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RESEARCH ARTICLE

VALUATION OF ECOSYSTEM SERVICES: A CASE OF PANCHASE PROTECTED FOREST IN THE MID-HILLS OF WESTERN NEPAL

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ABSTRACT

Forests provide numbers of ecosystem services for human wellbeing. However, the importance of ecosystem services arising from forests is poorly recognized in developing countries like Nepal. The present study has estimated economic value of ecosystem services provided by Panchase Protected Forest of Nepal. Applying contingent valuation method, 364 people were surveyed for their willingness-to-pay to estimate indirect use value of ecosystem services. The analysis revealed that total annual economic value of the Panchase Protected Forest is NPR 52.2 million (USD 521,930) and the per hectare annual economic value is NPR 9037.75 (USD 90.37).The regression analysis concludes that people having higher income and people having access to executive positions in community based forest management are willing to pay more to conserve forests. Creation of economic opportunities for local people and strengthening community engagement in forest management decisions are crucial for better management of protected forests.

INTRODUCTION

Natural ecosystems provide a wide range of services and economic benefits for local livelihoods (Pant et al., 2012) and human wellbeing (MEA, 2005). These benefits are the multiple commodities and services that are supplied by natural ecosystems as a result of their structure, ecological characteristics, functions or processes that directly or indirectly contribute to human wellbeing (Daily, 1997; Costanza *et al.,* 2017). Ecosystem services are the benefits people obtained from ecosystem (MEA, 2005). After the Millennium Ecosystem Assessment (MEA), ecosystem services science has made much progress in framing the concepts and approaches (Small *et al.,* 2017). MEA (2005) classifies ecosystem services into four broad categories *viz.* provisioning, regulating, cultural and supporting services. Later, the Economics of Ecosystem and Biodiversity (TEEB) slightly modified the MEA categories of ecosystem services into provisioning; regulating; habitat; and cultural and amenity services. Costanza *et al.* (2017) argues that the TEEB framework added more of the economic aspect of ecosystem services. Some of the ecosystem services have market prices, but others do not have since they are not traded in the market place (Dasgupta *et al.,* 2011). However, these services which are not measured through market mechanism are of high use or non-use value for the human wellbeing. TEEB (2010) has framed these non-use values into option value, existence value, altruistic value and bequest value.

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This study adopts the TEEB's frame and definition of non-use values.*Option value* is the future use of known and unknown benefits and relates to the importance that people give to the future availability of ecosystem services for personal benefit. *Existence value* is the satisfaction of knowing that ecosystem exists and relates to the satisfaction that individuals derive from the mere knowledge that ecosystems continue to exist. *Altruistic value* is the satisfaction of knowing that other people of the present generation have access to the benefits provided by ecosystems. *Bequest value* is the satisfaction of knowing that future generation will also have access to the benefits from ecosystems.

The complex dynamics between the ecology-economy interface, market and institutional failure, and human activities often lead to degradation of natural environment and accelerated loss of ecosystem services (TEEB, 2010). The failure to account for the full economic values of ecosystems has been a significant factor in their continuing loss and degradation (MEA, 2005). As the benefits received from ecosystem services are usually neglected or undervalued in decision-making due to the lack of market prices of such services, alternative valuation shows how conservation can deliver a range of economic advantage (TEEB, 2010). Moreover, valuation enables to estimate the value of goods and services provided by the ecosystems and helps in creating incentive mechanisms to conserve these ecosystems (DEFRA, 2007).

Despite smaller in size, 118 natural ecosystems exist in Nepal (Dobremez, 1976) of which forests have the most important

stake as it covers 44.74% (6.61 million hectare) of the total area of the country (DFRS, 2015). Nepal recently initiated 'protected forest', a new category of forest management regime, to balance human needs through conserving biodiversity and safeguarding environment (Shrestha *et al.,* 2014). Nepal has declared eight protected forests covering 133,754.8 hectares (GoN/MoFSC, 2014). Protected forests assumed to provide numbers of ecosystem services, however, the understanding and importance of ecosystem services arising from forests are not properly recognized in policy and management decisions (Paudyal, 2015). Therefore, valuation of ecosystem services is crucial in identifying economic benefits provided by the forests. The present research aimed at valuing a representative protected forest highlighting the non-use values of ecosystem services such as option value, existence value, altruistic value and bequest value.

MATERIALS AND METHODS

Study area

We conducted the research in Panchase Protected Forest (PPF). The PPFwas declared as protected forest, in 2012, considering its significance for biodiversity, ecotourism and religion (GoN/MoFSC). It comprises an area of 5,775 hectares at the juncture of *Kaski, Syangja* and *Parbat* districts in the western Nepal. The forest is rich in biodiversity as it has wide range of altitudinal variation from 900 m to 2,517 m above mean sea level. DoF (2012) has recorded 589 species of flowering plants including 107 medicinal and aromatic plants and 113 orchids, 56 species of wild mushrooms, and 98 species of ferns in this region. Out of total 35 forest types found in Nepal (Stainton, 1972), the PPF represents five forest types- alder forests, chirpine-broad leaved forest, oak-laurel forest, lower temperate oak forest, and *Schima-Castanopsis* forest (DoF, 2012).

The PPF has been zoned as core area (for conservation) and fringe area (for sustainable use) (Figure 1). Core area covers 2,035 ha in the innermost area whereas fringe area covers 3,740 ha outside the core area. The settlements outside the protected forest have been declared as impact zone. Impact zone covers the settlements within nine Village Development Committees (VDCs)-three VDCs of each Kaski, Parbat and Syangja districts. A total of 26,025 people resides within the total 7039 households in the impact zone (CBS, 2011).

Sampling and survey

Out of the total 7039 households in the impact zone of the Panchase Protected Forest, we selected 364 sample households (at a confidence level of 95% with a marginal error of 5%) for the research using Krejcie and Morgan (1970) sample size calculation formula.

$$n = \frac{NZ^2P(1-P)}{Nd^2 + Z^2P(1-P)}$$

Where,

n = sample size
Z = Z-value (1.96 for 95% confidence level)
P = population proportion (used 0.5 since this would provide the maximum sample size)
d = degree of accuracy (maximum acceptable error) expressed as a proportion (0.05)
N = population size (total number of households)

We distributed the sample size in all nine VDCs of the study area proportionally. After determining the sample size in each VDCs, we adopted simple random sampling method to select the sample household within the VDC. We conducted a survey within the sampled household in April 2017 using structured questionnaire. We designed questionnaire reviewing literatures

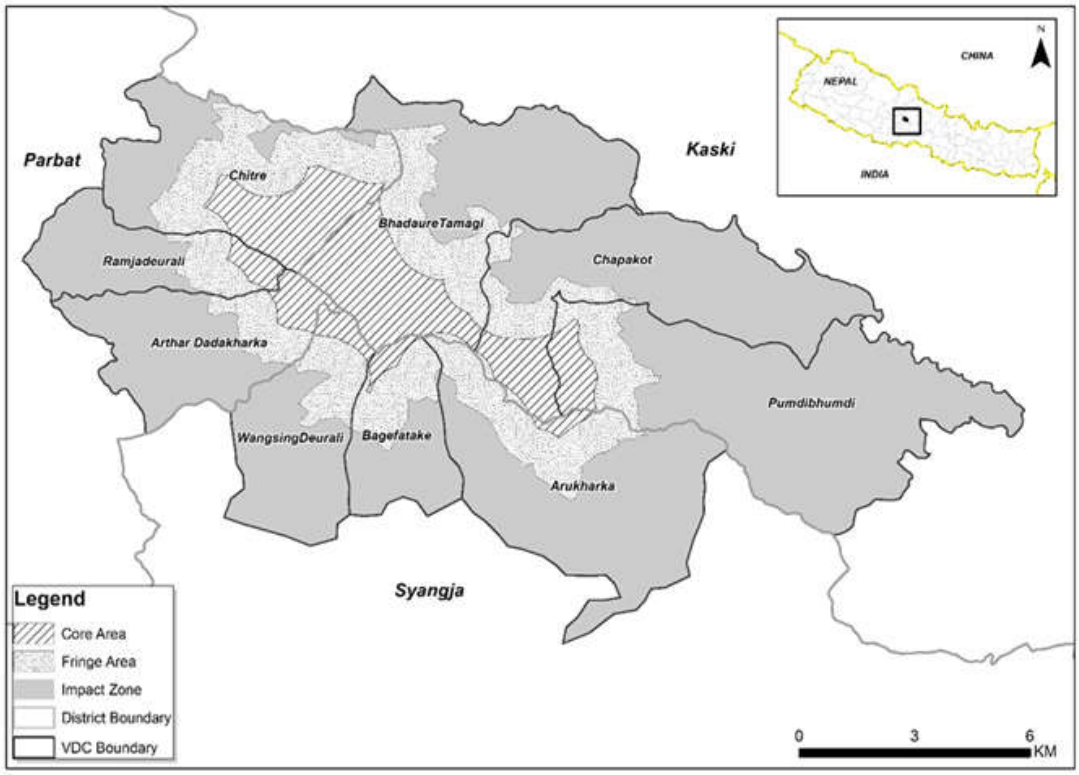

Figure 1. Panchase Protected Forest showing core area, fringe area and impact zone

and pre-tested in the study site. We conducted in-person interviews using the questionnaire through the help of three trained university students. We choose household head as a respondent for this survey.

Contingent valuation

We estimated the value of ecosystem services provided by the forests through applying Contingent Valuation Method (CVM). CVM is a survey based stated preference method most frequently used (Spangenberg and Settele, 2010) to estimate the non-use values of ecosystems (TEEB, 2010) creating a hypothetical market (Haque *et al.,* 2011). The CVM uses questionnaires to ask people to express their preferences in terms of their Willingness to Pay (WTP) to conserve the ecosystems services (CSUWN, 2011). Economic value is often defined in strict economic terms as aggregate willingness to pay for the stream of services (Costanza *et al.,* 2017). In the present research, we used labor contribution as a payment vehicle to estimate WTP. It is more realistic in a subsistence economy where most of the economic transactions are non-monetized (Rai and Scarborough, 2012). In this method, respondents are asked to measure their annual WTP in terms of their labor contribution. We asked separate WTP for option value, existence value, altruistic value and bequest value, and summed-up to calculate total WTP of a respondent. We converted the labor contribution into the monetary value using the average wage rate of the study site (NPR 500/day) as an opportunity cost of unskilled labor. The WTPs of all individual respondents then totaled and divided by the total number of respondents to calculate the average WTP of a household. The average value was then multiplied by total number of households within the study area to calculate the total WTP.

Econometric Model

We developed a multiple regression equation to understand the relationship between WTP and various socio-economic attributes. The socio-economic attributes considered for this research include age, gender, education, family size, landholding, livestock holding, income, distance to forest, and position in the community based forest management groups. As log-linear model is a commonly used form of regression model (Greene, 1993) that expresses linear relationship between dependent and independent variables (Gujarati, 2003), we used regression equation with logarithmic function of variables. The following log-linear model was used in this research.

$$\ln Yi = \beta + \sum \beta ij \ln Xij + ei$$

Where,

Y = WTP
β = regression coefficient
X = attributes
e = error

The model is described as the following equation, which analyzes the relationship between WTP and socio-economic attributes.

$$\text{Ln WTP} = \beta 0 + \beta 1 \ln \text{AGE} + \beta 2 \text{ GENDER} + \beta 3 \ln \text{EDUCATION} + \beta 4 \ln \text{FAMILYSIZE} + \beta 5 \ln \text{LANDHOLDING} + \beta 6 \ln \text{LIVESTOCK} + \beta 7 \ln \text{INCOME} + \beta 8 \ln \text{DISTANCEFOREST} + \beta 9 \text{ POSITIONFOREST}$$

Community based forest management is one the successful model of forest management in Nepal (Paudyal, 2015). This research intended to identify the relationship between WTP and position holders in executive committees of community based forest management (community forests/protected forest council). Similarly, various researchers (e.g. Bhandari and Uibrig, 2008) consider income as a strong socio-economic variable in Nepal's community based forest management. Therefore, this research is intended to observe the relationship between annual income and WTP. Moreover, based on literature review and consultation with the experts, other socio-economic variables such as age, gender, family size, landholdings, livestock, and distance to forest were chosen (Table 1). The qualitative variables used in this model are quantified as dummy variables. The data were analyzed using IBM SPSS 23.

RESULTS AND DISCUSSION

Economic value of protected forest

The results of the CVM survey reveal that the annual WTP of the people of impact zone in conserving Panchase Protected Forest is Nepalese Rupees (NPR) 52.2 million (USD 521,930 at the conversion rate of USD 1 = 100 NPR) (Figure 2). The per hectare annual economic value of the PPF is NPR 9037.75 (USD 90.37).The people of the impact zone of the PPF have highest WTP of NPR 17.1 million (USD 171,044) for bequest value followed by NPR 16.02 million (USD 160,215) for option value. The WTP for existence value and altruistic value are NPR 9.6 million (USD 96,399) and NPR 9.4 million (USD 94,272) respectively. The highest WTP for bequest value reveals that people in the study area are interested to contribute more in conserving forest so that future generations will also have access to the benefits of ecosystem services. Similarly, higher contribution to option value reveals that people are willing to contribute in conserving forest for future use of known and unknown benefits. This finding implies that protected forests are not only important for conserving biodiversity and environmental safeguards, but also provides economic benefits. It has policy implications. We did not find literatures to compare our findings with other protected forests in Nepal. However, Shrestha *et al.* (2007) has estimated annual economic value of USD 1.6 million for Koshi Tappu Wildlife Reserve of Nepal. Moreover, Baral *et al.* (2016) has estimated annual economic value of USD 0.9 million for Jagadishpur Ramsar Site of Nepal. The economic value of the Panchase Protected Forest is lower compared to the economic value of Koshi Tappu Wildlife Reserve and Jagadishpur Ramsar Site. It could be due to considering only non-use values in the present research.

Socio-economic attributes and WTP

The higher value of R^2(0.87) and adjusted R^2 (0.86) shows the strength of the model used for analyzing the WTP in this research (Table 2). Executive position in community based forest management are willing to pay more than the others. It is due to the increased ownership of local people in forest management.

Table 1. Socio-economic variables and description

Variables	Expected sign	Description
Age (AGE)	-	Age of household head in year
Gender (DENDER)	+	Sex of the respondent (male = 1, female = 0)
Education (EDUCATION)	+	Education of the respondent (no of school years)
Family size (FAMILYSIZE)	+	No of people in family
Landholdings (LANDHOLDING)	+	Land area owned by the household (in ropani, 1 ropani = 0.05 ha)
Livestock (LIVESTOCK)	+	Number of livestock unit owned by the household
Income (INCOME)	+	Annual income of the household
Distance to forest (DISTANCEFOREST)	-	Distance of the Panchase Protected Forest from the respondent's home
Position in forest management committee (POSITIONFOREST)	+	Position of the respondent in forest management committee (position holder=1, other=0)

Table 2. Socio-economic variables and coefficients

Variables	Coefficient	Standard Error	Standardized Coefficient	t-value	p-value
Constant	2.116	.241		8.788*	.000
GENDER	-.042	.029	-.033	-1.450	.148
POSITIONFOREST	.226	.031	.150	7.194*	.000
INCOME	.521	.012	.902	41.923*	.000
LANDHOLDING	-.008	.018	-.010	-.425	.671
LIVESTOCK	-.003	.019	-.003	-.167	.868
AGE	.005	.053	.002	.090	.928
EDUCATION	.002	.018	.003	.107	.915
FAMILYSIZE	.038	.033	.024	1.152	.250
DISTANCEFOREST	-.010	.018	-.010	-.521	.603

R^2 0.87; adjusted R^2 0.86
*significance at 5% level

It implies that community engagement in forest management needs to be increased for better conservation of forest and ecosystem services. The variable INCOME is positively and significantly related with the WTP. It reveals that people having higher income are willing to contribute more to conserve forest and ecosystem services than the people having lower income. It is due to the reason that the preferences of a poor people is to manage for subsistence living. This finding suggests that forest management interventions need to be focused on creating economic opportunities that increase income of the surrounding communities. This study finding is similar to the findings of Paudyal *et al.* (2015) and Bhandari et al (2016).The variables AGE, EDUCATION and FAMILYSIZE are positively related to the WTP but not statistically significant. Bhandari *et al.* (2016) also observed no significant correlation between the amount of WTP with age and education. The positive relationship indicates that adult persons and educated persons pay more to conserve forest than the youth and less educated people. It implies that conservation awareness and education programs need to be implemented with particular focus on youths.

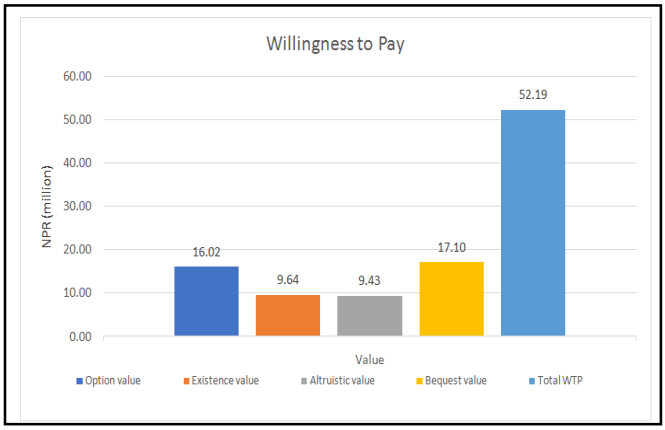

Figure 2: People's willingness to pay

Similarly, households having larger family size are willing to contribute more for forest conservation. It is partly due to their high demand of goods and services from the forests. The variable GENDER is negatively and insignificantly related with the WTP. Paudyal *et al.* (2015) has similar finding on it. The negative relationship indicates that women are willing to contribute more than the men to conserve the forest. It is partly because women are engaged more in collecting forest products such as fuelwood and fodder for their household needs. The variables LANDHOLDING and LIVESTOCK are negatively related with WTP although they are not statistically significant. The results indicate that the households having more lands and more livestock are willing to contribute less time than others. It is because they have goods and products to their own land and they need to spend more time in their lands and for their livestock, which reduces their time to contribute to forest management. Similarly, the variable DISTFOREST is negatively but insignificantly related with the WTP. The negative relationship indicates that households living far from forest contributes less than the households living near to the forests. It is partly because people near to forests are feeling more ownership as they depend more on forests.

Conclusion

The economic value of the ecosystem services of the Panchase Protected Forest estimated through WTP is NPR 52.2 million (USD 521,930). The per hectare annual economic value of the PPF is NPR 9037.75 (USD 90.37).This study concludes that protected forests are not only important for conserving biodiversity and environmental safeguards, but also important for economic benefits. Local people have the highest WTP for bequest value followed by option value. Based on this finding, this research concludes that people intend to conserve and manage forests keeping in priority that future generation will have access to ecosystem services. The regression analysis concludes that the people having higher income are willing to pay more to conserve forest. It suggests decision makers to

design forest management interventions that can create economic opportunities. Similarly, people having access to executive position in community based forest management are willing to pay more. Based on this conclusion, this study suggests strengthening community engagement in forest management decisions. It is also observed that women, educated persons, people proximity to forests are willing to pay more compared to men, less educated persons and people distant to forest, respectively. These trends suggest increasing investment to empower women in forest management decisions, and to raise awareness and education in forest resource conservation. This research highlighted on the non-use value of ecosystem services provided by protected forests in Nepal. It is suggested to conduct further research on economic valuation of protected forests including all use and non-use values of ecosystem services.

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REFERENCES

Baral, S., Basnyat, B., Khanal, R. and Gauli, K. 2016. A total economic valuation of wetland ecosystem services: An evidence from Jagadishpur Ramsar site, Nepal. *The Scientific World Journal Vol 2016 ID 2605609*.

Bhandari, A.R. and Uibrig, H. 2008. Who Is Benefitting More From Common Property Forest Resources: Poor or Less Poor?. *Banko Janakari (A Journal of Forestry Information for Nepal) 18 (1) pp 42-47.*

Bhandari, P., Shrestha, S., Aryal, A. and Shrestha, U.B. 2016. Assessment of ecosystem services indicators and stakeholder's willingness to pay for selected ecosystem services in the Chure region of Nepal. *Applied Geography 69 (25-34)*.

CBS. 2011. Population Census 2011 National Report. Central Bureau of Statistics (CBS), Kathmandu.

Costanza, R., De Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutten, P., Farber, S. and Grasso, M. 2017. Twenty years of ecosystem services: How fare have we come and how far do we still need to go? *Ecosystem Services 28(1-16)*.

CSUWN. 2011. An Economic Valuation Tool for Wetlands of Nepal. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.

Daily, G.C (Ed). 1997. Natures' Services. Societal Dependence on Natural Ecosystems. Island Press, Washington, DC.

Dasgupta, P., Kinzig, A. and Perrings, C. 2011. The Value of Biodiversity. University of Cambridge, UK

DEFRA. 2007. An Introductory Guide to Valuing Ecosystem Services. Department for Environment, Food and Rural Affairs, London.

DFRS. 2015. State of Nepal's Forests. Forest Resource Assessment Nepal, Department of Forest Research and Survey, Kathmandu, Nepal.

Dobremez, J.F. 1976. Ecology and Biogeography of Nepal. Centre Nationale de la Recherche Scientifique, Paris.

DoF. 2012. Panchase Protected Forest Management Plan. Department of Forests, Babarmahal, Kathmandu.

GoN/MoFSC. 2014. Nepal Biodiversity Strategy and Action Plan 2014-2020. Government of Nepal, Ministry of Forests and Soil Conservation, Kathmandu.

Greene, W.H. 1993. Econometric Analysis. Macmillan Publishing Company, New York.

Gujarati, D.N. 2003. Basic Econometrics. McGraw Hill Education.

Haque, A.K, Murty, M.N, Shyamsundar, P. 2011. Environmental Valuation: A Review of Methods. *In:Haque AK, Murty MN, Shyamsundar P. editors. Environmental Valuation in South Asia.* Cambridge University Press, New York, p.19-32.

Krejcie, R.V. and Morgan, D.W. 1970. Determining Sample Size for Research Activities. *Educational and Psychological Measurement, 30 (3), 607-610.*

MEA. 2005. Millennium Ecosystem Assessment. Ecosystems and Human Wellbeing: Synthesis. Island Press, Washington, DC.

Pant, K.P., Rasul, G., Chhetri, N., Rai, R.K. and Sharma, E. 2012. Value of Forest Ecosystem Services: A Quantitative Estimation from the Kangchenjunga Landscape in Eastern Nepal. ICIMOD Working Paper 2012/5. Kathmandu, Nepal

Paudyal, K., Baral, H., Burkhard, B., Bhandari, S.P., Keenan, R.J. 2015. Participatory assessment and mapping of ecosystem services is a data-poor region: Case study of community-managed forests in central Nepal. *Ecosystem Services 13 (81-92)*.

Rai R.K. andScarborough, H. 2012. Valuing the Damage Caused by Invasive Plant Species in a Low-income Community in Nepal. *SANDEE Working Papers WP 74-12*.

Shrestha, R.K., Alavalapati, J.R.R., Seidl, A.F., Weber, K.E. and Suselo, T.B. 2007. Estimating the local cost of protecting Koshi Tappu Wildlife Reserve, Nepal: A contingent valuation approach. *Environment, Development and Sustainability 9 (413-426).*

Shrestha, T.K., Aryal, A., Rai, R.K., Lamsal, R.P., Koirala, S., Jnawali, D., Kafle, R., Bhandari, B.P. and Raubenheimer, D. 2014. Balancing Wildlife and Human Needs: The Protected Forest Approach in Nepal. *Natural Areas Journal 34(3):376-380.*

Small, N., Munday, M. and Durance, I. 2017. The challenge of valuing ecosystem services that have no material benefits. *Global Environmental Challenge 44 (57-67)*.

Spangenberg, J.H. and Settele, J. 2010. Precisely incorrect? Monetizing the value of ecosystem services. *Ecological Complexity 7 (327-337)*

Stainton, J.D.A. 1972. Forests of Nepal. John Murray. London.

TEEB. 2010. The Economics of Ecosystems and Biodiversity. The Ecological and Economic Foundation. Edited by Pushpam Kumar. Earthscan, London and Washington.

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