COMMUNITY DEMAND TO PARTICIPATE IN ECOSYSTEM SERVICES SCHEME: A CASE STUDY OF BOLIKHAMSAY PROVINCE, LAO PDR

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Abstract

Payments for ecosystem services (PES), also known as payments for environmental services (or benefits), are incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service. They have been defined as a transparent system for the additional provision of environmental services through conditional payments to voluntary providers. These programmes promote the conservation of natural resources in the marketplace. This paper introduces PES scheme for local people at villages in Bolikhamxay Province, Lao PDR. It first gives an overal picture of PES at provincial level before going to details of local community willingness to pay to participate in PES schemes in the region.

Keyword: *payment for ecosystem services, contingent valuation method, community livelihood, willingness to pay*

1. Introduction

Ecosystem Services (ES) are benefits that humans obtain from natural and cultivated environments. For example, hydrological services can be obtained through river flow regulation, flood control or protection against soil erosion. ES are threatened worldwide, in a variety of ways, by human activities. In response to such threats, the concept of Payments for Ecosystem Services (PES) has been proposed as a simple scheme to reward land users who adopt practices that generate ES, hence promoting sustainable land use (Mayrand et al., 2004).

Lao DPR is currently undergoing a rapid increase in hydropower development. There is currently up to 3.800 Megawatts of generation in operation, and predictions are that generation capacity may increase to 12,500 Megawatts by 2020 (Ministry of Energy and Mines). Ecosystem intact upstream catchments are important for these hydropower projects as they provide a range of watershed services such as reduced sedimentation, water flow regulation, improved water quality, and reduced damage due to floods and associated debris.

Upland areas that make up hydropower catchments are often occupied and farmed by people who have lived in these areas for many years. While traditional widen farming practices have been largely sustainable, and conducted at low intensities in the past, increasing populations and demand for agricultural commodities, as well as road construction leading improved access for agricultural traders, is leading to reduced fallow lengths and deforestation through pioneering shifting cultivation, often for non-traditional species such as maize for export to international animal feed markets. Negative impacts of this trend include reduced farming land productivity, insecure livelihoods and reduced NTFP availability for local people, and a reduction in the watershed services that hydropower projects depend on. There is a need for mechanisms to ensure that catchments are managed sustainably for both watershed services for hydropower projects and for the needs of local communities. Payments for Environmental Services (PES) schemes have been suggested as one potential option.

This paper studies the demand for PES of local people at villages in Bolikhamxay Province. It first gives an overal picture of PES at provincial level before going to details of local community willingness to pay to participate in PES schemes in the region.

PES at study area – Bolikhamxay Province

Social - economic characteristics of study area

Bolikhamxay Province, situated in the central of the Lao PDR, is characterized by the Annamite Mountain Range stretching east to Vietnam, and the Mekong River and Thailand to the west. The Annamite Mountains in the east are blanketed by semi and wet evergreen forests and are home to a high number of endemic species. Western part of the province is largely covered by drier semi-evergreen forests of a type that is more widely distributed in Indochina and contains varied habitat including grasslands, wetlands, and limestone karst.

Bolikhamxay province is primarily covered with forest (57.9%) composed primarily of mixed deciduous forest and evergreen forests. The evergreen forest occurs primarily in the east of the province close to the Annamite range along the Vietnamese border. Plantation forest, mainly rubber and acacia, are found in the flatter areas and represent nearly 1% of the total forest cover. The Regenerating Vegetation describes fallow lands, both young and old, that can also be non-mature forest plantation areas or stable bamboo forest.

There are Protected Forest Areas such as; The Nam Kading NPA, Phou Sithone ESCA, Nhot Nam Mouand PPF and Nacheng PES are mostly covered by mixed deciduous forest in similar proportions (Figure 2.1). The Phou Chom Voy PPA has the highest forest cover of any of the protected areas; half of the protected area is covered in evergreen forest while an additional third is covered by mixed deciduous forest. The Nam Gnouang South Protection Forest Area is a combination of the THXP reservoir, agricultural land, perennial grassland and mixed deciduous forest on its west side. The Khamkhuna PES area has nearly 37% of its area covered by regenerating vegetation suggesting it may be the most disturbed of all the protected areas.

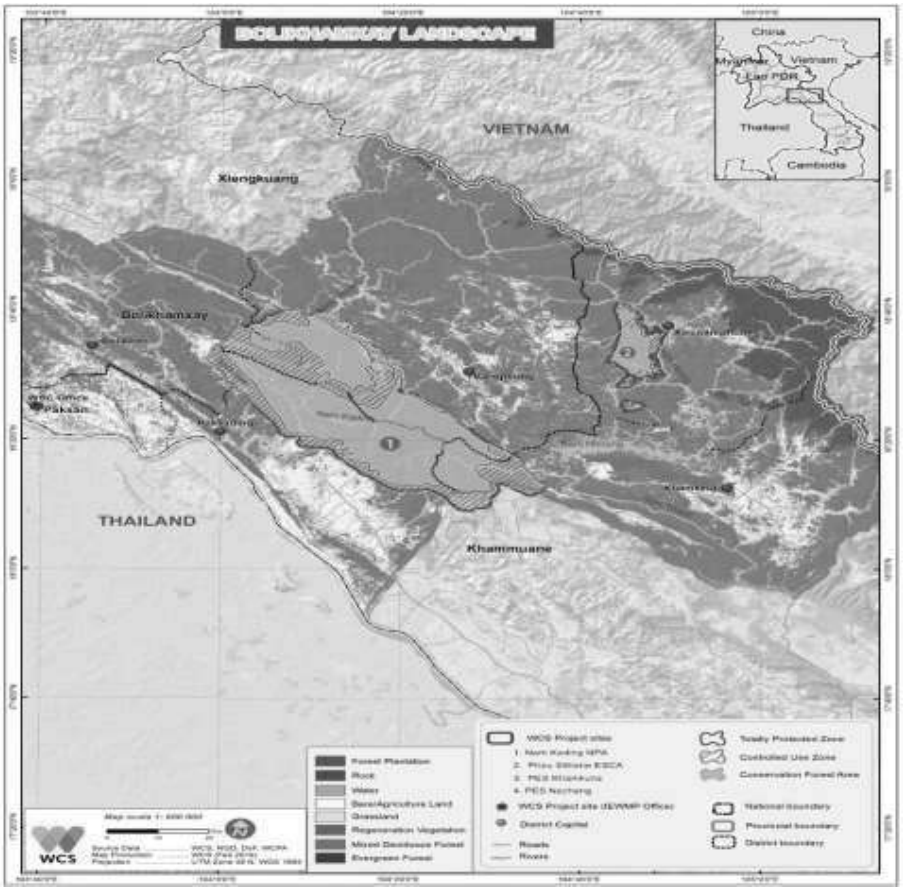


Figure 2.1. Location of the Study

The human population of Bolikhamxay is highly diverse, with several tribes from 3 major ethnic groups: Tai-kadai group, Khmuic group that encompasses Khamu and Pong, and Hmong group, totalling over 200,000 people. Population densities are, however, incredibly low with only 18 people/km^2. Around the protected areas where WCS is involved (Nam Kading and Phou sithone), community livelihoods rely on upland farming systems that are based on paddies, swidden agriculture, natural ecosystems and the services they offer, such as the provision of food, medicines, fuel, and non-timber forest products (NTFPs) that are both consumed and sold to help generate rural incomes.

Introduction to ecological services in the study area

Nam Kading NPA was created in 1993. With little villages located inside the NPA and given the difficult access to the core area, the forests remained in good state of conservation. In 2005, began support to the Nam Kading NPA Management Unit, providing technical assistance, intensive biodiversity monitoring, outreach to communities, ecotourism training and law enforcement. Nam Kading NPA is currently witnessing the development of the Nam theun 1 hydropower project, increasing pressure over land for agriculture, and significant hunting related threats. Although large fauna was present, it has disappeared or became scarce (Gaur, big cats, elephants and primates).

Since 2019, Provincial Authorities are engaged in the management of the NPA through integrated management of the Protected Area, that includes revision of the management plan, Spatial planning and land management, Law Enforcement and patrolling, capacity building of the personnel assigned, awareness campaign and Biodiversity monitoring. Approach adopted is to support rural communities in and around Nam KAding NPA to develop their livelihoods through ecotourism, non-timber forest products and village incentive funds. Finally, WCS is facilitating the Public Private Partnership between the Hydropower Company and the Government in order to sustain long term financing mechanism to the NPA.

2. Method

2.1. Models of non-market value evaluation

The parametric model is to calculate the willingness to participate for improving the forest environmental quality into the original state as if no degradation has occurred. In addition, the parametric model allows the integration of the socio-economic characteristics into the WTP function. Good understanding on how the WTP changes by individual characteristics allows surveyvers to understand the validity and reliability of the CVM method, then broaden the results of survey sample generally. Moreover, if the relationship between the independent and dependent variables in the WTP function complies with the theoretical models, the reliability of CVM will increase. The parametric model consists of two parts which are: estimating the WTP dominant function and from that function, calculating the WTP from the regression coefficients. Step 1 involves estimating the WTP function or Random Utility Model.

This model was initiated by Haneman (1984) and later developed by MacFaden. In the case of CV, there are two options. Indirect utility function of the j^{th} person is expressed by equation

$$u_{ij} = u_i(y_j, z_j, \varepsilon_{ij}) \qquad (1)$$

i = 1 is the post-improvement environmental condition (as before the degradation) or

the final state, i = 0 is the current state (degradation after the incident or pollution or deforestation). The factors that affect the utility of j[th] person including: y_j, which is the income of j[th] household, z_j is the m-dimensional vector of the socio-economic characteristics of j[th] household, and ε_{ij} are other dominant factors but not observed. $u_{ij} = u_i(y_j, z_j, \varepsilon_{ij})$ shows the variation of utility from the current state to the improved state.

More specifically, when the environmental quality increases from q0 to q1 , the utility will change from $u_0(y_j, z_j, \varepsilon_{0j})$ to $u_1(y_j - t_j, z_j, \varepsilon_{1j})$

Based on this model, jth person has an "acceptable" answer with an X level tj if result of the utility of the improvement program minus the cost is over the utility of the current state:

$$u_1(y_j - t_j, z_j, \varepsilon_{1j}) > u_0(y_j, z_j, \varepsilon_{0j}) \qquad (2)$$

However, the surveyors will not be able to observe the random bias of the preference but can only predict the probability of acceptance. The probability of an acceptance is the probability that the person thinks he or she will be better with the proposed scenario, even with any X level, to u1> u0. For j[th] person, this probability is

$$\Pr(yes_j) = \Pr(u_1(y_j - t_J, z_J, \varepsilon_{1J}) > u_0(y_j, z_j, \varepsilon_{0j}) \qquad (3)$$

Equation 2.3 is the basis for analyzing selected behavior and can be used for non-parametric estimation but too wide for the parametric model. Two more models are required. Firstly, the function form of của $u_{ij} = u_i(y_j, z_j, \varepsilon_{ij})$ must be selected. Secondly, the distribution of ε_{ij} needs to be defined. Since then, the above equation can turn into:

$$u_i(y_i, z_j, \varepsilon_{ij}) = v_i(y_j, z_j) + \varepsilon_{\cup j} \qquad (4)$$

Indirect utility are the sum of deterministic parts and transformations.

$v_i(y_j, z_j) = v\ (y_j, z_{j,} q_{ij,})$ with the integration of environmental factors. Therefore, 2.4 can turn into:

$$\Pr(yes_j) = \Pr(v_1(y_j - t_j, z_J) + \varepsilon_{1j} > v_0(y_j, z_J) + \varepsilon_{0j} \qquad (5)$$

$$\Pr(yes_j) = 1 - F_\varepsilon[-(y_j - t_j, z_j) - (v_0(y_j, z_j))] \qquad (6)$$

Equation 2.5 is the starting point for the WTP function in which the most common form is linear.

In experimental terms, in order to estimate the parameter WTP function, it is necessary to use the method of estimating maximum likelihood. The sample size T and Ij = 1 if the answer is accepted. The likelihood function is turned into:

$$L(\alpha, \beta | y, z, t) = \prod_{J=1}^{T} [\emptyset\left(\frac{\alpha z_J}{\sigma} - \frac{\beta t_j}{\sigma}\right)]^{I_J} [1 - \emptyset\left(\frac{\alpha z_j}{\sigma} - \frac{\beta t_j}{\sigma}\right)]^{1-I_J} \qquad (2.16)$$

$$lnL(\alpha, \beta | y, z, t) = \sum_{j=1}^{T} I_j \ln\left[\emptyset\left(\frac{\alpha z_j}{\sigma} - \frac{\beta t_j}{\sigma}\right)\right] + (1 - I_j) \ln\left[1 - \emptyset\left(\frac{\alpha z_j}{\sigma} - \frac{\beta t_j}{\sigma}\right)\right] \qquad (7)$$

for probit.

$$lnL(\alpha,\beta|y,z,t) = \sum_{j=1}^{T} I_J \ln\left[\left(1+e^{-\left(\frac{\alpha x_J}{\sigma}-\frac{\beta t_J}{\sigma}\right)}\right)^{-1}\right] + \left(1-I_j\right)\ln\left[1-\left(1+e^{-\left(\frac{\alpha x_J}{\sigma}-\frac{\beta t_J}{\sigma}\right)}\right)^{-1}\right] \quad (8)$$ for logit.

$\ln\left(\frac{M_j - t_j}{M_j}\right)$ is standard income. Parameter vector {∝/σ,β/σ} can be estimated by running the binary model on the matrix data $\left\{z_j, \ln\left(\frac{M_j - t_j}{M_j}\right)\right\}$, thereby allowing to calculate the average value of WTP.

$$E_\varepsilon\left[WTP_j\right] = M_j\left[1-\exp\left(-\frac{\alpha}{\beta}z_j + \frac{1}{2}\frac{\sigma^2}{\beta^2}\right)\right] \quad (9)$$

2.2. Data collection

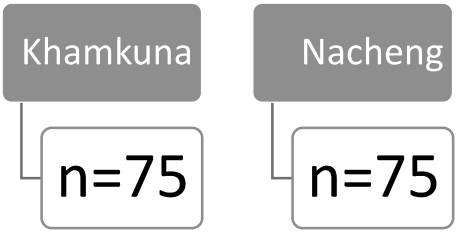
Selecting the survey sample

According to the General Statistics Office (2016), the population in the 2 villages in the study area is about 1,180 people (on average, each village has about 590 people). With an average population of 5 people / household, the total number of families is about 236 households. The study uses the following Moore formula (2003) to estimate the number of survey samples:

$$n = \frac{N}{1+N\times e^2}$$

In which: n is the sample size, N is the total number of households in the population, e is the accepted tolerance.

With e = 0.05 (the estimated error is 5%) and for a total of 236 households, the estimated number of samples to ensure reliability is n> 148. In this study, n = 150 households were chosen. To ensure the representation of each villages in the province, stratified samples were selected, in which the cluster was selected according to administrative units. N-There are 2 villages with relatively equal population so in each village, researchers will select 75 households for interview. The total number of research samples is therefore allocated as follows:



In each village, randomly selected 75 households were interviewed. Thus, each village will have 75 questionares, according to the structure below:

- At least 38 households are related to agriculture;
- There are 15 or at least 10 households involved in forests and forest-related activities;
- The rest households may be in other occupations such as office workers, civil servants, and small service traders.

Develop and test the questionnaire

When using the CVM method, the questionnaire is a key tool in collecting information and data for evaluation. In this study, the questionnaire was also built according to the standard procedure of Diamond (2000) including these steps:

Focus Group Discussion - FGD

In order to develop a questionnaire appropriate to the research conditions, two two group discussions were conducted during 2020 in the study area.

The first group discussion was conducted with state and professional management agencies in the province (Forest Protection Department, Provincial local goverment, commune and village staff, DONRE). The purpose of this group discussion is to provide a forum for managers and experts to discuss relevant issues to develop a questionnaire. The second group discussion was conducted with 150 households in Khamkuna village and Nacheng village.

Pre-test

Pre-test are an important step to gather information to complete content, format, structure of the questionare as well as enhance the skills of surveyvers. As for CVM, pre-test also plays an important role in deciding how to ask WTP questions (related to data processing model), determine the official received amount levels and participation methods

This study has conducted 02 pre-tests in Khamkuna and Nacheng. All surveyvers conducted interview to assess the actual conditions, advantages and disadvantages in the survey. Then, there are feedback to adjust the questionnaires on the format, questions, words and the order of the questions. A total of 50 local people in 3 provinces participated in the pre-test.

At the pre-test, open-ennded questions were used, in which people were informed about unused values and forest degradation were asked about WTP levels to prevent such degradation through a forest management and protection scheme. WTP levels are self-considered and stated by the people. The result was 9 levels (X): 1,000,000 kip, 1,500,000 kip, 1,700,000 kip, 2,000,000 kip, 2,500,000 kip, 3,000,000 kip, 3,500,000 kip, 4,000,000 kip, 5,000,000 kip / household.

Selection of non-market values and X levels

After FDGs and pre-tests, the study identified the most important non-market values for people (mentioned, consciousness, emotions, knowledge, understanding and beliefs of the people), include:

- The values of forest and forest protection to villagers' living and livelihood
- The values of materials reduction due to forests degradation and environmental problems
- The value of mental harm caused by degradation of forest

From the results of surveys in FDGs and pre-test, the cumulative probability of 5 levels X is 1,500,000 kip, 2,000,000 kip, 2,500,000 kip, 3,000,000 kip and 3,500,000 kip is 87% of the total number of selection. Other levels, although some people are willing to accept them, are very few, and when considering the correlation between household income that is willing to accept this level, it is inappropriate because these households have moderate income but the project offers too high or too low X. X levels of 1,000,000 VND, 1,700,000 kip, 4,000,000 kip and 5,000,000 kip are not used.

3. Results

3.1. WTP estimation model

The level of participation of Khamkuna and Nacheng people for improving forest environmental quality is estimated through models corresponding to the type of binary questionnaire (Yes or No for WTP - dichotomous questions).

For the binary questionnaires, the thesis used two model to estimate the WTP level for PFES participation of households.

The first is a parametric model that analyzes the impact of socio-economic factors of the respondents on the probability of accepting a certain received amounts (X), from which calculate the average WTP level of samples.

The second is called a non-parametric model based on the probability distribution willing to participate with a value level series (X) to estimate the expected value of WTP in that distribution (Bateman 1998).

The second model was used to estimate WTP for auction-type questionnaires. The model estimates the individual's WTP level based on the probability distribution in the certainty of participation in a predetermined value chain selected by the individual (Mc Connell, 2002, Wang, 1997).

The distribution of questionnaire samples in each village is summarized in the table below:

Table 4.1: The sample distribution rate for each village

Village	Binary question	
	Amount	%
Khamkuna	75	50
Nacheng	75	20
Total	**150**	**100**

Source: Processing from survey sample (2020)

3.2. WTP estimation in parametric model

The paper used a Random Utility Model (RUM) to estimate household WTP (called parametric model). The theoretical and economic basis of this model is presented in the previous section. Empirically, the thesis uses the Binary Logistic regression model and the Maximum Likelihood estimation to estimate the expected value of the WTP levels to improve the quality of forest (non-market value loss turned to the previous level, before degradation). At the same time, thesis analyzes the factors affecting the ability to participate at different levels of X.

03 models were estimated corresponding to three different sample data groups to find the range of WTP expectations. Dividing into different models also allows consideration of the differences in willingness to participate between villagers in each village and the overall model.

Table 4.18: Describe the WTP estimation model

Number	Model	Explaination	Sample size
1	A	Overall model	150
2	B	Khamkuna model	75
3	C	Nacheng model	75

Source: Processing from survey sample (2020)

There are 150 survey samples in this model of which 127 are used for estimation. Of the samples not used for estimation, 17 answered "not ready to participate", 6 answered unclear whether they were willing to participate or not. Carson (2003) identified these patterns as "objectionable". The investigated subjects did not agree to participate because they seemed to be opposed to a certain aspect of the investigation. These questionares were rejected for processing to estimate WTP. Thus, 127 questionnaires will be processed in the final.

The empirical model estimates WTP as a probability function of household participation to improve the quality of forest environment and preserve forest values. The probability of being willing to participate at a given X level of any observation takes the form:

$$\mathbf{Pr\ (Yes)} = a + \boldsymbol{\beta 1} * \mathbf{Xi} + \boldsymbol{\beta 2} * \mathbf{SEXi} + \boldsymbol{\beta 3} * \mathbf{AGEi} + \boldsymbol{\beta 4} * \mathbf{MARRIEDi} + \boldsymbol{\beta 5} * \mathbf{EDUi} + \boldsymbol{\beta 6} * \mathbf{MEMBERi} + \mathbf{b7} * \mathbf{INCOMEi} + \boldsymbol{\epsilon i}$$

- a is blocking factor
- βi is the regression coefficient of the independent variables (including X and other

household socio-economic characteristics)

- ϵi is the impact of other variables not listed in the model on the probability of participating at a given X level

Table 4.3: The variables in the WTP estimation model

Variables	Explaination	Coding
Pr (Yes)	Probability to participate at a certain level X to improve the quality of forest as before the deforestation and degradation	Willing to participate = 1 Not willing to participate = 0
X	The X level is set in the questionnaire and asked if people are willing to participate at that level (1000 kip / year).	Set at these valus: 1.500, 2.000, 2.500, 3.000 và 3.500 (1000 kip)
SEX	Gender of respondents	Male = 1 Female = 0
AGE	Age of interviewees (years old)	Continuous variable
MARRIED	Marital status	Married =1 Not married=0
EDU	Education level (years of schooling)	Continuous variable
MEMBER	Number of members in household (person)	Continuous variable
INCOME	Household income (thousand kip / month)	Continuous variable

Source: Processing from survey sample (2020)

The following two tables present the results of estimating WTP models by the maximum likelihood method. The parameters are estimated in the following models.

Table 4.4: Estimate the WTP model with parameters for the overall

Variable	Coefficient	Standard deviation	p-value
X	417.33	318.140	
AGE	48.54	12.450	
SEX	.32	.468	
MARRIED	.99	.115	
EDU	10.02	3.550	
MEMBER	5.10	2.021	
INCOME	12.5211	27.20	
Parametric model			
X	.003***	.000	.000
AGE	-.002	.010	.853
SEX	-.165	.247	.505
MARRIED	.624	.948	.511
EDU	.080**	.035	.023
MEMBER	.129**	.065	.047
INCOME	.022*	.017	.084
Intercept	0,73	1.195	.955

Source: Processing from survey sample (2020)

Note: ***: significant at the error of 1%. **: significant at the error of 5%. *: significant at the error of 10%.

Table 4.5: Estimate the WTP model with parameters for Khamkuna village

Variable	Coefficient	Standard deviation	p-value
X	420.00	319.748	
AGE	45.82	12.660	
SEX	.45	.499	
MARRIED	.98	.157	
EDU	9.91	3.210	
MEMBER	4.68	1.588	
INCOME	12.9188	34.62240	
Parametric model			
X	.002***	.001	.000
AGE	.015	.017	.369
SEX	.414	.387	.284
MARRIED	1.769	1.133	.118
EDU	.177**	.069	.011
MEMBER	.071	.117	.545
INCOME	.014**	0.58	0.021
Intercept	0.465	1.804	.090

Source: Processing from survey sample (2020)

Note: ***: significant at the error of 1%. **: significant at the error of 5%. *: significant at the error of 10%.

Table 4.6: Estimate the WTP model with parameters for Nacheng village

Variable	Coefficient	Standard deviation	p-value
X	415.86	317.794	
AGE	50.03	12.096	
SEX	.25	.435	
MARRIED	.99	.083	
EDU	10.07	3.728	
MEMBER	5.33	2.192	
INCOME	12.3017	22.14	
Parametric model			
X	.003***	.000	.000
AGE	-.009	.013	.010
SEX	-.513	.333	.247
MARRIED	-19.749	27503.9	.0948
EDU	.045**	.041	.035
MEMBER	.148*	.082	.065
INCOME	.023**	.021	.017
Intercept	0.756	27503.912	1.195

Source: Processing from survey sample (2020)

Note: ***: significant at the error of 1% . **: significant at the error of 5%. *: significant at error of 10%.

- Thus, in all models, the coefficient of the variable X is positive and significant at the error of 1%. This is in line with the theory that the higher the level of X is, the higher the probability of being willing to participate.

- INCOME variable in the models are positive but only significant at 5% error in all three models for overall and Khamkuna, Nacheng. Thus, in all these models, household income affects the willingness to participate in order to improve the quality of forest. Specifically, when the household income increases by 1 million kip / month, the probability of participating at a given X level increases to 2.2; 1.4 and 2.3% respectively in the overall model and research villages.

- EDU variable is also significant and positively correlated in all three models at 5% error. This means that as the level of education increases, the probability of being willing to participate and accepting a given X level also increases to improve non-market values from the latter to the pre-deforested level. When the level of education or the number of schooling increases by 1 year, the probability of participating at a given X level increases by 8% in the overall model.

- MEMBER is significant at the 5% error in the overall model. In this model, the number of people in the household affects their willingness to participate to improve the quality of the forest environment. When families have more people benefiting from better forest environmental quality, they are more willing to participate to improve and maintain the living and livelihood of their family.

- The remaining variables such as SEX, AGE, and MARRIED are not statistically significant and have no significant effect on the probability of accepting given X levels.

The average WTP was estimated from the results of the regression model following the procedure proposed by Haab and McConnell (2000). The average value of WTP for improving forest quality from the level after a deforestation and degradation to the initial level as before that of each parametric model is calculated according to the theoretical formula in the previous section and presented in the following table.

$$E_{\varepsilon}\left[WTP_j\right] = M_j\left[1-\exp\left(-\frac{\alpha}{\beta}z_j+\frac{1}{2}\frac{\sigma^2}{\beta^2}\right)\right]$$

Table 4.7: WTP Estimation from the parameter regression model

No.	Model	WTP expected value (1000 kip)
1	A	2.427
2	B	2.309
3	C	2.545

Source: Processing from survey sample (2020)

According to the estimation results, the average value of WTP in the overall model (for all observations) is 2,427,000 kip/ household. This value is different for each different model. In particular, the average WTP in Khamkuna is 2,309,000 kip (in model A) and in Nacheng village is 2,545,000 kip (in model B).

4. Discussion and Conclusion

This report aims to review PES implementation in Lao PDR and estimate the willingness topay of local community to participate in PES schemes in Bolikhamxay province. The Government of Lao PDR has shown strong interest in the PES mechanism. The main constraint in Lao PDR is not the legal issue itself, but rather the lack of human and financial capacity to implement PES. Thus, payment coming from local communities is of much critical. According to the estimation results, the average value of WTP in the overall model (for all observations) is 2,427,000 kip/ household. This value is different for each different model. In particular, the average WTP in Khamkuna is 2,309,000 kip (in model A) and in Nacheng village is 2,545,000 kip (in model B).

Understanding local people's decision processes is an essential precondition for designing effective and efficient PES programmes. The model used here show the willingness-to-consider decision from the subsequent enrolment decision, providing fresh insights into how tiered policies can facilitate participation in PES programmes. For farmers willing to consider PES, the model reveals factors deterring enrolment that can be overcome with higher payments. A small boost in compensation to farms with these traits could increase the total acreage enrolment from participants and some non-participants who will consider enrolling in PES.

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