have statistically positive impact on reforestation intervention.

Method

To examine the impact of land rights on deforestation in Lao PDR, we use the cross-sectional and secondary data collected by LECS 5 (Laos Expenditure and Consumption Survey 5) from Lao Statistics Bureau and use samples of 6,020 households to represent Laos for the analysis. The survey was carried out in the years of 2012 to 2013. We use Logistic regression model for estimating the analysis constructed by Greene (1997).

The simple Logistic model is shown as below:

$$\text{Prob (event)} = \frac{e^{(\beta_0 + \beta_1 x)}}{1 + e^{-(\beta_0 + \beta_1 x)}}, \text{ or Prob (event)} = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

- β_0 and β_1 : are the coefficients derived from the variable
- X: is the explanatory variable
- e: is the error terms.

In case there are many variables (p variables), we can write the equation as below:

$$\text{Prob (event)} = \frac{1}{1+e^{-z}}$$

$$Z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p$$

In this study, we use cutting timbers (yes = 1; 0 = no) as the dependent variable and there are 9 explanatory variables so the logistic regression model is shown in the equation below:

$$P(\text{Timber}_{i=1}) = \beta_0 + \beta_1 LR_i + \beta_2 LT_i + \beta_3 Area_i + \beta_4 HS_i + \beta_5 Educ_i + \beta_6 Gender_i + \beta_7 Age_i + \beta_8 Ethnic_i + \beta_9 Region_i + \mu_i$$

Where, β_0 is the constant coefficient and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9$ are the coefficients of the explanatory variables of land rights, land type, land area, household size, education of household head, gender of household head, age of household head, ethnic of household head and the region that households live respectively; μ_i is the error term. The details of the variables for the Logistic regression are in Table 2.

Results and Discussions

Table 1 presents the socio-economic variables of the households involved in the study sample. A total of 6,020 sample household data were used.

Table 1. Socio-economic characteristics of the households

Household characteristics	Number (household)	Percent
<i>Land rights of household</i>		
Owned	3,941	65.47%
Free-using	1,846	30.66%
Leased	233	3.87%
<i>Land type of household</i>		
Arable land for temporary crops	5,255	87.29%
Fallow land	133	2.21%
Land for permanent crops	385	6.38%
Grazing land	50	0.83%
Forest land	197	3.29%
<i>Agricultural Area of household (hectare)</i>		
<1	3,339	55.47%
1-4	2,600	43.19%
>4	81	1.39%
<i>Household size</i>		
1-3	1,036	17.21%
4-6	1,445	24.00%
7-9	1,228	20.40%
≥10	311	5.17%
<i>Education level of household head</i>		
Illiterate	3,057	50.78%

Primary school	1,232	20.47%
Secondary school	417	6.93%
Upper secondary school	238	3.95%
Technical training	699	11.61%
Bachelor's degree	358	5.95%
Higher than bachelor's degree	19	0.32%
<i>Gender of household head</i>		
Male	5,682	94.39%
Female	338	5.61%
<i>Age of household head</i>		
21-30	692	11.50%
31-40	1,600	26.58%
41-50	1,767	29.35%
51-60	1,345	22.34%
>60	616	10.23%
<i>Ethnic of household head</i>		
Lao	2,590	43.02%
Khmu	1,742	28.94%
Hmong	703	11.63%
Otherwise	985	16.36%
<i>Region in Laos</i>		
North	2,432	40.40%
Central	2,222	36.91%
South	1,366	22.69%

The majority of households are landowners, which accounted for 65.47 percent. However, many households still use and hold the land for free and temporarily rent from others which account for 30.66 and 3.87 percent respectively. About 87.29 percent of the households own arable land for temporary crops and the rest are forest land, grazing land, arable land for growing permanent crops, and fallow land.

For the agricultural land area, less than 1-hectare accounts for 55.47 percent following by 1-4 hectares accounts for 43.19 percent and households who own agricultural land more than 4 hectares is about 1.35 percent. Households are mostly large families with family members around 4-6 people. However, the education level of household heads is very low and approximately 50.78 percent of them have no education at all and with male dominate the gender of the household head. The age of the household head is around 41-58 years old indicating that they are still in active manual workers and have plenty of life experiences. For the ethnicity of the household head, Laos ethnic is made up 43.02 percent following by Khmu, Hmong and other minorities.

To estimate the impact of land rights on deforestation, Logistic regression model is applied. The logistic model might have econometric problem specifically multicollinearity, that can be investigated and removed during the estimation. Multicollinearity is a very severe problem when using Logistics method. If the coefficients of the correlations between the explanatory variables have an absolute value equal to or above 0.80, then the multicollinearity is severe (Gujariti, 1995). The explanatory variables for this study are verified to have no multicollinearity because the highest absolute value is 0.36 which is much less than the criteria value.

Table 2. The variables for the Logistic regression

Variables	Definition		Expected Sign	Sources of variables
<i>Dependent variable</i>				
Timber	Cutting timbers	1 = yes; 0 = otherwise		
<i>Independent variable</i>				
LR	Land rights	1 = yes; 0 = otherwise	Negative	Etongo et al. (2015)
LT	Land type	1 = arable land for growing temporary crops; 0 = otherwise	Negative	Author
Area	Agricultural land area	Hectare	Negative	Author
HS	Household size	Person	Positive	Dolisca et al. (2007)
Educ	Education of household head	in year	Negative	Godoy et al. (1998)
Gender	Gender of household head	1 = male; 0 = female	Positive	Legesse et al. (2018)
Age	Age of household head	in year	Negative	Dolisca et al. (2007)
Ethnic	Ethnic of household head	1 = Laos; 0 = otherwise	Negative	Author
Region	Region of Laos	1 = central; 0 = otherwise	Negative	Author

Table 3 shows the impact of land rights on household deforestation. The households who own the lands have a negative coefficient with the expected negative sign. This sign shows that there is a negative relationship between land rights (LR) and deforestation (cutting timbers).

If households have land rights, the probability of cutting timbers decreases 11.12 percent compared to the households who have no land rights and the coefficient is statistically significant at 1 percent level. This result is consistent with the results of some studies, which demonstrate that secure land tenure appears critical to reducing annual deforestation compared to unsecured land tenure and households with insecure land titles are more likely to clear forest (Araujo et al., 2009; Damnyag et al., 2012; Dolisca et al., 2007; Etongo et al., 2015; Robinson et al., 2014).

Land type (LT) was expected to be negatively correlated with cutting timbers because if households have arable land for growing temporary crops, they will generate income from selling their agricultural products and less likely to cut timbers for household consumption as they can buy processed woods for household usage instead.

The logistics regression result shows that if households have arable land for growing temporary crops, they will decrease the chance of cutting timbers in the surrounding forests by 6.07 percent compared to other land and the coefficient is statistically significant at 1 percent level.

Table 3. The impact of land rights on deforestation (cutting timbers)

Variables	Definition	Coefficient	t-test
LR	Land rights of the household	-0.1112***	-12.27
LT	Land type of the household	-0.0607***	-5.62
Area	Agricultural land area	0.0092*	1.84
HS	Household size	0.0061***	2.85
Educ	Education of household head	-0.0144***	-23.53
Gender	Gender of household head	-0.0090	-0.50
Age	Age of household head	-0.0014***	-3.72
Ethnic	Ethnic of household head	-0.0281***	-2.80
Region	Regional part of Laos	-0.0389***	-3.67
Constant		3.9797***	13.88
Number of observations		6,020	
F-statistic		954.82	
Probability		0.000	
R ²		0.1646	

Agricultural land area (Area) was expected to be negatively correlated with cutting timbers because if households have adequate land area to grow crops then they could be able to generate permanent income from selling their agricultural outputs and then be less likely to engage in cutting timbers in the surrounding forests.

However, the result shows that there is a positive relationship between land area and deforestation. If the area increases by 1 hectare, the chance of cutting timbers will increase by 0.9 percent and the coefficient is statistically significant at 10 percent level. This happens may due to household behaviors. One possible answer is that most of the households in Lao PDR still hugely rely on the forests especially cutting and collecting woods and timbers for cooking and building their houses. Even they have the agricultural land increases they still have to use timbers for household consumption.

Household size (HS) was expected to be positively correlated with cutting timbers because of increased food needs and the greater availability of workers. Table 3 indicates that households with fewer members are more likely to cut fewer timbers. The probability of cutting timber increases by 0.61 percent as the household size increases and this coefficient is statistically significant at 1 percent level. This result is consistent with the results of the studies by Dolisca (2007) and Godoy et al (1998).

As expected, education of the head of household (Educ) has a significant negative effect on deforestation. The result indicates that 1-year increase in education of the household head lowers the chance of cutting timbers by 1.44 percent and the coefficient is statistically significant at 1 percent level. This might be due to the fact that education helps them to acquire information and knowledge regarding appropriate and efficient land use and understand the impact of deforestation. This result is consistent with the studies by Godoy et al. (1998) and Lesgesse et al. (2018).

Gender does not appear to be a significant determinant of deforestation in our study. This may explain by the fact that only 5.61 percent of the female are household heads. Age of

household head has a negative impact on deforestation. The result indicates that the probability of cutting timbers in surrounding forests decreases by 0.14 percent as the age of the household head increases, which could be due to the fact that by getting older, they may not do the heavy tasks specifically cutting timbers as it needs lots of energy to do this work. Empirical studies by Dolisca et al. (2007) and Etongo et al. (2015) showed that the age of the household head had a negative relationship with deforestation. However, the findings were not statistically significant.

As expected, ethnic (Ethnic) has a negative impact on deforestation. The result shows that the probability of cutting timbers in surrounding forests decreases by 2.81 percent if the ethnic of the household head is Lao and it is statistically significant at 1 percent level. This may due to the fact that Lao households live in urban areas and have permanent rice paddy fields compared to other minorities that mostly live in the mountains and heavily rely on shifting cultivation that is the main issue of deforestation.

The result also shows that region has a negative effect with deforestation in our study. If the households settle or live in the central part of Laos, the probability of cutting timbers decreases by 3.89 percent and it is statistically significant at 1 percent level. The result may be explained by the fact that households in the central part tend to live near big cities and they also permanently hold rice field area as the central part mainly is flat and fertile land suitable for agricultural production.

Conclusion and Recommendations

The insecure land right is one of the issues causing deforestation. Due to the lack of study, its impact may not be clear. The main purpose of the present study is to examine the impact of land rights on deforestation especially cutting timbers in surrounding forests in Lao PDR.

The study is based on cross-sectional and secondary data collected by LECS 5 (Laos Expenditure and Consumption Survey 5), in period 2012 to 2013, from Lao Statistics Bureau and use samples of 6,020 households in the country. The econometric model of Logistic regression is used for the analysis. The study finds that land rights have a negative impact on deforestation and the impact is statistically significant. Therefore, the author concludes that secured landholding will lower the probability of cutting timbers of the households in the country.

In addition, the important determinants influencing deforestation include land type, agricultural land area, household size, household head's age, household head's education, ethnic of household head and the region that household live or settle.

This paper has some limitations. First, the cross-sectional data might only show the short-term effect and might not anticipate the long-term impact, which might have been possible to ascertain by using panel data. Second, the sample size is quite small for national level analysis. Third, we need more advanced econometric methods to examine the impact of land rights on deforestation as the cause of deforestation is multifaceted, and we need more time to investigate the real causes. Fourth, primary data should be used in the study to effectively investigate household's timber-cutting activities and also face-to-face interview is crucial for the analysis.

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