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Regular Research Article

Contribution of forest to rural households' livelihood: evidences from Da river basin in the northwest mountainous region of Vietnam

Tran Van Chu[1], Trinh Quang Thoai[1], Cao Quoc An[1], Pham Minh Toai[1], Leni D. Camacho[2], Hoang Van Sam[1*]

[1] Vietnam National University of Forestry, Vietnam
[2] University of the Philippines Los Baños, Philippines
* Corresponding author: samhv@vnuf.edu.vn

Abstract: This paper examined how forest has contributed to rural households' livelihood in Da river basin, the northwest mountainous region of Vietnam. The results revealed that forest predominantly contributes to the total income of rural residents in the region. Specifically, forestry land area, access to non-timber forest products, and payment for forest environmental services significantly affected household's income in the region. However, rural people in the region have still faced several difficulties that constrain household's livelihood. Of these difficulties, lack of financial capital, epidemic diseases in animal husbandry, limited access to market information and natural disaster are popular barriers to livelihood of people in the region. This paper also recommended several policies to improve rural livelihood in Da river basin. These includes: (i) integrating issues regarding payment for forest environmental services and REDD+ into socioeconomic development plan; (ii) improving awareness of local people on sustainable natural capital use through ecosystem conservation policy; (iii) providing preferential credit and training on agricultural production techniques; and (iv) encouraging market-oriented agriculture.

Keywords: Da river basin; factors affecting; forest; household's income; rural livelihood

1. Introduction

Hydropower development has benefited economies of several countries in different aspects such as electricity generation, increase in irrigated areas and reduction of flood and drought (Kuenzer et al., 2013; Sayatham and Suhardiman, 2015; Intralawan et al., 2018). In addition, hydropower development may also bring several positive impacts on livelihood of riparian households, for example provision of employment, infrastructure development, and improvements in tourism and hospitality facilities (Sivongxay et al., 2017). However, hydropower development also has many adverse effects on livelihoods of the people who live in the surrounding hydropower reservoir including alterability of water flow and sediment load, changes in river hydrology and capture fisheries (Kuenzer et al., 2013; Intralawan et al., 2018). Generally, hydropower development has degraded mainly natural capital which is a major factor affecting people's livelihood (Sivongxay et al., 2017). Thus, analysis of factors influencing riparian households' livelihood in the hydropower reservoir is necessary to help affected people confront negative impacts of hydropower development and reach sustainable livelihood (Sivongxay et al., 2017; Colombo et al., 2018).

Da River locates in the northwest mountainous region where most of people are forest-dependent (Thoai and Rañola, 2010). With most of the forest in the region still being natural forest, it serves as a watershed area which is very important for the development of hydroelectric plants in Vietnam. At present, there are three biggest hydropower plants of Vietnam namely Hoa Binh, Son La, and Dien Bien in Da river basin. However, the northwest mountainous region is still one of the major vulnerable areas to poverty (World Bank, 2010). The northwest mountainous region is also homes to many ethnic minority groups that have low income and have limited access to infrastructure, education, health services, nonfarm employment, and other welfare-related services (Thoai and Rañola, 2011; Tran, 2014). Thus, understanding of the factors influencing

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livelihood of people in the region is really important for policy making process to improve people's welfare in the remoted areas. Several studies have mentioned livelihood of people in the northwest mountainous region of Vietnam. Tran (2014) focused only factors affecting livelihood of ethnic minorities. Nhuan et al. (2017) mentioned the important role of agricultural research for development (AR4D) for people's livelihood. Huong et al. (2018) determined how household livelihood is vulnerable to climate change in the region. However, there have been few studies to examine how has forest contributed to livelihood of riparian households in the hydropower reservoir of the northwest mountainous region. Hence, this paper aims to determine contribution of forest to livelihood of households in Da river basin in the northwest mountainous region of Vietnam.

2. Research methodology

2.1. Conceptual framework

In this paper, forest and other related issues were hypothesized to affect rural livelihood. Thus, this paper used the sustainable livelihood approach developed by the UK Department for International Development (DFID) in 1999. According to Liu and Xu (2016), the DFID's sustainable livelihood approach focuses on the quantities and qualities of livelihoods assets possessed by household. DFID (1999) proposed five livelihood assets including human, natural, physical, social, and financial capital (Figure 1). Nguyen et al. (2015) classified livelihood assets into natural capital and household capital that is combination of human capital, physical capital, financial capital, and social capital.

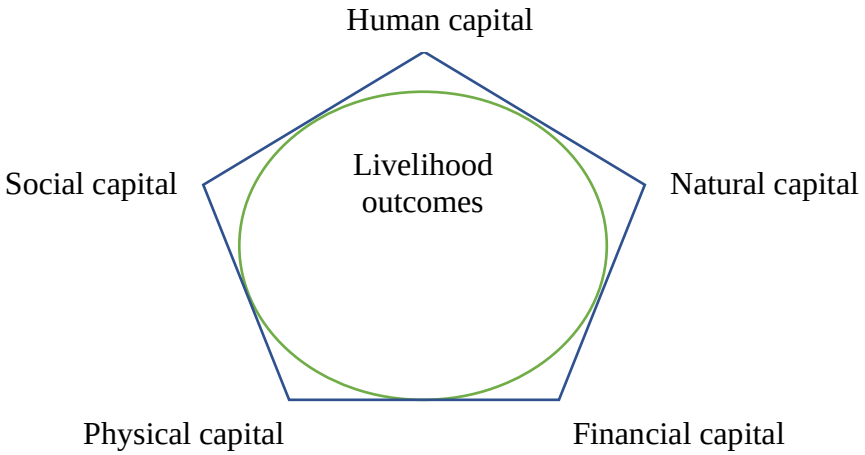

Figure 1. The factors affecting household's livelihood (modified from DFID, 1999)

According to DFID (1999), human capital includes availability and quality (education, skills, experience, etc.) of household's labor. Social capital relates to social resources such as network and connection. Natural capital is defined as natural stocks or natural ecosystem available that are useful for people's livelihood. Physical capital is basic infrastructure, while financial capital consists of financial resources such as available stock and regular cash inflow. Practically, the DFID's sustainable livelihood approach was applied by different authors in many empirical studies in different countries such as Tesfaye et al. (2011) in Ethiopia; Fang et al. (2014), Liu and Xu (2016) in China; Nguyen et al. (2015) in Cambodia and Kura et al. (2017) in Laos. This paper aims to test how

natural capital including forest and other livelihood's assets contributed to rural livelihood in the northwest mountainous region of Vietnam.

2.2. The study sites and method of data collection

Data used in this study was collected in Hoa Binh and Lai Chau province in Da river basin (Figure 2). Hoa Binh province has Hoa Binh hydropower plant that is the first and biggest hydropower plant of Vietnam. Meanwhile, Lai Chau province has Lai Chau hydropower plant which is located in the upstream of Da river. Hoa Binh is the home of Kinh group (the major resident group of Vietnam) and Muong group (one of the biggest ethnic minority group in Vietnam), while Lai Chau is the place of Kinh group and several ethnic minority groups such as Dao, H'mong, Thai, and Lu.

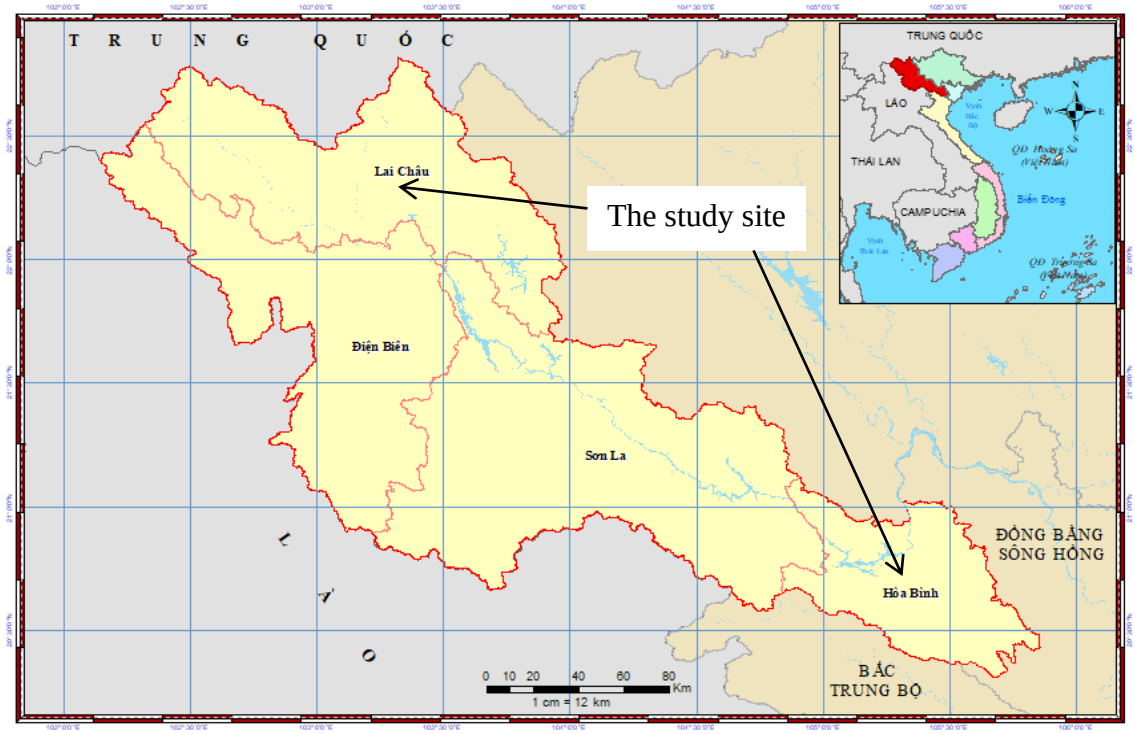

Figure 2. Map of the study site

According to Green (1991), the sample size of the research that has multiple regression model is determined by following formula:

N ≥50 + 8*m (m is number of independent variables of multiple regression model)

Since this study was conducted in two provinces (Hoa Binh and Dien Bien) and the multiple regression model has 10 independent variables (see Table 2), thus sample size in each province includes 130 and total sample size is 260 respondents. After cleaning data, 250 respondents were selected into sample size.

Thus, sample size of this study includes 250 respondents who are representative for 250 riparian households in Da river basin of Hoa Binh and Lai Chau province. Respondents were selected by using prepared questionnaires and stratified random sampling method with strata is study area. In addition, the sample size determination in this paper also focused on ethnic group. It means that respondents of this study include both Kinh group (the major resident group in Vietnam) and ethnic minority groups. Table 1 shows general characteristics of respondents of this study. There was not much different in general characteristics of repondents between Hoa Binh

and Lai Chau province. This implies that the respondents in this study are highly homogeneous, and could contribute to the reliability of the study.

Table 1. General characteristics of respondents

Items	Hoa Binh (n = 125)	Lai Chau (n = 125)	General (n = 250)
Age of respondents (year)	46	44	45
Female respondents (%)	53.6	56.8	55.2
Ethnic minority respondents (%)	44.8	42.4	43.6
Educational level (year)	7.9	7.5	7.7
Farming experience (year)	25	23	24

2.3. Analysis tools

2.3.1 Basic statistical method

This paper used descriptive statistics to analyze the general status of livelihood's assets of respondents. This study also used the T-test to compare the mean values of different characteristics between two different groups of respondents in the two different provinces (Lai Chau and Hoa Binh). This study also applied the two-sample Z-test for the difference between proportions (Z-test) to compare percentages of the indicators between two mentioned respondent groups.

2.3.2 Regression analysis

This paper used the multiple regression model to analyze factors affecting rural households' income (the core issue of rural households' livelihood). Specifically, the log-line regression model (semi-log model) was applied in this paper. The empirical log-lin model in this paper has following equation:

$$LnY_i = \beta_0 + \beta_i \sum_{i=1}^{k} X_i + \alpha_i \sum_{i=1}^{k} D_i + u_i$$

Where:

Y_i is income of the i^{th} household

X_i is quantitative factors affecting household's income

D_i is qualitative factors influencing household's income

β_0 is intercept of the model

β_i and α_i are regression parameters

u_i is error term

The quantitative (X_i) and qualitative (D_i) independent variables of the empirical log-linear regression model were defined in the Table 2.

Table 2. Definition of explanatory variables of the log-lin model

Variable definition	Notation	Measured unit
Age of household head	age	Year
Sex of household head	gender	1 = male; 0 = female

Ethnicity of household head	ethnicity	1 = Kinh; 0: other group
Farming experience	experience	years
Household agricultural labor availability	aglabor	Laborers
Forestry land area	forestland	ha
Access to non-timber forest products	ntfps	1 = yes; 0 = no
Access to credit	credit	1 = yes; 0 = no
Get payments for environmental services	pes	1 = yes; 0 = no
Training attendance	training	1 = yes; 0 = no

3. Results

3.1. Forest situation in the study areas

Forest and forestry sectors has played important roles for the development of Da river basin. This is because forest and forestry land areas cover large proportion in total land area of the region. The proportion of forest and forestry land areas in Lai Chau and Hoa Binh provinces are 78% and 75.7% respectively. Forest area of Lai Chau cover 45.4% of the total land area of the province. Meanwhile, the proportion of forest area compared to total land area of Hoa Binh province is also 51.2% (Table 3).

Table 3. Forest and forestry land situation of Lai Chau and Hoa Binh provinces, 2016

Item	Hoa Binh		Lai Chau	
	Amount (thousand ha)	%	Amount (thousand ha)	%
Total land area	459.1	100.0	907.0	100.0
Total land area assigned for forestry	112.4	24.5	295.4	32.6
Total forest area	235.0	51.2	412.0	45.4
Of which:				
Natural forest	158.8	67.6	404.0	98.1
Plantation forest	76.2	32.4	8.0	1.9

Source: General Statistical Office, Lai Chau People's Committee, Hoa Binh People's Committee

The large proportion of forest area in Da river basin is natural forest. Over 98% of forest area in Lai Chau province is natural forest. In Hoa Binh province, natural forest also shares about 68% of total forest area in the province. From the social point of view, forest especially natural forest areas have played important roles for people who have limited access to other livelihood's assets (Thoai and Rañola, 2011). In Da river basin, quite large forest areas have been managed by households and communities (Table 4). The forest areas managed by households and communities in Hoa Binh and Lai Chau provinces are respectively 57.2% and 41.7% of total forest and forestry land area. This is believed that forest has significantly contributed to rural livelihood in Da river basin. It is because the payment for environmental services policy has been deployed in the region since 2008. Thuy et al. (2012) revealed that Lai Chau province received USD 11 million (the highest amount of payment for forest environmental services compared to other provinces in Vietnam) in period 2009-2012.

Table 4. Forest and forestry land areas classified by owners in the study sites, 2016

Item	Hoa Binh		Lai Chau	
	Amount (thousand ha)	%	Amount (thousand ha)	%
Total forest and forestry land area	347.4	100.0	707.4	100.0
By forest owners				
- State forest management boards	42.9	12.4	297.2	42.0
- Forest companies	13.3	3.8	6.8	1.0
- Households and communities	198.8	57.2	295.4	41.7
- Other forest owners	92.4	26.6	108.0	15.3

Source: General Statistical Office, Lai Chau People's Committee, Hoa Binh People's Committee

3.2. Rural livelihood and contribution of forests to rural livelihood

Agriculture based on forest has still played important roles in household's income of rural residents in Da river basin (Table 5). In Lai Chau province, agricultural sector contributed 57% (annual crop: 25.6%; livestock: 15.6%; and forestry: 15.8%) to household's income of farmers in the province. In Hoa Binh province, 47.9% of household income is from agriculture production (23.5% of annual crop; 11.8% of livestock; 12.3% of forestry). Generally, the contribution of agricultural sector (51.2%) to total household's income is slightly higher compared to contribution of non-farm and off-farm activities (48.9%). Non-farm activities such as construction workers and motorbike taxi drivers were mostly done by male farmers. Off-farm activities contributed around 30% to total household income in the study areas. After cultivating and harvesting seasons, most of farmers (especially male farmers) worked as hired laborers to earn additional income. Many of them worked as loggers and porters for forest owners who have large plantation forests in the region. This implies the importance of forests for rural livelihood in Da river basin.

Table 5. Household's income and income sources in the study sites

Item	Hoa Binh (n =125)		Lai Chau (n =125)		General (n = 250)	
	Amount (VND mil.)	%	Amount (VND mil.)	%	Amount (VND mil.)	%
Annual crop	31.4	23.8	18.1	25.6	24.7	24.4
Livestock	15.6	11.8	11.0	15.6	13.3	13.2
Forestry	16.2	12.3	11.2	15.8	13.7	13.6
Non-farm activities	27.5	20.9	9.5	13.4	18.5	18.3
Off-farm activities	41.0	31.1	20.9	29.6	30.9	30.6
Total income	131.7	100.0	70.7	100.0	101.1	100.0

Forest and forestry land predominantly occupy the area of the region. Thus, most of agricultural activities in the region are carried out in the forest and forestry land. Many respondents reported that maize (the second major crop of the region) is mainly cultivated in the slope forestry land. Meanwhile, major animal husbandry activities (e.g. cattle, goat) are also conducted in the forest or buffer zone of the forest. Other benefits of forest for households in the region are non-timber forest products and payment for environmental services. Over twenty percent of respondents reported that they harvested non-timber forest products from natural forest in the region. In addition, more than fifty percent of respondent get additional income as payment for forest environmental services (Figure 3). This indicates that forests provided the main sources of income for rural households in Da river basin.

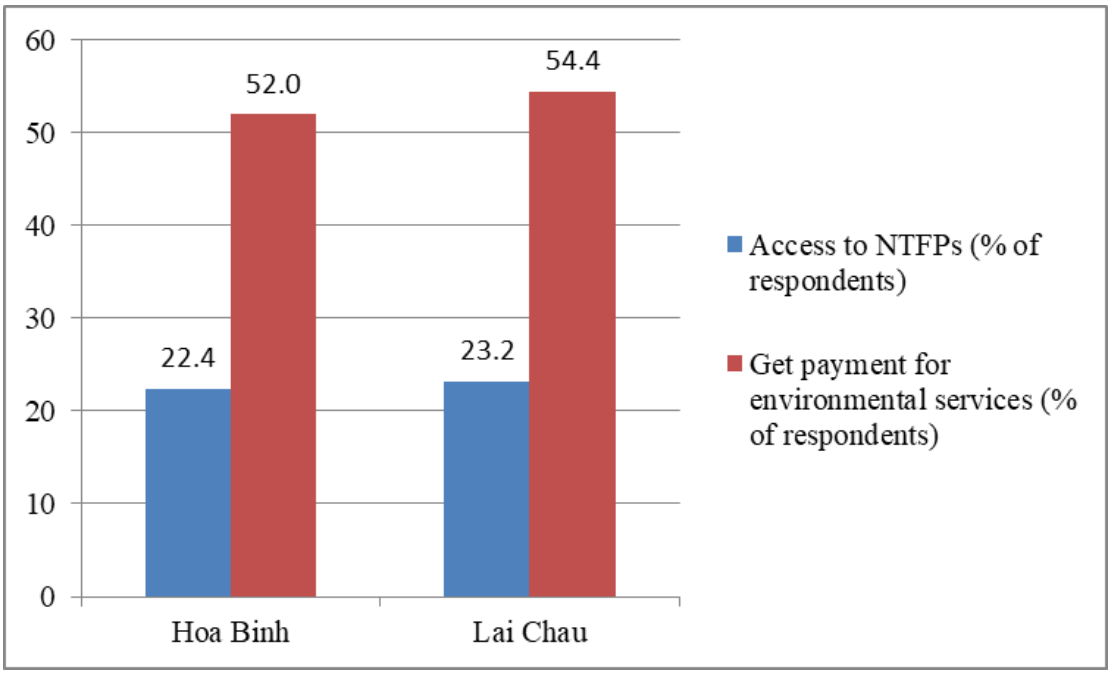

Figure 3. Benefits of forests for households in the study sites

For comparison, most of household's income items in Hoa Binh province are significantly higher than those in Lai Chau province (Table 6). This is because farmers in Hoa Binh province have more chances to access market due to it's closeness to Hanoi capital (central market). In addition, the number of factories and industrial zone of Hoa Binh province is much higher than Lai Chau province. These provide more opportunities for farmers in Hoa Binh province to earn additional income by doing non-farm and off-farm activities.

Table 6. Comparison of household's income between the two study sites (VND million)

Item	Hoa Binh	Lai Chau	Difference
Annual crop	31.4	18.1	13.3***
Livestock	15.6	11.0	4.6**
Forestry	16.2	11.2	5.0^{ns}
Non-farm activities	27.5	9.5	18***
Off-farm activities	41.0	20.9	20.1***
Total income	131.7	70.7	61***

*** and ** are significant at 1% and 5%, respectively; ns is non-significant based on T-test results

To analyze detailed contribution of forests to rural livelihood, this paper used multiple log-line regression model of which factors related to forest were focused. By using this regression model, the paper aims to test how livelihood assets including natural, physical, social, financial, and human capitals affect rural livelihood. Of these livelihood assets, natural capital related to forests and forestry was mainly emphasized. Table 7 described the explanatory variables of the empirical model.

Table 7. Description of explanatory variable of the empirical log-lin model

Item	Mean	Std. Dev
Age of household head (year)	45.0	11.0
Educational level (year of schooling)	7.7	2.1
Farming experience (year)	24.0	10.9
Total labor (laborer)	3.0	1.1
Agricultural labor (laborer)	2.1	0.7
Forestry land area (ha)	0.8	1.1
Access to NTFPs (dummy)	0.228	0.42
Access to credit (dummy)	0.436	0.497
Training attendance (dummy)	0.588	0.493
Get payment for environmental services (dummy)	0.532	0.412

Estimated result of multiple log-line regression model on factors affecting household's income of farmers in Da river basin was presented in Table 8. All of VIF (Variance Inflation Factor) values are really small and less than 10. This means the multicollinearity problem of the empirical model in this paper is minimal and the existence of all the independent variable (factors affecting) is acceptable. In addition, Chi-square value (0.33) of Breusch-Pagan/Cook-Weisberg test for heteroskedasticity is not significant (Prob>chi2 = 0.5642). This implies that the heteroskedasticity problem of the model in the paper is relaxed.

Table 8. Estimated result of multiple log-lin model on factors influencing household's income of farmers in Da river basin

Indicators	Coefficients	P-value	VIF
Intercept	3.558***	0.000	-
Age of household head	-0.003ns	0.224	1.05
Sex of household head	0.242***	0.000	1.06
Ethnicity of household head	0.133**	0.039	1.03
Farming experience	0.008***	0.010	1.26
Household agricultural labor availability	-0.043ns	0.128	1.17
Forestry land area	0.136***	0.000	1.13
Access to non-timber forest products	0.283***	0.000	1.11
Access to credit	0.130**	0.034	1.04
Get payment for environmental services	0.639***	0.000	1.12
Training attendance on agricultural production	0.322***	0.000	1.08
R^2	0.5738***	0.000	-
Observation	250	-	-

*** and ** are significant at 1% and 5%, respectively; ns is non-significant

The R2 coefficient (0.5738) is highly significant (Prob > F = 0.0000), meaning that the model is significantly existed and ten explanatory variables in the model explained significantly 57.38% of changing in income of farmers in the study areas. Eight out of ten factors affected significantly the household's income of farmers in Da river basin. These include age, sex, ethnicity, and farming experience of household head; household agricultural labor availability; forest land area; access to non-timber forest products; access to credit; and membership of local organizations (Table 8).

The estimated result of empirical regression model shows that income of households with better livelihood assets is higher than that of other households. Firstly, the factors regarding natural capital such as forestry land area, non-timber forest products (NTFPs), and payment for forest environmental services significantly contributed to household's income of farmers in the region. Households with larger forestry land area have higher income compared to those have smaller areas. Similarly, households that have accessed to NTFPs are more likely to have higher total income compared to other households. Income of the households that get payment for forest environmental services is higher than that of households without this kind of payment.

Human capital related to characteristics of household head (sex, ethnicity, farming experiences) significantly affected on household's income of farmers in the study areas. Specifically, households with male heads are more likely to have higher income compared to households with female heads. Income of major group of farmers (Kinh farmers) was higher than that of ethnic minority group. Ethnic minority people mostly live in the remoted areas therefore their access to education and other social services are quite limited. Thus, ethnic minority farmers have lower income compared to Kinh farmers who have better livelihood assets. More experienced farmers have higher income compared to those who have less farming experience.

Other livelihood assets such as financial capital and social capital also have significant effects on household's income of farmers. Income of households that have access to rural credit or other financial sources was significantly higher than that of households that could not access. Households with a member attended the training course on agricultural production techniques are more likely to have higher total income. Moreover, total income of households with a member participated local organizations (e.g., Farmer's Union, Cooperative, etc.) was significantly higher than that of households with non-membership of local organizations. By contrast, two factors including age of household head and household agricultural labor availability did not significantly influence household's income of farmers in the study sites. The reason may be that there was not a significant difference in age of household head and number of agricultural labor among households in the study area.

Table 9. Constraints to rural household's livelihood (% of respondent)

Item	Hoa Binh	Lai Chau	General
Lack of financial capital	48.8	62.4	55.6
Poor techniques for agricultural production	41.6	32.8	37.2
Affected by natural disasters	23.2	40.8	32.0
Epidemic diseases in animal husbandry	51.2	44.0	47.6
Poor infrastructure system (road, irrigation...)	16.0	26.4	21.2
Limited access to market information	35.2	54.4	44.8
Lack of agricultural land	28.0	34.4	31.2

Although forests and other livelihood assets significantly affected household income in the region, farmers in both Hoa Binh and Lai Chau provinces reported several barriers to their household's income (Table 9). Of these barriers, the most key constraints to farmers in Hoa Binh province include epidemic diseases in animal husbandry (51.2%) and lack of financial capital (48.8%). Meanwhile, the major barriers for farmers in Lai Chau province were lack of financial capital (62.4%) and limited access to market information (54.4%). In general, lack of financial capital (55.6%) and epidemic diseases in animal husbandry (47.6%) were two main constraints to income of farmers in Da river basin. The third barrier for farmers' income is limited access to market information that was reported by 44.8% of respondents. The poor techniques for agricultural production (37.2% of respondents) and lack of agricultural land (31.2) of respondents) are other

two constraints to farmers' income. The last barrier to household's income mention by respondents is the poor infrastructure system (21.2% of respondents).

4. Discussions

This paper revealed that agriculture based on forest and forestry crucially has contributed to the livelihood of farmers in Da river basin. This is consistent with the finding of Perge and McKay (2016) that agriculture based on forest is the main source of livelihood for rural households (e.g., food, income) in the Tsimane' of Bolivia even for those have other income sources. In addition, this is also similar to finding of Bakkegaard et al. (2017) that forest provided importance source of income to improve rural livelihood in Indonesia.

Other finding of this paper is that natural capital with components directly related to forest and forestry such as forestry land area, non-timber forest products, and payment for forest environmental services significantly contributed to total income of farmers in the study sites. The farmers with large forestry land area could have more chance to increase their income through harvesting NTFPs and payment for forest environmental services that has been conducted in Vietnam since 2008. This is consistent with findings of Tesfaye et al. (2011) in Ethiopia, and findings of Wunder et al. (2014) in several developing countries. Fang et al. (2014) and Kura et al. (2017) also indicated importance role of natural capital for farmer's livelihood in mountainous region of China and Laos. Trædal and Vedeld (2018) emphasized the significant contribution of forestry land to livelihood of the poor households with less access to off-farm income in the northeast mountainous region (Bac Kan province) of Vietnam. Ali and Rahut (2018) also had similar finding about the importance of forest resources for livelihood of rural households in Pakistan. However, these are much different from finding of Tran (2014) that forestry land did not significantly influence minorities in the northwest mountainous region of Vietnam.

This paper also indicated that other livelihood assets including financial, social and human capitals significantly affected total income of farmers in Da river basin. This is in line with findings of Fang et al. (2014) and Kura et al. (2017) that livelihood capitals are likely to have significant effects on livelihood of households in mountain areas of China and Laos. Specifically, financial capital (credit) positively contributed to livelihood of rural people in the study area. This finding confirms the discussions of Nguyen et al. (2015) in Cambodia, Ali and Rahut (2018) in Pakistan. In contrast, Tran (2014) concluded that there was no significant relationship between credit and livelihood of minority people in the northwest mountainous region of Vietnam. Human capital (sex, ethnicity, and farming experience of household head) significantly influenced rural livelihood in Da river basin. The findings of Fang et al. (2014) in China and Nguyen et al. (2015) in Cambodia are also similar to the findings about the importance of human capital in this paper. The paper also found that there is positively significant relationship between social capital (memberships, training attendance, etc.) and livelihood of rural people in the study area. This could be also found in the studies of Nguyen et al. (2015) in Cambodia and Ali and Rahut (2018) in Pakistan.

5. Conclusions and policy recommendations

This paper determined contribution of forest and other factors to rural households' livelihood in Da river basin, the northwest mountainous region of Vietnam. The paper revealed that agriculture based on forest and forestry has significantly contributed to livelihood of people in the region. By using multiple log-line model the paper also revealed that forestry land area; non-timber forest products; payment for forest environmental services and other factors such as sex, ethnicity, and farming experience of household head; access to credit; and training attendance significantly affected household's income. Generally, total income of the households with better livelihood assets was significantly higher than that of other households. In addition, natural capital regarding forest resources had significant impact on household's livelihood. This finding is really

importance for authorities and policy makers since most of residents in the region are forest-dependent people. However, farmers in the region have to face several difficulties that are barriers for their livelihood. Of these barriers, lack of financial capital, epidemic diseases in animal husbandry, limited access to market information and natural disaster are popular constraints to livelihood of people in the region.

The findings of the paper provide important recommendations for policy makers to improve rural livelihood in Da river basin. Firstly, the polices should integrate the program regarding forest and forestry sector such as payment for environmental services, REDD+, etc. into other socioeconomic development plans of the region. Secondly, the policy on harvesting forest landscape (e.g., ecotourism...) should also be considered to help residents in the region earn additional income and therefore improve livelihood. In addition, there is need a policy on ecosystem conservation to help local people how to use sustainably natural capital to improve their livelihood. Recanati et al. (2017) reminded that the livelihood activities based on forest may conflict with sustainable natural resources use and ecosystem conservation. Other recommendations included providing preferential credit and training on agricultural production techniques and encouraging market-oriented agriculture in the region.

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