Using the Non-market Value of Ecosystem Services to Mainstream Biodiversity into Community Forest Management

Rajesh K Rai[1], **Priya Shyamsundar**[2], **Mani Nepal** [3]and **Laxmi Dutt Bhatta**[4]

Abstract

This study estimates the economic value of ecosystem services generated from the management of community forests at sub-watershed level. A total 300 households were surveyed in Jhikhu khola watershed of Kavrepalanchok district. We used discrete choice experiment method to estimate the value of ecosystem services generated from ecosystem management at watershed level. Random parameter logit model was used to analyze choice responses. Three data sets were generated to analyze the data including pool, upstream and downstream.

The results indicate that drinking water, irrigation water, forest litter and fuelwood are the locally important ecosystem services. Forest users are keen to contribute to management activities through their community forest user groups. On average, forest users are willing to pay NPR 29 per year for one additional liter of drinking water per household per day during the dry season. They are willing to pay more than NPR 1,444 per year for an additional month of irrigation. Respondents are willing to pay approximately NPR 1,300 for an additional 30 baskets of leaf litter per month or NPR 43 per basket. This reflects the value of leaf litter as a substitute for chemical fertilizers. Respondents are willing to pay approximately NPR. 117 per *bhari* or head load fuelwood. The estimated average annual household willingness-to-pay is NPR. 3,136 for the specific community forest management scenario.

In addition, up-stream community member are willing-to-pay 1.37 times more for watershed services relative to downstream members. In addition, drinking water demand, irrigated land holding size and sex of respondents are main demographic characteristics to determine willingness-to-pay of forest users. The study suggests that choice experiment is useful tools to mainstream biodiversity into community forest management.

Key words: **Choice Experiment, Economic Valuation, Willingness-to-Pay, Upstream, Downstream, Forest Products**

[1] *Corresponding authors' email: rajeshr@sandeeonline.org*

1.0 INTRODUCTION

Forests in developing countries have received considerable attention in international climate policy discussions. Forest depletion in these countries is responsible for approximately one-fifth of all anthropogenic carbon emissions (IPCC, 2007). The causes and drivers of deforestation are multifaceted, and range from subsistence use to commercial exploitation (Geist and Lambin, 2001; Fine, 2002). For this reason, no single strategy can be effective to protect these forests and curb the current destructive trend. Reversing this trend requires addressing a myriad of social issues, including poverty and governance decisions (Agarwal, 2001; Scherr *et al*., 2003; CFD, 2004).

Forest governance is receiving increasing attention in international forest policy discussions, which are primarily aimed at addressing the problems associated with the depletion of forest resources. The participation of local community and market actors in addressing future governance challenges is necessary to lead to effective governance (Agrawal *et al*., 2008). Economic valuation is considered a tool for promoting good ecosystem governance through the supply of information about the values, incentives and options of forest management (King, 2007).

Our study estimates demand for watershed services using non-market valuation technique in the Koshi river basin of Nepal (Merz *et al*., 2003b). Watershed services are important for rural households to maintain their agriculture and forest based livelihoods (Merz *et al*., 2003a; Bhandari and Grant, 2007). Furthermore, there is a growing interest in managing watershed services to enable better adaptation to climate change, which is expected to affect both water quality and quantity in many parts of Nepal (Dongol *et al*., 2005).

2.0 STUDY AREA

This study was carried out in the Jhikhu Khola watershed area in the middle hills of central Nepal. This watershed covers a population of 10,875 households and an area of 11,141 ha. dominated by agriculture and forests. The population is governed by eleven village development committees and the Dhulikhel Municipality of Kavrepalanchok District, while forest patches are managed by some 29 community forest user groups (IUCN, 2007; Central Bureau of Statistics, 2012). Upstream forests are dominated by Chirpine (*Pinus roxburghii)* plantations, while Sal (*Shorea robusta)* dominates downstream areas.

In this watershed, both irrigation and drinking water are seasonally scarce during the dry season (see Table 3). According to local people the landscape and ecosystem services in the region have changed significantly over the last decade, primarily as a result of growth in agricultural markets, population changes and invasion of exotic plant species. Urban demand for vegetables, due to its proximity to the capital city Kathamndu, has triggered intensive farming with multiple crops and heavy use of chemical fertilizers and pesticides. These practices require increased water usage and can contribute to water quality degradation (Foley *et al*., 2005).

Furthermore, during the 1970s, most degraded forest patches in the Himalayan region were re-vegetated with pines (Gautam *et al*., 2003). These pine stands, which are now mature and dense, produce fewer forest products and services such as fuelwood, fodder and leaflitter that are locally useful (Saxena *et al*., 2002). Pine needles are usually nutrient poor and have a slow decomposition rate (van Wesemael, 1993); if not removed in a timely manner they begin to acidify forest soil (Lavelle *et al*., 1995), which ultimately limits the regeneration of native vegetation. Furthermore, exotic species are widespread in the pine stands also limit the regeneration of native species, reducing the availability of forest products such as fuelwood and fodder (McWilliam, 2000; Rai *et al*., 2012).

A common understanding among development practitioners is that integrated watershed management can offer some remedies. This approach seeks to balance ecological, economic and social dimensions of watershed management and can contribute to increases in the availability of ecosystem services (Heathcote *et al*., 1998). The question is whether the demand for these local services is sufficient to allow villagers to manage watersheds for improved provision of these services and sustain any investments that may be required.

3.0 METHODS

To understand the nature of the local demand for watershed services, we undertook a discrete choice experiment (DCE). The DCE sought to answer two questions: whether demand for improved watershed services differed for different categories of users, particularly for downstream versus upstream users? A random parameter logit (RPL) model was estimated to analyze choice responses. The RPL model is expressed as:

$$V_{ij} = ASC + \Upsilon x_{ij} + \eta x_i + \gamma s_i \qquad (1)$$

Where, V_{ij} refers to indirect utility obtained by the i^{th} individual for the j^{th} alternative. Υ is the sum of the population mean and η is individual deviation of the random parameter, and x is attribute. The alternative specific constant (*ASC*) captures the effect of unobservable factors on the selection of alternatives relative to the status quo. In this model, socio-economic variables (*s)* are introduced to detect sources of heterogeneity. Further, interaction terms in *s* identify the impacts of individual-specific characteristics on selected alternatives and the ASC.

3.1 Selection of attributes

We undertook five 'Focus Group Discussions (FGDs)' in the study area to identify attributes. Participants were first asked to prepare a list of watershed services and rank them according to their importance. The FGDs indicated that the most important watershed attributes that villagers were interested in were irrigation water, drinking water, fuelwood and leaflitter (Table 1).

FGD participants were also asked to identify changes in attributes that could make a tangible difference to their household. For example, households currently obtain 8 months of irrigation water and participants indicated that they would prefer 10 or 12 months of water. This increased level of irrigation water would allow households to cultivate their farms during the dry season. We also consulted key informants and experts to ascertain the maximum level of enhancement possible for each attribute.

A third issue that was discussed was the payment vehicle (how to collect and manage fees) and mode of payment. Respondents indicate that they would like to pay through their respective community forest user groups (CFUGs). The range of payment is based on the focus group discussion. A ten-year program for managing the watershed was discussed in the FGDs as well as with local officials. These discussions identified a program for integrated watershed management whereby community forest user groups would collect a fee to implement the plan and a sub-watershed level community development group would be organized to manage activities at the landscape level. The program laid out three conservation activities: gradual conversion of pine forest to broadleaved species, harvesting of sub-surface water from water bodies, and construction of water retention holes and conservation ponds to enhance water availability.

3.2 Experimental Design and survey implementation

We used the Ngene (1.0.1) software for generating experimental designs. Each choice set included two policy alternatives (Alternative 1 and Alternative 2) plus the status-quo. Respondents were asked to pick one alternative out of the three for each choice set. The 20 identified choice sets were divided into five versions of the survey questionnaire. During the survey, each respondent was presented four cards (see Figure 1) and asked to choose one option from each card. Thus, each respondent made four choices.

TABLE 1: ATTRIBUTES AND THEIR LEVELS

Attributes	Description	Levels
Drinking water	Amount of water availability per household (hh) per day during the dry season (February to May) for household use.	i. as much as now (100 liter/day/hh)*, ii. twice as much as now (200 liter/day/hh), iii. thrice as much as now (300 liter/day/hh)
Irrigation water	The number of months during which the irrigation water is available for farming.	i. as much as now (8 months)*, ii. 10 months, iii. 12 months,
Forest Litter collection	Number of leaf litter sacks per household per day during the leaf litter collection period (forest user groups open forests for collection for a month annually).	i. as much as now (1 sack per day)* , ii. twice as much as now (2 sacks per day), iii. thrice as much as now (3 sacks per day),
Fuelwood collection	Amount of fuelwood available per household per year from community forest (forest user groups collect fuelwood and distribute to users once in a year).	i. as much as now (20 bhari) * , ii. 30 bhari, iii. 40 bhari
Watershed management fee	An introduction of new annual fee for watershed management. This is a fee additional to what households are paying now for community forest membership. Users can pay in twelve monthly installments.	i. No additional fee*, ii. NPR. 600, iii. NPR. 1,800, iv. NPR. 3,000.

*** Levels used in status quo (current situation).**

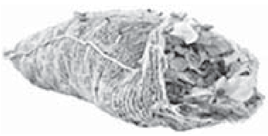
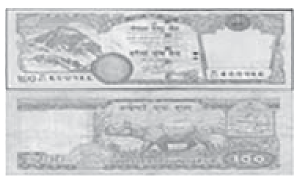
Attributes	Alternative 1	Alternative 2	Current situation
Drinking water 	200 liters/day 	200 liters/day 	100 liters/day 
Irrigation water Jan Feb Mar Apr May June Jul Aug Sep Oct Nov Dec	12 monthsavailable	8 months available	8 months available
Leaflitter collection 	2 sacks/day 	2 sacks/day 	1 sacks/day 
Firewood collection 	30 Bhari 	30 Bhari 	20 Bhari 
Watershed management fee 	NRs. 3,000 	NRs. 600 	No additional fee
Your choice M Please tick (√) one box			

Figure 1: An example of choice set

Face-to-face interviews were carried out with 300 households, 150 each from upstream and downstream areas. A systematic sampling approach was used to select households. Villages within the watersheds were first geographically stratified into upstream and downstream locations. Then from each geographical group, 10 *wards* of different village development committees were randomly selected and 15 households from each *ward*. The first household was selected randomly and then every 6th household was interviewed on both sides of a street. The available head of household (male or female) was interviewed.

4.0 RESULTS AND DISCUSSION

4.1 Sample characteristics

Table 2 presents basic socio-economic information and compares upstream and downstream households. Only about a sixth of the farmers (17%) generate sufficient income to sustain their livelihoods from farm production, while one tenth maintain their family expenditure for less than three months from their farm income. A majority (87 percent) of the families have a traditional house and one third (36%) of households use traditional stoves. Likewise, 13 percent households have pit toilets, while six percent practice open defecation.

TABLE 2: SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS (STANDARD ERROR IN PARENTHESES)

Characteristics	Location (n=300)	
	Upstream	Downstream
Age (years)	45.28 (15.59)	46.67 (15.61)
Education (years)	2.75 (2.14)	3.03 (2.48)
Family size	4.71 (2.13)	4.26 (1.87)
Irrigated land (ha)	0.17 (0.16)	0.27 (0.25)
Unirrigated land (ha)	0.29 (0.27)	0.24 (0.30)
Drinking water demand (Liter/day/family)	276 (175)	291 (196)
Traditional house	141 (94%)	121 (85%)

4.2 Choice responses analysis

All RPL models are statistically significant with Chi-square statistics of 307.24 and 594.25 for upstream and downstream respectively. As per expectations, respondents in both communities prefer the condition with increased availability of drinking water, irrigation water, leaflitter and fuelwood in the watershed but lower watershed management fee. Both upstream and downstream respondents having high water demand select the alternative more frequently compared to respondents having less water demand for household use. While family size has contrasting effects on selecting watershed management alternatives between upstream and downstream households. For instance, downstream respondents having large family size are less likely to select the alternatives over status quo. On the contrary, upstream respondents having large family size are likely to select alternatives more frequently. While exploring the reason for this divergent result, the correlation coefficients indicate that, in upstream, larger family size means small irrigated land holdings and living far from community forest.

TABLE 3: RESULTS OF RPL MODELS (UPSTREAM AND DOWNSTREAM SUB-SAMPLES OF MONETARY COHORT)

Variables	Coefficients (SE)	
	Upstream	Downstream
Irrigation water	0.45 (0.10)***	1.22 (0.25)***
Drinking water	8.43e-3 (1.82e-3)***	1.51e-2 (2.95e-3)***
Leaflitter	0.46 (0.17)***	1.18 (0.28)***
Fuelwood	5.11e-2 (1.80e-2)***	0.10 (2.83e-2)***
Contribution	-3.22e-4(1.18e-4)***	-5.94e-4 (1.84e-4)***
Age	-2.89e-2 (1.00e-2)***	-2.03e-2 (1.68e-2)
Education	-5.43e-2 (8.03e-2)	0.15 (0.18)
Traditional house	-0.82 (0.67)	-1.07 (0.96)
Landholding	-0.22 (0.16)	-8.62e-2 (0.16)
Family size	0.20 (7.09e-2)***	-0.33 (0.13)**
Water demand	2.33e-3 (1.24e-3)*	8.67e-3(3.73e-3)**
Male * leaflitter	-4.68e-2 (0.14)	2.07e-2 (0.15)
Irrigated land * fee	2.13e-5 (2.28e-5)	3.80e-5 (2.16e-5)*
Male * fuelwood	-1.39e-2 (1.45e-2)	-3.97e-2 (1.80e-2)**
Landholding * irrigation water	3.65e-2 (1.70e-3)**	1.86e-2 (1.51e-2)
ASC	-0.14 (0.12)	0.15 (0.19)
Standard deviation of random parameter		
Irrigation water	0.52 (0.20)***	0.86 (0.25)***

Note: *, **, *** denote statistical significance at 10%, 5% and 1% level, respectively.

On the other hand in downstream, larger family size means large irrigated landholdings and living close to community forest. This means small farmers living far from community forest suffer more from the degeneration of watershed services. The studies have shown that small farmers are more likely to invest on resource conservation when they have cash income (Reardon and Vosti, 1995; Clay *et al*., 1996). The distance between forest and users house may affect the symmetry of relationships among resources users and their relationship with resource (Varughese and Ostrom, 2001). Users living closer to forest may have a more secure and easy access to forest products. In order to secure resources, distant users may select the alternatives with improved watershed services more frequently compared to their neighbor living close to forest.

Some socioeconomic variables have significant effect on only one location. For instance, elder people are less likely to select alternatives compared to their younger counterparts in upstream but this variable is not significant in downstream. However, previous study in the lowland of Nepal indicated that elder people have higher Willingness To Pay (WTP) compared to their younger counterparts(Rai and Scarborough, 2015). This contrasting result could be because in recent days young people are more engaged in commercial farming close to city area. Similarly, households with larger landholdings prefer the alternatives with more irrigation water available compared to their small holder farmers in upstream. Likewise, male respondents are unlikely to select the alternatives with more fuelwood availability in downstream community.

4.3 Estimation of willingness-to-pay

WTP for watershed services is estimated in three-stages. First, marginal WTP or the implicit price of individual attributes included in the choice task. Then, WTP for specific policy options at the household level is estimated and third is the estimation of social benefits.

The implicit price of attribute *k* is estimated as a negative ratio of coefficients between the attribute (k) and the cost attribute (c).

$$IP_k = - \beta_k / \beta_c \quad \text{.......} \quad 2$$

The estimated implicit prices indicate that downstream households have a higher WTP for all attributes included in the experiment, except for drinking water (Table 4). This is likely because most of the downstream households have access to piped drinking water.

TABLE 4: IMPLICIT PRICES (NPR) AND THEIR CONFIDENCE INTERVALS IN PARENTHESES

Attributes	Upstream	Downstream
Drinking water	26.14 (14.62-37.66)	25.45 (16.66-32.24)
Irrigation water	1,417.47 (842.29-1,992.65)	2,067.53 (1,479.86-2,655.20)
Leaflitter	1,430.55 (612.60-2,248.50)	1,988.35 (1,262.97-2,713.73)
Fuelwood	158.62 (72.83-244.41)	175.80 (105.71-245.89)

The change in household's welfare from implementing the proposed watershed management program can be estimated using the following formula (Hanemann, 1984):

$$CS = \frac{1}{\beta c}[In(\Sigma_{j\varepsilon R} exp\ (V_0))\text{-}In\ \Sigma_{j\varepsilon R}\ exp(V_1))] \quad \text{.......} \quad 3$$

Where, CS is compensating surplus also referred to as household WTP (WTP_{hh}), V_0 is utility in the current situation and V_1 is utility in new situation. The CS is the change in utility moving from the current situation to new scenario.

The 'status quo' situation and the proposed plan are reported in Table 1. The new *watershed management* scenario expected from implementing a watershed plan would be an additional 10 liters of water/day/household during the dry season, one additional month irrigation water, one extra basket of leaf-litter per day during the forest opening period (1 month) and one additional *bhari* of fuel wood per year.

The estimated average household WTP for the new watershed management program is NPR. 3,268 for upstream users and NPR. 4,486 for downstream households, which is 1.37 times higher than the average WTP for upstream residents. This is reasonable since downstream household practice commercial vegetable farming that requires more irrigation water but upstream households are still in subsistence farming.

5.0 CONCLUSION

This study shades light on the implementation of non-market valuation in community forest management. The estimated value of the watershed management program not only focuses on the overall value of the forest ecosystem but also the on the WTP for each attribute. This study indicates that non-market valuation is one of the important tools in decision making, which is based on the participation of beneficiaries. The results of the DCE survey have also demonstrated the impact of socio-economic factors on the watershed management program. This can help to minimize controversy surrounding the watershed management program.

This study shows that downstream households' have higher WTP for watershed management compared to upstream household. Our results also reinforce the understanding that gender is an important consideration in assessing demand for forest products such as fuelwood and leaf litter, which may offer significant benefits to rural women. In conclusion, this study indicates that operational plans of community forest should be a part of watershed management plan. This can contribute to maintain the environment of entire landscape.

REFERENCES

Agarwal, B. 2001. Participatory Exclusions, Community Forestry, and Gender: An Analysis for South Asia and a Conceptual Framework. World Development. **29**: 1623-1648.

Agrawal, A., Chhatre, A. and Hardin, R. 2008. Changing governance of the world's forests. Science. **320**: 1460-1462.

Bhandari, B.S. and Grant, M. 2007. Analysis of livelihood security: A case study in the Kali-Khola watershed of Nepal. *Journal of Environmental Management*. **85**: 17-26.

Central Bureau of Statistics. 2012. National Population Census 2011: Household and Population by sex and ward level Central Bureau of Statistics Kathmandu

CFD. 2004. Twenty-five years of Community Forestry. Proceedings of the Fourth National Workshop on Community Forestry. In: Kanel, K.R., Mathema, P., Kandel, B.R., Niraula, D.R., Sharma, A.R. and Gautam, M. (Eds.), Fourth national workshop on Community Forestry. Community Forest Divison, Kathmandu, Nepal.

Clay, D.C., Byiringiro, F.U., Kangasniemi, J., Reardon, T., Sibomana, B., Uwamariya, L. and Tardif-Douglin, D. 1996. Promoting food security in Rwanda through sustainable agricultural productivity: Meeting the challenges of population pressure, land degradation, and poverty. Michigan State University, Department of Agricultural, Food, and Resource Economics.

Dongol, F.G., Jehangir, M., Joshi, B.K., Ma, X., Nakarmi, G., Prajapati-Merz, B., Salam, A., Satyal, G.S., Shrestha, S. and Verma, P. 2005. Water related key issues in meso-scale of the Hindu Kush Himalayas Renewable Natural Resources Management for Mountain Communities.p. 115.

Fine, P.V.A. 2002. The Invasibility of Tropical Forests by Exotic Plants. *Journal of Tropical Ecology*.**18**: 687-705.

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C. and Gibbs, H.K. 2005. Global consequences of land use. Science. **309**: 570-574.

Gautam, A.P., Webb, E.L., Shivakoti, G.P. and Zoebisch, M.A. 2003. Land use dynamics and landscape change pattern in a mountain watershed in Nepal. Agriculture, ecosystems & environment. **99**: 83-96.

Geist, H.J. and Lambin, E.F. 2001. What Drives Tropical Deforestation? A meta-analysis of proximate and underlying causes of deforestation based on subnational case study evidence. LUCC Report Series. LUCC International Project Office, Louvain-la-Neuve.

Hanemann, M. 1984. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*. **66**: 332-341.

Heathcote, I.W., Edwards, J.R., Greener, H. and Coombs, H.M. 1998. Integrated watershed management: principles and practice. Taylor & Francis.

IPCC. 2007. Climate Change 2007: The Physical Science Basis: Summary for Policymakers. Intergovernmental Panel on Climate Change.

IUCN. 2007. Good practices in watershed management: lessons learned in the mid-hills of Nepal. Kathmandu. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu

King, N.A. 2007. Economic valuation of environmental goods and services in the context of good ecosystem governance. Water Policy. **9**: 51-67.

Lavelle, P., Chauvel, A. and Fragoso, C. 1995. Faunal activity in acid soils. In: Date, R.A., Grundon, N.J., Rayment, G.E. and Probert, M.E. (Eds.), Plant-Soil Interactions at Low pH: Principles and Management. Springer. pp. 201-211.

McWilliam, A. 2000. A plague on your house? Some impacts of Chromolaena odorata on Timorese livelihoods. Human Ecology. **28**(3): 451-469.

Merz, J., Nakarmi, G., Shrestha, S.K., Dahal, B.M., Dangol, P.M., Dhakal, M.P., Dongol, B.S., Sharma, S., Shah, P.B. and Weingartner, R. 2003a. Water: A Scarce Resource in Rural Watersheds of Nepal's Middle Mountains. Mountain Research and Development **23**: 41-49.

Merz, J., Nakarmi, G. and Weingartner, R. 2003b. Potential Solutions to Water Scarcity in the Rural Watersheds of Nepal's Middle Mountains. Mountain Research and Development. **23**: 14-18.

Rai, R.K. and Scarborough, H. 2015. Nonmarket valuation in developing countries: incorporating labour contributions in environmental benefits estimates. *Australian Journal of Agricultural and Resource Economics*. **59** (4): 479-498.

Rai, R.K., Scarborough, H., Subedi, N. and Lamichhane, B. 2012. Invasive plants – Do they devastate or diversify rural livelihoods? Rural farmers' perception of three invasive plants in Nepal. *Journal for Nature Conservation*. **20**(3): 170-176.

Reardon, T. and Vosti, S.A. 1995. Links between rural poverty and the environment in developing countries: asset categories and investment poverty. World development. **23**: 1495-1506.

Saxena, K.G., Rao, K.S., Sen, K.K.C., Maikhuri, R.K. and Semwal, R.L. 2002. Integrated Natural Resource Management: Approaches and Lessons from the Himalaya. Ecology and Society 5.

Scherr, S.J., White, A. and Kaimowitz, D. 2003. A New Agenda for Forest Coservation and Poverty Reduction: Making markets Work for Low-Income Producers. Forest Trends, Washington D.C.

van Wesemael, B. 1993. Litter decomposition and nutrient distribution in humus profiles in some mediterranean forests in southern Tuscany. Forest Ecology and Management. 57: 99-114.

Varughese, G. and Ostrom, E. 2001. The contested role of heterogeneity in collective action: some evidence from community forestry in Nepal. World development. 29: 747-765.