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Working Paper, No 88–14

Demand for Watershed Services: Understanding Local Preferences through a Choice Experiment in the Koshi Basin of Nepal

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Published by the South Asian Network for Development and Environmental Economics (SANDEE)
PO Box 8975, EPC 1056, Kathmandu, Nepal.
Tel: 977-1-5003222 Fax: 977-1-5003299

SANDEE research reports are the output of research projects supported by the South Asian Network for Development and Environmental Economics. The reports have been peer reviewed and edited. A summary of the findings of SANDEE reports are also available as SANDEE Policy Briefs.

National Library of Nepal Catalogue Service:

Demand for watershed services: Understanding local preferences through a choice experiment in the Koshi Basin of Nepal

(SANDEE Working Papers, ISSN 1893-1891; WP 88–14)

ISBN: 978-9937-596-18-3

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September 2014

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SANDEE Working Paper No. 88–14

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SANDEE is financially supported by the International Development Research Center (IDRC), The Swedish International Development Cooperation Agency (SIDA), the World Bank and the Norwegian Agency for Development Cooperation (NORAD). The opinions expressed in this paper are the author's and do not necessarily represent those of SANDEE's donors.

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Contents

Abstract

In this study, we undertake a choice experiment in order to identify differences in local demand for watershed services in the Koshi basin of Nepal. We first examine the possibility of using a non-monetary numéraire to estimate household willingness-to-pay for watershed services. Survey results indicate that while some 50% of the population is willing to pay in monetary terms for environmental services, this number goes up to 75% when asked to contribute in labor time. Social benefits from environmental services are 1.4 to 2.2 times higher in labor hours relative to benefits estimated in monetary terms. Thus, in developing countries, households are more likely to express their demand for watershed services by offering their time rather than making a monetary payment. Our results also suggest that locational differences matter. Down-stream community members, who practice commercial vegetable farming, have a higher demand for watershed services and are willing to pay a third more than upstream farmers for these services.

Key words

choice experiment, labor contribution, mode of payment, opportunity cost of time, watershed services.

Demand for watershed services: Understanding local preferences through a choice experiment in the Koshi Basin of Nepal

1. Introduction

This study estimates demand for watershed services in the Koshi river basin of Nepal, where water in the dry season is scarce and forest products are increasingly in short supply (Merz et al., 2003b). Watershed services are important for rural households to maintain their agriculture and forest based livelihoods (Bhandari and Grant, 2007; Merz et al., 2003a). 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 (Bhandari and Grant, 2007, Barnett et al. 2005, (Dongol et al., 2005) Our study is part of a program organized by the International Center for Integrated Mountain Development (ICIMOD) to enhance community resilience to climate change through sustainable management of ecosystem services. As part of this effort, we sought to examine demand for watershed services and understand how households perceive the need for different services and the trade-offs among them. (Bhandari and Grant, 2007; Dongol et al., 2005).

In this paper, a choice experiment was used to examine differences in demand for local environmental services among downstream and upstream watershed users. This study also probe how demand changes based on whether villagers are asked to pay for these services in cash or in kind. Finally, because the labor market is lean in rural Nepal, this study estimates the opportunity cost of labor using non-market valuation techniques and use this information to derive social benefits from conserving local environmental services. The authors are hopeful that this information will feed into better management of watershed programs in the Koshi River Basin.

2. Literature Review

Given the multiple environment-development problems faced in developing countries, it is important to identify appropriate policy instruments for better managing environmental services. Non-market valuation techniques are one set of tools that can be used to estimate the net-benefits from policy and management changes to different users. However, their use to identify demand for services and appropriate payment mechanisms is often limited in developing economies because of low household income and the non-monetized nature of sub-economies (Bennett and Birol, 2010).

Generally, willingness-to-pay (WTP) for environmental services is positively associated with household income (Lehtonen et al., 2003; Martínez-Alier, 1995). Thus, in low income economies, with informal non-monetized activities, survey-based mechanisms to identify demand, and taxes or monetary fees for service use, can encounter a high proportion of protest votes (Bennett and Birol, 2010). Further, in regions where many transactions are not monetized, asking people how much they are willing to pay for a good or a service can be confusing and can result in in-correct estimates of value (Alam, 2006).

In order to better understand the demand for environmental services among cash constrained households, some valuation studies have attempted to use labor time as a numéraire to determine WTP (Eom and Larson, 2006; O'Garra, 2009; Rai and Scarborough, 2013). Community based natural resource management with labor contributions is a common resource management strategy in many developing countries, including Nepal (Maskey et al., 2006). Households, even in the most remote rural areas, understand how much their labor is worth. This makes labor contribution a good measure for understanding rural peoples' interest in and their willingness to underwrite natural resource management. Benefits from programs and policy interventions can first be identified in terms of time spent, and, WTP, elicited in time, can be monetized using wage rates (O'Garra, 2009).

However, challenges remain with using labor time to value benefits. For instance, aggregating individual WTP to estimate social benefits is not straightforward because the opportunity cost of time varies across individuals and situations. To address this concern, researchers have used non-market valuation techniques to identify the shadow value of time for conservation activities. Eom and Larson (2006), for example, used contingent valuation in South Korea to estimate the value of time when studying water quality improvements. Similarly, Rai and Scarborough (2013) used a discrete choice experiment (DCE) to estimate the shadow value of time spent in invasive plant management in Nepal. But the issue of whether estimated WTP is sensitive to the mode of payment – monetary or non-monetary – is yet to be answered, which is the main focus of this study.

3. Study Area

Nepal is geographically segregated into the high mountains, the middle-hills and the Terai or the low plains. This study was carried out in the Jhikhu Khola Watershed area in the middle hills of central Nepal. As shown in Figure 1, water in this catchment area drains into the Indrawati River, which is part of the Koshi river basin. 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[1] and the Dhulikhel Municipality of Kavrepalanchok District, while forest patches are managed by some 29 community forest user groups (CBS, 2012; IUCN, 2007).[2] 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). Discussions with local villagers suggest that 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 Kathmandu, 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). Besides, population growth has also augmented demand for drinking water. Local communities also perceive that the upstream Chirpine plantations and unplanned road construction have contributed to erosion and water depletion.

In addition to water scarcity, villagers' are facing a decline in the supply of forest products such as fuelwood, fodder and leaf litter. Most households in rural Nepal depend entirely on fuelwood for cooking and heating, fodder is essential for feeding livestock and leaf litter, in combination with manure, is used to support agriculture (Adhikari et al., 2004). However, forest degradation has led community forest user groups to limit access to forests for collecting these products. 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 including *Lantana camara* and *Eupatorium adenophorum* that 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).

Local communities are beginning to feel the pressure of declining water and forest resources. A common understanding among development practitioners is that integrated watershed management can offer some remedies. This approach seeks to increases the availability of ecosystem services by balancing ecological, economic and social dimensions of watershed management(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.

[1] This is the lowest local unit of political governance.
[2] Group of villagers living close to the forest organized to primarily manage village 'common' forests in Nepal.

4. Choice Experiment

To understand the nature of the local demand for watershed services in the Koshi river basin, we undertook a discrete choice experiment (DCE). The DCE sought to answer two questions: whether household willingness to pay for watershed services changed when households were asked to make labor contributions rather than pay cash. And, whether demand for improved watershed services differed for different categories of users, particularly for downstream versus upstream users. The goal was to improve watershed management by providing village leaders and government and non-government agencies with nuanced information on local demand and preferences.

4.1 Theoretical Background

DCEs build on the theory that consumers derive utility from the characteristics of goods rather than goods per se (Lancaster, 1966). Individuals maximize utility by selecting the best among different alternative options, which represent hypothetical outcomes of a proposed program. Alternatives are made up of a set of attributes, which in turn are differentiated by levels.[3] Therefore, choice is a function of attributes presented in multiple choice sets. In our case, the program under consideration was a plan for watershed management and the set of alternatives included different levels of forest and water services and associated fees or labor contributions.

In a DCE, the utility derived by individual (*i*) from an alternative (*j*) is not limited to the attributes (*x*) given in the experiment. Several unobservable factors can influence utility, which are captured by a random part (ε). Consistent with random utility theory (Hensher et al., 2005), the random and unobservable term is assumed to enter the utility function additively. Therefore, individual (*i*)'s utility (*U*) from alternative *j* is expressed as follows:

$$U_{ij} = x_{ij} + \varepsilon_{ij} \qquad (1)$$

In order to ensure internal consistency, a DCE contains multiple choice sets. Each choice set includes the status quo, representing no change in the prevailing levels of different attributes (*x*), and two (or more) hypothetical alternatives; noting that each alternative identifies different levels of a number of attributes. Therefore, individual (*i*) selects alternative *j* over alternatives *j'* when expected utility (*U*) is greater than expected utility from all other options (*U*). The probability (*Pr*) that individual *i* will choose alternative *j* over other alternatives *j'* in a complete choice set *R* is given by:

$$Pr(j \setminus R) = Pr\{(Uij > Uij', s.t. \forall j' \in R, \text{ and } j \neq j')\} \qquad (2)$$

In order to identify the most preferred alternative, equation (2) can be econometrically estimated based on responses to a household or individual survey. Assuming that the error term is identically and independently distributed (iid) and indirect utility (V) is linear in attributes (x), equation (2) can be estimated with a conditional logit (CL) model (McFadden, 1974). The CL model is expressed as:

$$V_{ij} = ADC + \beta_{ij} \qquad (3)$$

Where, *V* refers to indirect utility obtained by the i^{th} individual for the j^{th} alternative and βis the coefficient of the attributes (*x*) included in the experiment. The alternative specific constant (ASC) captures the effect of unobservable factors on the selection of alternatives relative to the status quo. In this analysis, ASC is a dummy variable that is coded as 1 for two hypothetical alternatives in the choice set, and 0 for the status quo.

A random parameter logit (RPL) model can also be estimated by relaxing some of the constraints associated with the *iid* assumption in the CL model. In the RPL model, the observed component (βx) is decomposed into two parts: the sum of the population mean (Υ) and individual deviation of the random parameter (η). 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. The RPL model is expressed as:

$$V_{ij} = ASC + \Upsilon x_{ij} + \eta x_i + \gamma s_i \qquad (4)$$

[3] The utility from an alternative is expected to vary with a change in the levels of attributes. For instance, the likelihood of selecting specific alternatives increases with increases in the level of positive attributes (for example, improvements in drinking water, irrigation water and forest products). On the other hand, the probability of selecting specific alternatives decreases with increase in the level of negative attributes (for example, water pollution, costs of management or participation fees).

4.2 Selection of attributes

The first step in conducting a DCE is to identify different attributes, their status and trends (Bergmann et al., 2006). In order to establish those attributes of watershed services that were important, we undertook five 'Focus Group Discussions (FGDs)' in the study area. The FGDs – three in downstream and two in upstream areas – were carried out with community forest users during August 2013. Focus group 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 were asked about two different modes of payment: (i) a watershed management fee, and (ii) labor contributions. FGD participants identified the minimum (2 days per year) and maximum time (10 days per year) they could put into watershed management activities. These declared working days were monetized based on the prevailing local wage rate (NPR[4] 300/day) to establish different levels of watershed fees in monetary terms.

To identify a concrete plan for improving watershed services and to clarify that local labor participation would be required for implementing this plan, 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.

4.3 Experimental Design

Designing an experiment generally involves identification of choice sets made up of optimal combinations of attributes and their levels. Since each of the five attributes had several levels, combining these into a limited number of choice sets or combinations of alternatives is not easy. For this purpose, we used the Ngene (1.0.1) software[5] that is often used for generating experimental designs. Using this software, 20 choice sets were created using D-efficient design. Each choice set included two policy alternatives (Alternative 1 and Alternative 2) plus the status-quo. Rrespondents were asked to pick one alternative out of the three for each choice set that they were offered.

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 2) and asked to choose one option (either the status quo or one of the two alternatives) from each card. Thus, each respondent made four choices. The cards were visual depictions of choices and used pictures and bars (as shown in Figure 2) and included different levels of the same five attributes: irrigation water, drinking water, fuelwood collection, leaflitter collection and a payment (either in labor or cash in the form of a watershed management fee). In addition to the differing choice scenarios, respondents were provided with socio-economic and forest and water use information.

4.4 Survey implementation

Once the scenarios and choice sets were created, face-to-face interviews were carried out with 600 households, 300 each from upstream and downstream areas, between August and October 2013. In both upstream and downstream areas, respondents were divided into two equal groups, based on the mode of payment (labor or

[4] NPR = Nepalese Currency, USD 1~ NPR. 100 (November 2013 exchange rate)
[5] Ngene 1.0.2 is software for generating experimental designs for CEs. It was developed by ChoiceMetrics.

cash). Thus, 300 respondents faced 4 choice scenarios with a cash payment and 300 respondents faced the same 4 choice scenarios, except that they were asked if they would contribute their labor for watershed management. Respondents in the labor group were informed that their participation in watershed management activities would be as per the annual watershed management plan rather than cash payments.

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 sub-units called *wards*[6] of different village development committees were randomly selected. From these *wards*, 30 households for labor and 30 for watershed fee were selected.

In each *ward*, the first household was selected randomly and then its closest neighbor was identified. The first household received the choice set with the cash choice, and the second, the labor alternative. Using this paired approach, every 6th household (and neighbor) was interviewed on both sides of a street (taking into account some scattered houses as well).7 The available head of household (male or female) was interviewed.

5. Results and Discussion

We discuss the results from our survey below. Since each respondent was asked to respond to four choice sets, there are 2,400 (600x4) observations in the data set.

5.1 Sample characteristics

Table 2 presents basic socio-economic information and compares the monetary versus labor cohorts as well as upstream and downstream households. As the table indicates, the average respondent in our survey was 45 years old and had less than three years (primary school) of education. Our respondents were largely smallholder farmers, farming on less than 0.26 ha of irrigated plus 0.32 ha of un-irrigated land. The average household had a little over one unit of livestock. Household size is about 4.5 members per family. Fifty six per cent of the survey respondents were male.

The respondents were somewhat evenly divided between upper caste and lower caste households. In both payment cohorts, indigenous people were 48 per cent, Brahmin/Chhetri 47 per cent, and Dalit five percent.8 The distribution is similar in the upstream and downstream sub-samples and is representative of the ethnic composition in the district (Central Bureau of Statistics, 2013).

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 per cent of the households have pit toilets, while six per cent practice open defecation. In general, this area is representative of rural forest-dependent agricultural communities in Nepal (Karmacharya, 2012).

Table 2 shows that there are no major differences between the different sub-populations sampled. There are, however, small but significant differences in the average size of irrigated landholdings between downstream and upstream households. Similarly, unirrigated landholdings and drinking water demand differ when the monetary cohort is compared with the non-monetary cohort.

5.2 Household perceptions regarding trends in locally important services

A majority of households perceive that watershed services (except for forest condition) have declined over the past five years (Figure 3). There is almost a consensus that water availability has decreased in the area. Households state that road construction, population growth and reduced rainfall are major causes of water scarcity. While almost half of the respondents think forest condition has improved due to the involvement of communities in

[6] Local political unit. Usually, one village development committee comprises of nine wards.

[7] Enumerators visited villages in pair – one with choice sets that elicited cash contributions and another with sets that elicited labor contributions.

[8] In Hindu Caste system, Bhramhin and Chhetri are higher castes and Dalit is untouchable caste.

forest protection, they also suggest that the availability of forest products has decreased. Some 56 per cent of the respondents indicated that the planted stands of pine contribute to a decrease in the supply of water and forest products.

In the study area, the average water requirement for household use is 259 liter per day. Table 3 presents information on the availability of water and time trends in forest product collection. As Table 3 shows, on average, households collect 139 liters and 195 liters water during the dry and other seasons (winter and rainy) respectively. Average irrigation water availability, seven months per year, is not sufficient to fulfill farming requirements. Based on respondents' judgment, available irrigation water meets 49 and 59 per cent of household requirements in the dry and other seasons respectively. In addition, based on household recall, forest products collection time (excluding travel time) per trip appears to have increased compared to five years ago (Table 3). Forest products collection time is consistently higher in the dry season compared to the other seasons. In general, Figure 3 and Table 3 both suggest that households face difficulties in accessing water and forest products in the dry season, in particular, and certainly perceive that resources have become scarcer over time.

5.3 Modeling household choices – cash versus labor contributions

The DCE responses were analyzed separately, first for the monetary and labor cohorts, and then for downstream and upstream users. All respondents were asked a follow-up question to see if they preferred an alternate mode of payment. In the monetary cohort, over 50 per cent of the respondents said they preferred to contribute in labor terms; while in the labor group only 24 per cent respondents expressed their preference to pay in monetary terms.[9] This result suggests that rural households have a strong preference for labor payments, i.e. participation in watershed management activities would significantly drop if households were asked to make payments for watershed services in monetary terms. This result corroborates existing literature that suggests that eliciting WTP in labor terms reduces the protest bids in low-income communities (Hung et al., 2007; O'Garra, 2009; Rai and Scarborough, 2013).

The data on choices were analyzed using two models – conditional logit (CL) and random parameter logit (RPL) (see Table 4). In these regressions, the dependent variable is *choice* – out of three alternatives in each choice set, the selected alternative is coded as 1 and other two alternatives are coded as 0.

The CL model presented in table 4 (column 1 & 3) shows the importance of different attributes in explaining choices of respondents across three alternatives. In the RPL model, we introduce socioeconomic variables. This is because individual characteristics including age, education, demand for services and income variables including house type and farm size can influence the selection of alternative services (Rai and Scarborough, 2013; Sangkapitux et al., 2009). By allowing socio-economic variables (respondent's age, traditional house, irrigated land, drinking water demand and family size) to interact with the ASC and selected attributes (see Table 4), we try to identify the sources of heterogeneity in decisions respondents make related to attributes.

Table 4 shows the results for the CL and RPL models for both modes of payment. In the CL probabilistic model, the estimated coefficients can only be interpreted in terms of sign and significance. The coefficients of attributes in all models have the expected signs and are significant. This suggests that these variables are relevant for explaining respondent behavior and the choices they made. Table 4 indicates that farmers prefer increased amount of water (drinking and irrigation), leaf litter and firewood, while they prefer to pay less in terms of watershed management fee or in terms of labor contribution. This confirms the internal validity of the choice experiment.

The RPL coefficients (columns 2 and 4 of Table 4) are outcomes from several estimations after 500 random draws (Hensher et al. 2005).[10] The attribute *drinking water* was estimated as a random parameter with a normal distribution, while all other attributes are treated as non-random parameters. Both RPL models are statistically

[9] In the labor cohort, only one respondent (~0.33% of total respondents) selected the status quo in all choice scenarios, while sixteen (5 percent) selected the status quo in the monetary cohort. The respondents who selected the status quo stated that the government should pay for watershed management.

[10] Following Hensher (2005), the models were first estimated with all attributes, except the payment attribute, considered as random parameters. Then, parameters with insignificant standard deviations were re-estimated as non-random parameters. The models were estimated assuming different distributions of attributes and their combinations. This process of re-estimating models with different combinations of distributions was repeated several times and the distribution of parameters eventually selected based on the model fit.

significant with Chi-square statistics of 833.28 and 865.50 for the monetary and non-monetary cohorts respectively, with 17 degrees of freedom and very low p-value. The pseudo R2 ranges from 0.175 to 0.232 for the monetary and labor time cohorts respectively. In the RPL models, attributes have similar signs in both cohorts and resemble the results of CL models.

Table 4 RPL results show that in most cases, socio-economic variables have similar effects in the two cohorts. For instance, the age of respondents is negatively associated with selecting alternatives in both the labor and monetary cohorts. This suggests that older respondents may be less willing to move away from the existing scenario relative to younger respondents. This result is in line with previous studies that show that younger respondents prefer improved environmental conditions (Carlsson et al., 2003; Lehtonen et al., 2003).

Availability of irrigated land is an influential variable in explaining people's preferences. Respondents with larger irrigated lands are more likely to select alternatives with higher levels of irrigation water availability. Interestingly, respondents in the monetary cohort with larger farm (irrigated) land prefer alternatives with a higher monetary fee, while respondents in the labor cohort with larger farms do not prefer the option of higher fees. Further, the coefficient on irrigated land is negatively significant for the labor cohort. Thus, in the labor cohort, respondents with more irrigated land are less likely to choose alternatives to the status quo compared to their neighbors. This suggests that households with larger farm sizes may be willing to pay a watershed management fee but are more labor constrained.

Some socioeconomic variables have significant effects on one cohort but not on other cohort. For instance, respondents with a higher drinking water demand select alternatives to the status quo more frequently in the monetary cohort. However, in the labor cohort demand for drinking water does not influence choice. Similarly, preferences among men and women related to forest services are different in the two cohorts. For example, in the monetary cohort, female farmers are more likely to select alternatives with more fuelwood (relative to males). This makes sense because women are the main collectors and users of fuelwood in rural Nepal (Maskey et al., 2006) and may want more fuelwood even when confronted with the idea of paying a monetary fee for watershed management. In the labor cohort, female respondents select alternatives with more leaf litter more frequently than their male counterparts.

Respondents with traditional houses select alternatives more frequently compared to their neighbors with concrete houses in the labor cohort. But, this coefficient is not significant in monetary cohort. Thus, less wealthy households more actively seek alternatives if they are allowed to contribute in labor time (Rai and Scarborough, 2013).

5.4 Estimation of willingness-to-pay

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

There are two types of attributes in the model – random and non-random. The implicit price for non-random parameters is estimated as a negative ratio of coefficients between the non-random attribute and the cost attribute. In the case of a random parameter, the implicit price (IP) of attribute *k* is estimated using following equation:

$$IP_k = -(\beta_k + \sigma_k \times \varphi_k) / \beta_c \qquad (5)$$

where, β and β are coefficients of *drinking water* and *water fee* respectively, σ is the estimated standard error of *drinking water*, φ is a draw from the standard normal distribution (Hensher et al., 2005).

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

$$CS = \frac{1}{\beta}\left[\ln\left(\sum_{j \in R} exp\,(V)\right) - \ln \sum_{j \in R} exp\,(V)\right] \qquad (6)$$

Where, CS is compensating surplus, also referred to as household WTP (WTP), V is utility in the current situation and V is utility in the new situation. The CS is the change in utility from moving from the current situation to the new scenario.

As previously noted, the ‘status quo’ situation and elements of the proposed program are reported in Table 1. The new watershed management scenario reflects a *minimum* set of outcomes expected from implementing a watershed plan over a ten year period. This scenario assumes that each household would, on average, see an increase in 10 liters of water for household use per day during the dry season, an increase in irrigation water by one additional month, one extra basket of leaf litter per day during the forest opening period (1 month) and one additional *bhari* of fuel wood per year. Equation (6) reflects household benefits will all of these benefits are in place.

Table 5 presents estimated implicit price of each attribute for the monetary and labor cohorts. The confidence intervals for the implicit prices of attributes were estimated using the Wald procedure and these parameters are significant at the 5 per cent level. WTP is estimated for each additional unit of each attributes – one additional liter of drinking water per day during the dry season, one more month of irrigation water, one more basket of litter collection per day for a month, and one bhari increase in fuelwood collection during the collection season.

Examining column 1 in Table 5, respondents, on average, are willing to pay NPR 29 per year for one additional liter of drinking water per household per day during the dry season. This means that households are willing to pay NPR 290 per year for an additional 10 liters of water each day. They are willing to pay more than NPR 1,444 per year for an additional month of irrigation. Leaf litter is closely associated with agriculture and native broad leaved vegetation, and 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.[11] Respondents are willing to pay approximately NPR. 117 per *bhari* or head load fuelwood. This value is higher than what households pay their forest user groups as fees for fuelwood collection but lower than the market price.[12]

The estimated average annual WTP per household or benefits from moving from the current to the new watershed management scenario is, at a minimum, NPR 3,136 (USD 31) for the monetary cohort and 13 days of labor contribution for the labor cohort. This amounts to approximately two per cent of average annual household income in the rural hills of central Nepal.[13] If the value of time (13 days) is converted using the market wage rate (NPR. 300 per day), the WTP of households for the labor cohort in monetary terms would be NPR. 3,900 (USD 39) per year.

In order to estimate the social benefits from the project, we identify the shadow price of time. The opportunity cost of respondents’ time to participate in watershed management activities can be estimated as a ratio between households’ WTP in monetary terms and labor terms for a given expected outcome (Eom and Larson, 2006). This estimated shadow value of time for watershed management activities is NPR. 241 (USD 2.41) per day, which is 80 per cent of the current market wage rate. The estimated opportunity cost of time is similar to that of Korean households for water quality improvements (Eom and Larson, 2006). However, it is substantially higher than the estimated opportunity cost of time in Nepal’s low lands for forest management activities, which is 47 per cent of the market wage rate (Rai and Scarborough, 2013). There might be two reasons for the higher estimates in our study area. First, this study area serves as a pocket for vegetable farming, making the opportunity cost of labor higher (Karmacharya, 2012). Second, the previous results from Rai and Scarborough (2013) were based on demand for subsistence products, whereas this study includes commercial demand for water as well.

Using the average WTP, the social benefits from the improved watershed services are estimated using the following formula:

$$\textit{Social benefits}_m = WTP_{hh} \times \textit{population} \times p_m \qquad (7)$$

[11] One basket or sack of leaf litter is approximately 20 kg, which can produce around 8 kg compost. In the local market, the price of chemical fertilizers (Urea) is NPR. 20 per kg. Though, as a substitute of chemical fertilizer, the WTP for leaf litter is lower than the market price of fertilizer, converting leaf litter into compost require resources and time.

[12] Forest users currently pay a fee of NPR. 20 per bhari to their forest user groups, while the price for fuelwood in the local market is NPR. 500 per bhari.

[13] The estimated annual household income in the given region is NPR. 189,754. (Central Bureau of Statistics, 2011. Nepal Living Standards Survey 2010/11: Statistical Report Volume Two in: Central Bureau of Statistics, N.P.C.S., Government of Nepal (Ed.), Kathmandu .

Where *m* refers to the mode of payment (labor or monetary) and *p* is the percentage of household with a particular WTP and population is the total number of households in the watershed area.

We calculated *p* excluding protest respondents. In this analysis, protest respondents are those who: (i) select the status quo in all four scenarios, and (ii) prefer another mode of payment when asked a follow up question. In our sample, 16 respondents (5%) in the monetary cohort and only one respondent (~0.33%) in the labor cohort preferred the current situation in all four choice scenarios indicating that the government should pay for watershed management. Furthermore, 50 per cent of households in the monetary scenario preferred to make labor payments and 24 per cent of households in the labor cohort preferred to make monetary payments. Thus, all these households were considered as protest respondents.

After taking protest bids into account, we calculate that 23 per cent of households in the labor cohort and 50 per cent of households in the monetary cohort were actually willing to pay in monetary terms for watershed improvements. Similarly, 72 per cent of households in the labor cohort and 50 per cent of households in the monetary cohort were willing to pay in labor terms.[14] These numbers allow us to establish the lower and upper bounds for social benefits. Thus, as shown in Figure 4, the upper bound for annual social benefits in terms of labor payments is NPR 24,538,881 (USD 245,389), which is based on the assumption that 72 per cent of the population obtains an annual average benefit of NPR 3,136 (USD 31 per household) from improved watershed services. In the estimations shown in Figure 4, labor contributions are converted to monetary terms using the estimated shadow value of time.

Figure 4 clearly shows that along with encouraging participation in watershed management activities, allowing households to contribute in labor time increases the estimation of social benefits from watershed management by 1.4 to 2.2 times. Thus, social benefits from the watershed project are, at a minimum, 40 per cent higher if households are asked to contribute in time relative to a situation where they are asked to make monetary payments. Social benefits, at a maximum, are more than twice as high if payments are required to be made in labor terms rather than monetary terms.

Figure 4 also shows the present value of benefits estimated for a 10 year period using a 10 per cent discount rate. The estimates indicate that lower bound of social benefits estimated in labor terms equals to the upper bound of social benefits estimated in monetary terms. The estimated maximum social benefit in labor terms is significantly higher than the maximum social benefit estimated in monetary terms.

5.5 Differences in up-stream and downstream locations

In order to better understand upstream and downstream dissimilarities in the watershed, though no distinct differences were found during focus group discussions, respondents in the monetary cohort were divided into two groups (upstream and downstream) based on their location. We focused on the monetary cohort exclusively because there is no significant difference between upstream and downstream community in labor cohort.

Table 6 presents RPL models estimated separately for upstream and downstream respondents. As Both RPL models are statistically significant with Chi-square statistics of 307.24 and 594.25 for upstream and downstream cohorts respectively with 17 degrees of freedom and very low p-value. The pseudo R2 ranges from 0.13 to 0.26 for upstream and downstream samples.

As per our expectations, respondents in both locations prefer watershed alternatives that offer an increase in drinking water, irrigation water, leaf litter and fuelwood and a lower management fee. Upstream and downstream respondents are quite similar in that various indicators of capital assets (education, type of house, land holding size) make no difference to preferences in either location. In both locations, households with high water use demand prefer alternatives to the status quo more frequently compared to respondents with lower water demand.

There are, however, differences in the determinants of preferences in upstream and downstream locations. Family size, for instance, has dis-similar effects. Upstream respondents with larger families were more likely to choose an

[14] The estimated number of households having WTP in monetary terms are between 2,471 and 5,437, and households prefer to contribute in labor terms are between 5,473 and 7,824.

alternative to the status quo, while the opposite is true in downstream areas. In upstream areas, large families tend to dwell at further distances from the community forest. The distance between forest and user homes can have a substantial influence how communities use resource (Varughese and Ostrom, 2001). In order to secure resources for their use, distant users may select alternatives with improved watershed services more frequently compared to neighbors living close to forest.

Another interesting locational difference is seen in the effect of age on choices. Younger people are more likely to select alternatives compared to their older counterparts in upstream areas, but this variable is not significant in downstream areas. Interestingly, a previous study in the lowlands of Nepal indicated that older people have a higher WTP for forest management compared to their younger counterparts (Rai and Scarborough, 2014). The contrasting result in our study could be because young people in our area are engaged in commercial farming close to the capital city.

Households with larger landholdings prefer alternatives with more irrigation water in upstream areas; while this coefficient is not significant in downstream areas. Another difference is with female respondents – in downstream areas they are more likely to select alternatives with more fuelwood, but this variable is not a significant in upstream areas. This reinforces our understanding that downstream areas are more fuelwood constrained and women, who are the main collectors of fuelwood, perceive this constraint strongly relative to their male counterparts.

Table 7 presents the implicit prices and their confidence intervals for each attribute for downstream versus upstream users. The estimated implicit prices indicate that downstream households have a higher WTP for all attributes included in the experiment, except for drinking water. This is likely because most of the downstream households have access to piped drinking water while upstream households do not.

The estimated average household WTP for the new watershed management program is NPR. 3,268 (USD 33) for upstream users and NPR. 4,486 (USD 45) for downstream households, which is 1.37 times of 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. This difference in demand for services suggests that there may be some potential for schemes, such as payment for ecosystem services that involve trade between downstream and upstream users of watershed services.

6. Conclusions and Policy Recommendations

Our choice experiment suggests that surveys that identify WTP for environmental services in non-monetary terms can provide reliable estimates of household demand for environmental programs in developing countries. High protest rates for any proposed fees for environmental services can be circumvented by improving research design and using a non-monetary numéraire such as labor.

The choice of the numéraire is important for assessing the economic viability of rural projects. In this study, social benefits from watershed management are 1.4 to 2.2 times higher when estimated in labor terms versus monetary terms. If subsistence farmers are not allowed to express their willingness to pay in non-monetary terms then the implementation costs of environmental programs may outweigh the benefits generated from the program. As a result, environmental programs may receive too little attention in policy decisions, and, ultimately, compromise the welfare of households in subsistence communities (Costanza et al., 2007) .

Besides estimating the value of watershed management strategy, our study also identifies the value of individual services. These values can be used to estimate benefits from specific watershed management strategies, such as improvements in irrigation water, other attributes remaining constant. Households in our study area are willing to pay the most for irrigation water, followed by leaf litter production – both these inputs contribute to commercial farming.

The study also highlights differences in preferences for watershed services among households. For instance, younger respondents are more likely to prefer alternatives to the status-quo when compared to their older counterparts. Also the benefits from watershed services are much higher for downstream users compared to upstream households. This suggests that participation in watershed activities may increase if government programs exploited this information on differential preferences. Our results also reinforce the understanding that gender is an important consideration in assessing demand for forest products such as fuelwood and leaf litter.

Acknowledgements

This study is a product of a joint project between South Asian Network for Development and Environment Economics (SANDEE) and International Center for Integrated Mountain Development (ICIMOD) as a part of the Himalayan Climate Change Adaptation Programme - HICAP. HICAP is implemented jointly by ICIMOD, CICERO, and GRID-Arendal in collaboration with local partners and is funded by the governments of Norway and Sweden. The views and interpretation in this publication are those of the authors and should not be ascribed to SANDEE, ICIMOD or their donors.

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Tables

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.	• as much as now (100 liter/day/hh)*, • twice as much as now (200 liter/day/hh), • thrice as much as now (300 liter/day/hh)
Irrigation water	The number of months during which the irrigation water is available for farming.	• as much as now (8 months)*, • 10 months, • 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).	• as much as now (1 sack per day)* , • twice as much as now (2 sacks per day), • 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).	• as much as now (20 bhari)1* , • 30 bhari, • 40 bhari
Labor contribution OR Watershed management fee	Number of working days households are willing to participate to implement the watershed management plan annually. This is obligatory and households have to participate according to the operational plan. OR 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.	A. Labor contribution • no additional contribution* • 2 days, • 6 days , • 10 days OR B. Management fee • No additional fee*, • NPR. 600, • NPR. 1,800, • NPR. 3,000.

* Levels used in status quo (current situation).

Table 2: Socio-economic characteristics of respondents (standard error in parentheses)

Characteristics	Description	Mode of payment (n= 600)			Location (n=300)		
		Monetary cohort	Non-monetary cohort	P-value	Upstream	Downstream	P-Value
Age	Average age of respondent in year.	45.97 (15.59)	44.14 (16.02)	0.55	45.28 (15.59)	46.67 (15.61)	0.43
Education	Average education of respondents in year.	2.88 (2.32)	2.97 (2.07)	0.36	2.75 (2.14)	3.03 (2.48)	0.33
Family size	Average number of member per family.	4.48 (2.01)	4.36 (2.03)	0.73	4.71 (2.13)	4.26 (1.87)	0.15
Irrigated land	Average size of irrigated land holdings per household in ha.	0.26 (0.22)	0.25 (0.22)	0.83	0.17 (0.16)	0.27 (0.25)	0.00
Unirrigated land	Average size of unirrigated land holdings per household in ha.	0.29 (0.30)	0.32 (0.33)	0.00	0.29 (0.27)	0.24 (0.30)	0.27
Livestock unit	Average size of livestock holdings per household.	1.37 (1.01)	1.22 (1.01)	0.59	0.88 (0.89)	1.01 (1.26)	0.34
Drinking water demand (Liter)	Average daily required amount of water for household use per family	283 (184)	236 (168)	0.00	276 (175)	291 (196)	0.75
Traditional house	Number of households having traditional house. Household having traditional house is coded as 1 and other households as 0.	269 (89%)	249 (83%)		141 (94%)	121 (85%)	

Note: P-value indicates the mean difference test between sub-samples from the corresponding mode of payment and location respectively.

Table 3: Water Use and Forest products collection time (hour/trip) in the study area (standard error in parentheses)

	Forest products			Water	
	Fuelwood (hour/trip)	Fodder (hour/trip)	Leaflitter (hour/trip)	Household use (Liter/day)	Irrigation (% of requirement)
Dry Season (February-May)	2.56 (1.25)	2.10 (1.05)	1.93 (1.05)	139.72 (148.77)	49.43 (34.12)
Other Seasons (June – January)	2.21 (1.15)	1.87 (1.22)	1.82 (1.23)	195.03 (191.44)	59 (37.55)
5 years ago	1.89 (1.07)	1.55 (0.97)	1.49 (0.90)	-	-

Note: standard deviations in parentheses.

Table 4: Results of conditional logit (CL) and random parameter logit (RPL) models

Variables	Monetary		Labor Time	
	N=1196		n = 1198	
	1	2	3	4
	CL	RPL	CL	RPL
ASC	-8.76e-2 (6.85e-2)	-5.89e-2 (8.73e-2)	-0.451*** (6.92e-2)	-0.238 (0.226)
Drinking water	6.16e-3*** (4.38e-4)	8.49e-3*** (1.09e-3)	1.15e-2*** (6.83e-4)	1.62e-2*** (3.51e-3)
Irrigated water	0.467*** (2.32e-2)	0.558*** (6.35e-2)	0.630*** (3.38e-2)	0.887*** (0.179)
Leaf litter	0.351*** (4.37e-2)	0.496*** (0.102)	0.815*** (6.23e-2)	0.889*** (0.227)
Fuelwood	2.12e-2*** (4.14e-3)	4.51e-2*** (1.03e-2)	7.04e-2*** (6.19e-3)	5.82e-2*** (2.19e-2)
Fee	-2.49e-4*** (3.61e-5)	-3.87e-4*** (8.45e-5)	-3.25e-2*** (1.21e-2)	-0.154** (6.18e-2)
Age		-1.89e-2** (7.57e-3)		-7.31e-2** (2.89e-2)
Traditional house		-0.731 (0.458)		4.494*** (1.484)
Drinking water demand		3.84e-3*** (1.17e-3)		9.33e-3 (6.49e-3)
Irrigated land * irrigation water		2.06e-2*** (7.73e-3)		3.32e-2* (1.09e-2)
Irrigated land * fee		2.24e-5* (1.16e-5)		-1.59e-2* (9.04e-3)
Male * leaflitter		-2.06e-2 (8.47e-2)		-0.360** (0.179)
Male * fuelwood		-1.81e-2** (9.25e-3)		-1.30e-2 (1.99e-2)
Irrigated land		-9.46e-2 (9.26e-2)		-0.463** (0.196)
Family size		5.35e-2 (5.71e-2)		0.754 (0.515)
Education		3.49e-2 (6.70e-2)		0.176 (0.241)
Standard deviations of random parameter				
Drinking water		7.80e-3*** (2.45e-3		2.85e-2*** (7.34e-3)

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

Table 5: Estimated implicit price of each attribute and their confidence intervals at 95%

Attributes	Monetary (NPR)	Labor time (Days)	Monetary value of IP in labor (Col 2 × market wage rate in NPR)
	(1)	(2)	(3)
Drinking water	29.37 (22.93-35.81)	0.11 (0.065-0.15)	33.00 (19.65-46.35)
Irrigation water	1,443 (1,132-1,754)	5.76 (3.79-7.73)	1,728 (1,137-2,319)
Leaf litter	1,283 (854-1,712)	5.77 (2.92-8.62)	1,731 (876-2,586)
Fuelwood	116.75 (75.40-158.10)	0.38 (0.20-0.56)	114 (60-168)

Table 6: Results of RPL models (upstream and downstream sub-samples of monetary cohort)

Variables	Coefficients (Upstream)	Coefficients (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. Standard errors in parentheses.

Table 7: Implicit prices (NPR) and their confidence intervals (in parentheses) of (upstream and downstream sub-samples of the monetary cohort

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)

Figures

Figure 1: Map of the study area

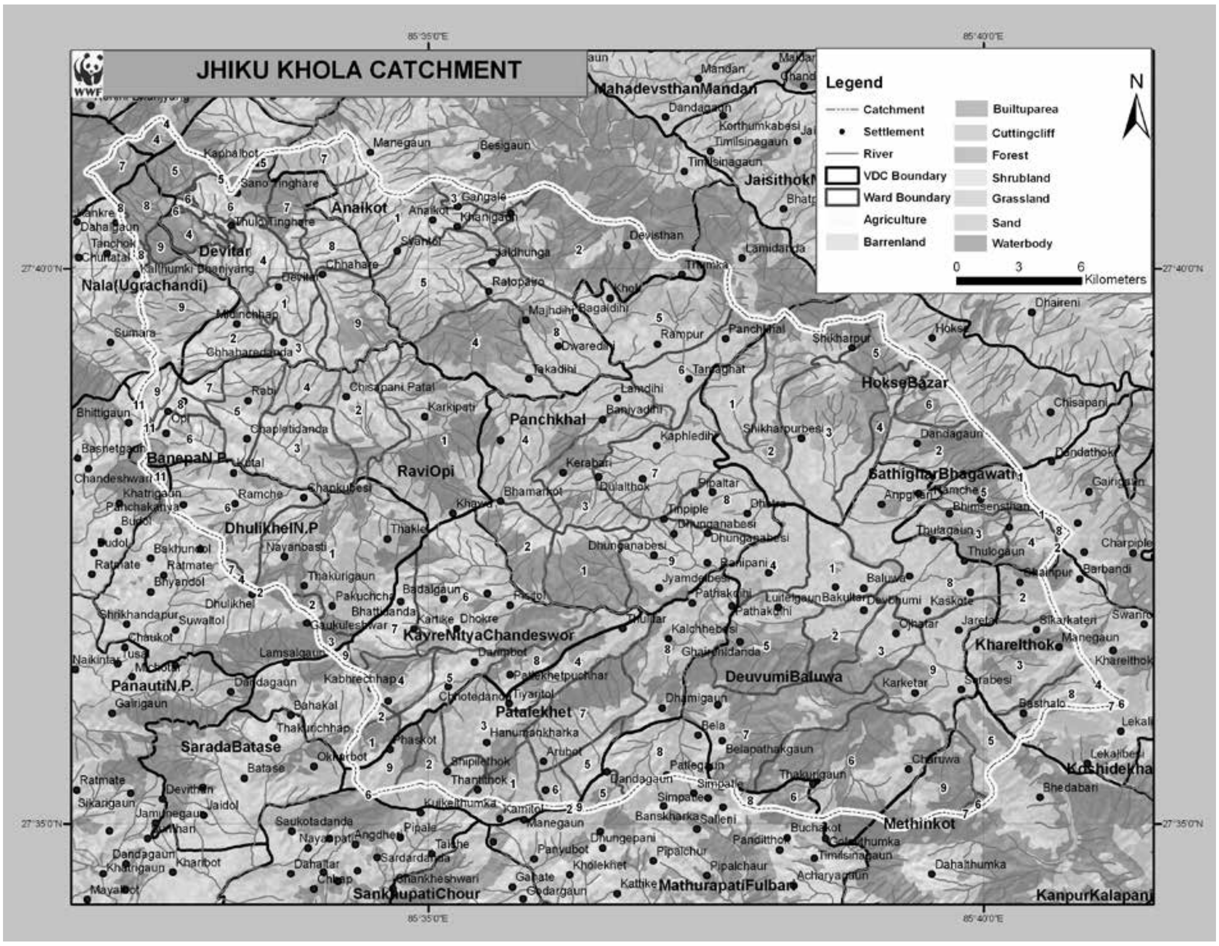
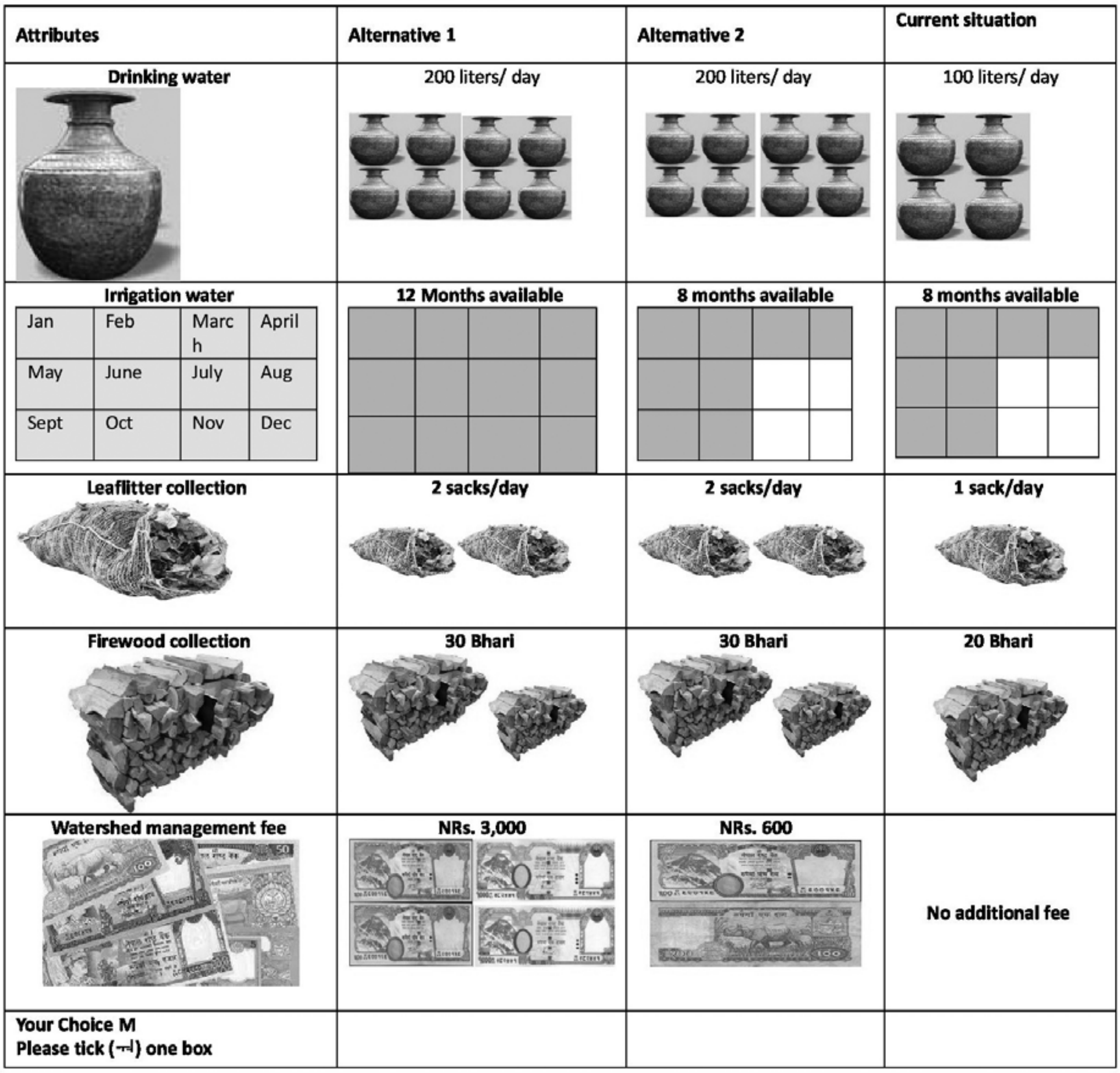


Figure 2: An example of choice set



Attributes	Alternative 1	Alternative 2	Current situation
Drinking water	200 liters/ day	200 liters/ day	100 liters/ day
Irrigation water Jan Feb Marc h April May June July Aug Sept Oct Nov Dec	12 Months available	8 months available	8 months available
Leaflitter collection	2 sacks/day	2 sacks/day	1 sack/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 3: Household perceptions on changes in watershed services relative to five years ago (% of households)

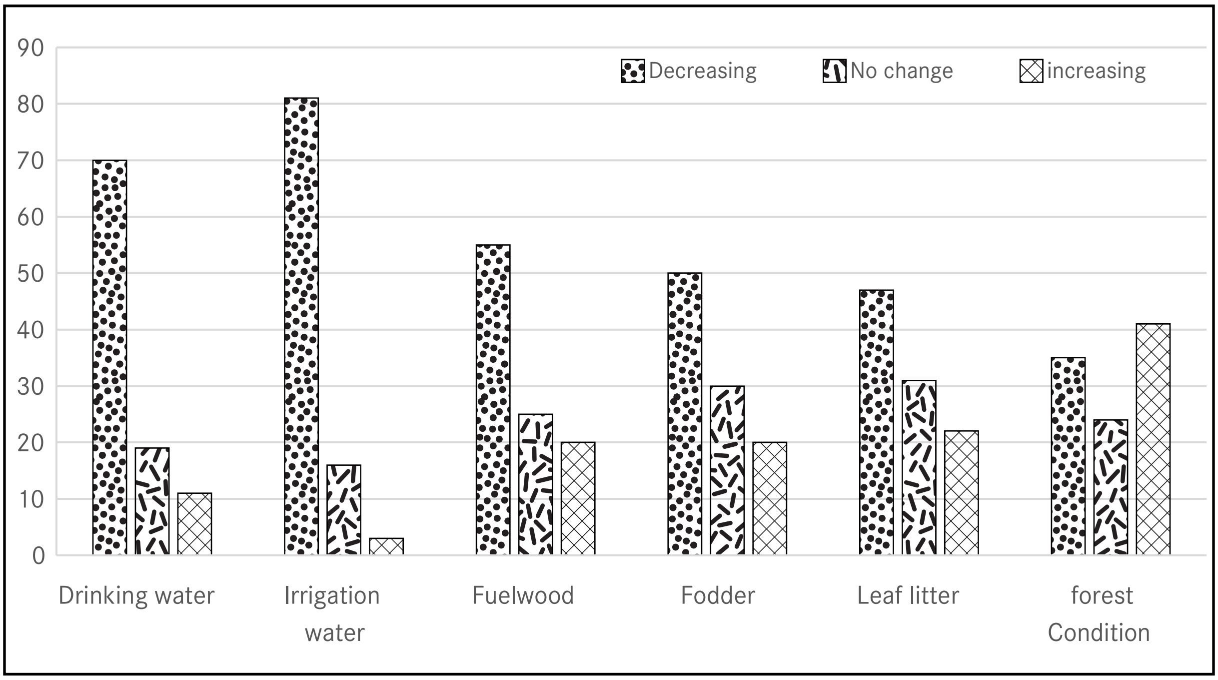
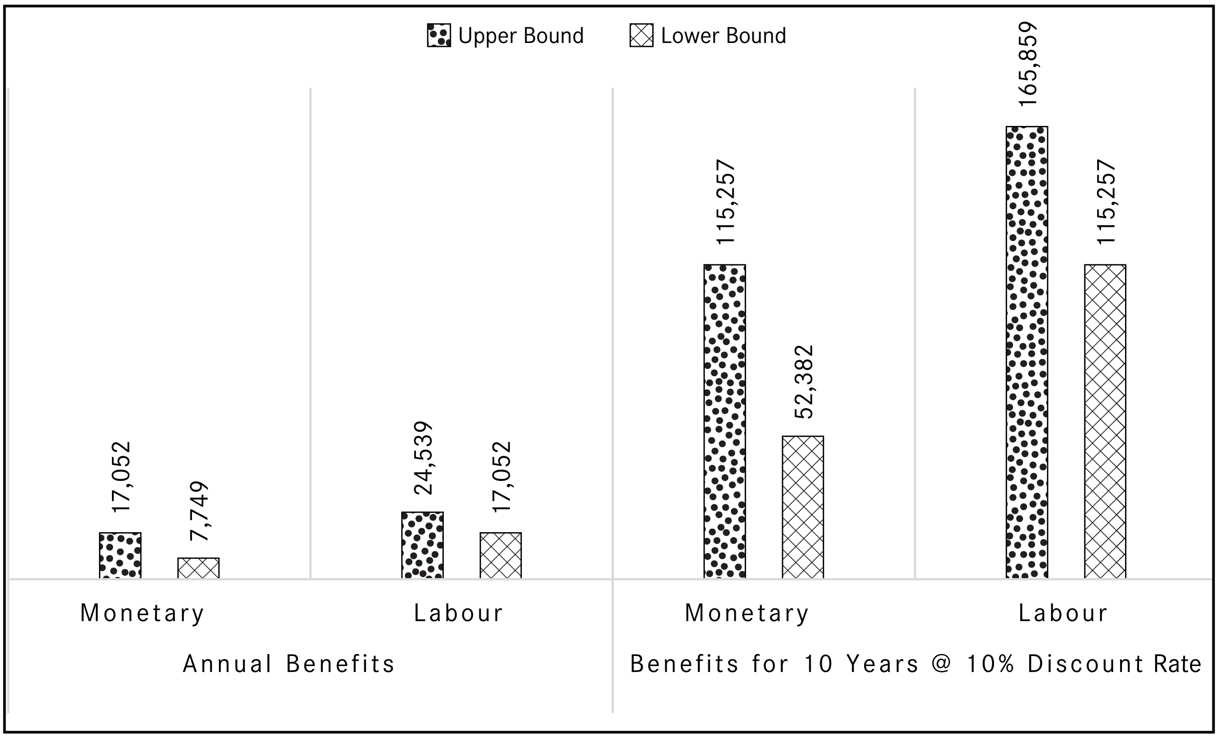


Figure 4: Estimates of Social Benefits if payments are made in labor or monetary terms (NRs in '000)



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