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Analysis

Valuing the Environmental Costs of Local Development: Evidence From Households in Western Nepal

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ABSTRACT

Environmental quality is rarely prioritized along the development pathways of developing countries, even though little is known about how individuals in these settings value intact environments. In 2017, we conducted a survey with a representative sample of 3660 households living throughout the Karnali and Mahakali River Basins in Western Nepal. As part of the survey, respondents were asked about how they use environmental services and participated in a double-bounded, dichotomous choice contingent valuation exercise designed to elicit their ability and willingness to pay (WTP) for a land conservation program that would prevent future development in and around their villages. We estimate the average monthly WTP for land conservation to be 202 NRs (US$1.96) and a lower bound of monthly household WTP to be 165 NRs (US$1.60). We find that households with higher levels of education exhibit higher willingness to pay; as do male respondents. We also find a significant negative relationship between household WTP and both migration and local NGO familiarity.

1. Introduction

Environmental quality is often considered a luxury good. The environmental Kuznets curve (EKC) provides a conceptual underpinning for this idea: At low levels of development, environmental quality is high; as development progresses, so too does environmental degradation up to a point where society deems environmental quality a priority and environmental conservation commences (Grossman and Krueger, 1995; Kuznets, 1955). The EKC does not provide the only potential relationship between environmental quality and economic development; rather, it describes a commonly-observed correlation. Between the increasingly evident consequences of global exploitation of natural resources and the continued reliance on these for subsistence and livelihood among individuals in developing countries, however, there surfaces the possibility that an EKC-like relationship between environmental quality and economic development may be–whether voluntarily or by necessity–shifting (Stern, 2004). Payment for ecosystem services schemes, conservation area designations, and initiatives taken by communities to sustainably manage natural resources all demonstrate efforts to reduce environmental degradation (Edmonds, 2002; Ferraro et al., 2012; Whittington and Pagiola, 2012). That we observe these initiatives in developing countries points to this potential recalibration of the relationship between environmental quality and economic development. They also suggest an important role for environmental quality valuation to support resource management decision-making, particularly in places where such valuation may be difficult to elicit or currently unknown.

In this context, a general lack of understanding of the value of environmental quality and intact, undisturbed lands contributes to the challenge of effectively implementing and enforcing effective conservation policies (Ferraro et al., 2012; Whittington and Pagiola, 2012). Nunes and van den Bergh (2001) argue that traditional stated preference valuation methodology may be ill-suited to ecosystem valuation in such contexts due to a lack of adequate information among respondents; Barkmann et al. (2008) demonstrate, however, that including contextual factors and social norms within stated preference valuation elicitation instruments can minimize information bias in value estimates. In this paper, we contribute to this debate by using the contingent valuation (CV) method to derive estimates of willingness to pay (WTP) for environmental conservation in Western Nepal.[1] Furthermore, the richness of our household-level data allows us to provide preliminary evidence on the correlations between environmental

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[1] We characterize environmental conservation as efforts to promote forest conservation to prevent additional deforestation and development of undisturbed lands.

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quality valuations and household characteristics, focusing on property rights, community resource management, environmental shocks, and migration–all of which are highly relevant in Western Nepal. We rely on empirical evidence from a representative sample of households living in the Karnali and Mahakali River Basins in Western Nepal.

Several characteristics of Western Nepal make this location particularly relevant for expanding the literature on valuing environmental quality in developing countries. First, Nepal's water and forest endowments are among the country's most valuable resources, which establishes the relevance of the research questions in this setting (Edmonds, 2002; WECS, 2005). Second, Western Nepal is the least developed region of the country and development plans place high importance on utilizing its vast hydropower potential for both rural electrification and energy export (WECS, 2005). Thus, Western Nepal appears poised to embark on a development trajectory, the shape and consequences of which remain unclear. Without environmental quality valuation, the full costs of environmental degradation associated with infrastructure and other development initiatives are difficult to identify, leaving open the possibility of economic development pursuit without full consideration of its potential environmental consequences. In particular, the opportunity cost of land development is likely to be underestimated (Jeuland, 2010; Jeuland and Whittington, 2014).

The rest of the paper is structured as follows. Section 2 discusses relevant literature. Section 3 contextualizes the setting, outlines the structure of the survey instrument, and provides descriptive statistics for the sample. Section 4 presents the empirical methods applied in the analysis. Section 5 provides the results of the analysis. Finally, Section 6 concludes with a discussion of the results and their policy implications.

2. Existing Literature

While applications of nonmarket valuation techniques to elicit valuation for environmental quality in developed countries abound (Adamowicz et al., 1997; Bhat, 2003; Font, 2000; Hanley et al., 2003), a targeted review of stated preference techniques for environmental quality valuation in resource-constrained settings reveals a large gap in the literature.[2] Ferraro et al. (2012) and Whittington and Pagiola (2012) provide reviews of forest ecosystem valuation and watershed management and conservation, respectively, finding limited results relevant for policy application within the existing literature. Ferraro et al. (2012) argue that although ecosystem services have received significant research attention in the most recent decade, the failure to include valuation within the policy evaluation framework has led to disjointed analysis that communicates neither the value of environmental quality among individuals in developing countries nor the efficacy of conservation policies. Among the literature that does exist in developing country settings, valuation of environmental quality follows traditional nonmarket valuation patterns; that is, revealed preference applications use travel cost assessments or use values for national parks, conservation areas, and ecotourism as a means for valuation (Ellingson and Seidl, 2007; Navrud and Mungatana, 1994), while stated preference applications assess survey data for insight on non-use values (Barkmann et al., 2008). While evidence from both categories is limited, applications of stated preference methods in developed country contexts are particularly scarce.

There are several potential explanations for this lack of sufficient evidence on environmental quality valuation in developing countries. First, as Nunes and van den Bergh (2001) argue, the ecological mechanisms underpinning environmental quality can be challenging to understand even among the most well-informed of respondents. Thus, elicitation of valuations in resource constrained settings where environmental quality information is generally inaccessible can yield results that are of questionable relevance. Yet, assuming away indigenous knowledge about the environment seems problematic. Barkmann et al. (2008) empirically test the concerns of information and methodological misspecification biases using a choice experiment in rural Indonesia and find that respondents are highly attuned to their ecological surroundings. The authors conclude that careful valuation elicitation design informed by extensive *ex ante* study contextualization and field testing of stated preference survey instruments can overcome potential bias and yield more accurate estimates of the value of environmental quality in information-constrained settings. Second, standard concerns about yea-saying, hypothetical bias, strategic behavior, and framing yielding biased valuations from stated preference methods remain problematic within the context of environmental quality valuation (Diamond and Hausman, 1994; Hausman, 2012). These concerns notwithstanding, stated preference techniques remain the only option to elicit non-use values, which is particularly important for environmental quality valuation. Thus, there is considerable space in the literature for stated preference elicitation of the nonmarket value of environmental quality in a developing country context (Arrow et al., 1993; Carson, 2000; Whittington, 1998).

3. Reseach setting and data

3.1. The Karnali and Mahakali River Basins

Both geographical and man-made boundaries divide Nepal into a country of distinctive regions. North-to-south, Nepal has three geographic zones–the northernmost high Himalayas, the central mid-hills, and the southern Terai; east-to-west, Nepal has five development regions–the Eastern, Central, Western, Mid-Western, and Far-Western Development Regions. Along the north-to-south dimension, livelihood activities vary with terrain, with most agricultural production occurring in the fertile and irrigable flatlands of the Terai and small-scale agriculture dominating the hill and mountain zones. Although engagement in the agricultural sector dominates occupations and livelihoods, temporary and seasonal migration as well as a growing tourism industry supplement livelihoods, especially for those residing in less agriculturally-favorable terrain (Bohra-Misra, 2013; Mahajan et al., 2013; Massey et al., 2010).

The setting for the study, the Mid-West and Far-West Development Regions of Nepal, is an area rich in natural resources but poor in economic development. The Karnali and Mahakali Rivers flow through these regions and a variety of lands are deemed important for environmental and biodiversity reasons (Baral, 2007). Although ecosystem protection has risen in priority at both the central and regional levels (WECS, 2005), a lack of knowledge regarding the value of environmental quality among inhabitants of the region presents a challenge in the crafting, implementation, and enforcement of environmental policy. Given the region's high development potential and this increasing environmental prioritization, there is a uniquely relevant opportunity to implement stated preference environmental quality valuation techniques that would support current policy making.

The survey that yielded the valuation data analyzed in this paper took place during June and July of 2017 in the Karnali and Mahakali River Basins, the two westernmost river basins in Nepal. Fig. 1 provides a map of these river basins. The project area spans over 46,000 square kilometers (km^2) within Nepal and is home to over 2.6 million inhabitants (Khatiwada et al., 2016; Pandey et al., 2010; WECS, 2005).[3]

[2] Studies that consider WTP for environmental quality in developing countries among respondents (tourists) from developed countries also exist, see Baral et al. (2008).

[3] Neither the Karnali nor Mahakali River Basin falls entirely within Nepal's administrative boundaries. Six percent of the Karnali River Basin lies in Tibet; 66% of the Mahakali River Basin in India (WECS, 2005). The portions of these river basins outside of Nepal's administrative boundaries were not included in the survey.

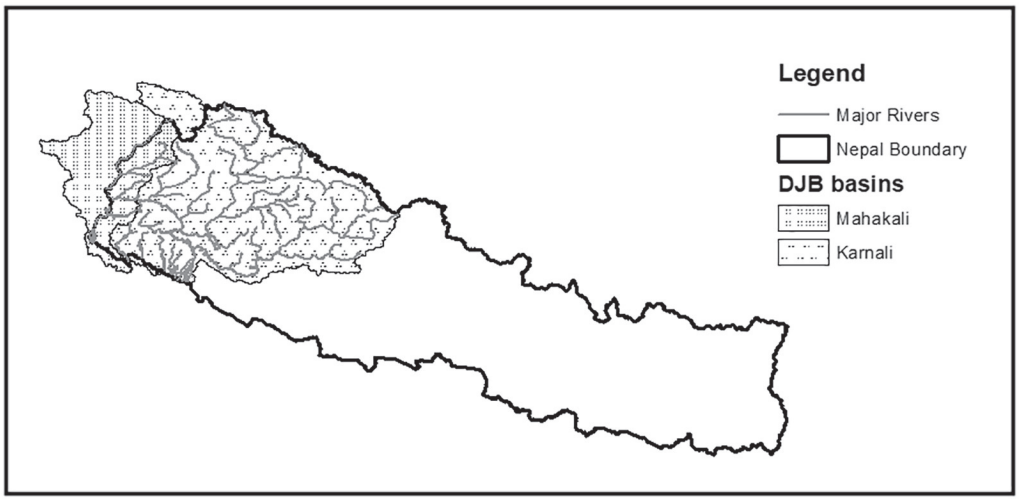

Fig. 1. Map of Karnali and Mahakali River Basins, Western Nepal.

The region is predominately rural and agrarian, with cultivation of paddy, maize, barley, millet, potatoes, and other vegetables among the most important contributions to local economies, livelihoods, and food security. In addition to agriculture, reliance on forest resources including fodder for livestock, firewood, medicinal herbs, and spices is common throughout the region. As both agriculture and natural resources contribute in vital ways to sustaining households and communities throughout Western Nepal, tradeoffs arise in land and resource use. Policies and initiatives at both central and local levels have addressed such tradeoffs; however, these remain controversial.[4] It is within this context that we seek to provide insight into how inhabitants of the Karnali and Mahakali River Basins value environmental quality.

3.2. Survey Instrument

The survey instrument was designed to collect information on livelihood practices, natural resource reliance, and economic activities from a representative sample of respondents residing in the region. The survey had ten sections. Section one collected locational data, obtained informed consent, and gathered demographic information about the respondent. Section two compiled a household roster containing demographic information about all individuals residing in the household.[5] Section three gathered information about land tenure, rental, and any land-related transactions in the previous ten years. Section four assessed living standards and asset ownership, spanning livestock, sanitation facilities, sources of drinking water, and fuel access, among others. Section five determined natural resource use and perceptions of natural resource quality and introduced the CV scenario used to assess WTP for environmental quality. Section six collected data on irrigation and other agricultural technologies. Section seven detailed crop production. Section eight gathered information about agricultural training and credit opportunities available to the household. Section nine outlined income and expenses. Finally, section ten recorded external shocks and household adaptation. The survey took between 45 and 60 minutes to complete, with the contingent valuation portion requiring about 15 minutes of this time.

3.2.1. Contingent Valuation Questionnaire

The CV portion of the questionnaire was designed to gauge interest in participation in local forest and land conservation efforts. We adhered to survey best practices for eliciting WTP from respondents, using a double-bounded, dichotomous choice questionnaire format (Arrow et al., 1993; Hanemann et al., 1991). After describing the relationship between limiting deforestation and environmental quality, enumerators asked respondents if they would vote to support establishment of an NGO-managed fund for maintaining forested areas in their community (i.e., avoiding future development of forest land), to which all community members would be required to contribute a fixed monthly amount.[6] Respondents received randomized initial bids for monthly fund contributions from a set of four different prices.[7] If respondents replied affirmatively to the initial bid, they received a follow up question with a payment option that was double the initial bid; if respondents replied negatively to the initial bid, they received a follow up question using a payment option that was half the initial bid.

The CV questionnaire contained several *ex ante* design elements and *ex post* checks intended to minimize potential bias. Before the initial bid question, respondents had multiple opportunities to ask questions about the presented scenario. Furthermore, we utilized a "cheap talk" script to remind respondents of the importance of accurate responses.[8] Finally, enumerators reminded respondents of their budget constraints several times and used visuals to convey and reinforce key elements of the valuation scenario. After the valuation questions, the script contained several debriefing questions to assess respondents' understandings of

[4] At the central level, irrigation infrastructure determines water resource availability in some areas and preservation and conservation area designations disallow the conversion of forest lands. At the local level, farmer managed irrigation schemes and irrigation, water, and forest user groups provide systems and enforcement mechanisms for communities to manage their own resources (WECS, 2005).

[5] Temporary and permanent migrants supporting the household through regular remittance payments were included in the household roster.

[6] The CV question reads: "Suppose a local NGO were to manage a special fund for natural land preservation. This would be funded by a required monthly contribution from each household in the community that would be collected and kept by the local NGO. The local NGO would use the money in this fund to preserve/protect areas of your community that have not yet been converted for agriculture. Your community would have the opportunity to work with the local NGO to decide which areas should be preserved under this fund. Specifically, this fund would be used to compensate people who want to and have the right to develop that land, so that they do not develop it. Keeping in mind your household budget and the potential impacts of this proposal, would you vote to support a household contribution of [80/150/250/350] rupees each month to fund this land preservation fund?".

[7] The initial bids were 80, 150, 250, and 350 Nepalese Rupees, which correspond to 0.78, 1.46, 2.43, and 3.40 US Dollars using the exchange rate prevailing at the time of approximately 103 NRs = 1 USD.

[8] "Cheap talk" scripts are intended to inform respondents of the consequences of stating a response that differs from their actual valuation. Cummings and Taylor (1999) demonstrate this strategy is effective in reducing some types of response bias.

the CV exercise. Respondents stated their certainty about their responses to each valuation question as well as answered an open-ended question to explain the rationale for their response.

Pilot testing of the CV script and broader survey during focus groups and enumerator training informed the design of the final survey instrument and selection of the payment vehicle-a community-mandated contribution to an NGO fund based on the results from a local vote.[9] Given the limited previous work in valuing environmental quality in a developing country context, this piloting was essential and informative in framing the CV scenario to make it relevant and appropriate for inhabitants of Western Nepal. Pilot testing strengthened the relevance of the initial bids, payment vehicle, visual aids, and scenario structure of the CV script for our sample population in Western Nepal.[10]

3.3. Survey Implementation

The representative sample of the Karnali and Mahakali River Basins was drawn based on a multi-step sampling procedure. First, the entire region was divided into five river basins, the Karnali Main, Bheri, Seti, Mahakali, and Mohana.[11] Each river basin was further divided according to Nepal's three geographical zones–mountain, mid-hill, and Terai–yielding twelve clusters.[12] Based on the population of each cluster, Village Development Committee (VDC) wards were randomly selected for fieldwork. The final sample included 122 such VDC wards.

Enumerators randomly selected thirty households from each VDC ward through a systematic procedure whereby a central landmark was selected and every *n*th household was selected for the survey.[13] Households were eligible for the sample if they were a permanent resident of the ward and if the chief wage earner or alternative knowledgeable household member was available and willing to participate.[14] Enumerators revisited households when respondents were available to maintain the sampling procedure; in cases where a household failed to meet the inclusion criteria or refused to participate, the next neighboring household was selected in its place. Enumerators received training in the sampling procedure and survey context and participated in pilot testing prior to the initiation of fieldwork.[15] The final sample of respondents comprised 3660 households living in the 122 selected VDCs.[16]

[9] We tested alternative payment vehicles, including local and regional taxes, during the pilot testing. At pilot sites, respondents were wary of the government's ability to enforce and maintain such a program, leading to the selection of the mandatory, monthly payment to a local NGO fund as the payment vehicle in the main study.

[10] For example, bids were determined by analyzing pilot test results (sample size $n = 100$) that included bids both higher and lower than the bids used in the study. Nearly 100% of respondents in the pilot survey responded affirmatively to a bid of 40 NRs; and only 13% responded affirmatively to a bid of 600 NRs. As the dichotomous choice format necessitated second round bids that doubled and halved the initial bids, we considered initial bids between 80 and 350 NRs to provide a reasonable range. Four bids were selected to maintain sufficient sample size at each initial bid for analysis.

[11] The Bheri, Seti, and Mohana are all sub-basins of the Karnali; given the population distribution we designated sub-basins for the sampling procedure.

[12] There are no Terai wards in the Bheri and Seti sub-basins and no mountain wards in the Mohana basin, leaving twelve clusters.

[13] Determination of n depended on the number of households in a given VDC ward: $n = (number\ of\ households)/30$.

[14] Respondents living in the ward for at least one year were considered permanent residents.

[15] The training contained specific emphasis on the CV script. Enumerators practiced with trainers, among themselves, and in pilot testing prior to participating in fieldwork.

[16] Given the sampling strategy and desired sample size of 3660 households, households that were approached and unwilling to participate were replaced by neighbors. There were few refusals reported by the survey team; however, as household refusal and replacement was not recorded in the final dataset, the refusal rate is unknown.

3.4. Descriptive Statistics

Table 1 reports descriptive statistics of the respondent and household characteristics of the sample; descriptive statistics are reported for each basin individually as well as the entire sample. Panel A provides the measures relating to survey respondents. Enumerators attempted to interview the chief wage owner, yielding a sample that was majority male and where the average respondent age was 40.

Panel B reports household-level descriptive statistics. We observe the highest educational level within households to be either some secondary education or completion of secondary education, demonstrating that many households have at least one member who has attended secondary school. Households have, on average, less than one member under the age of 5 and a total of about 6 members. Drinking water sources vary by river basin, with public and private taps dominating the Karnali and Mahakali Basins and tubewells more common in the Mohana Basin where groundwater is more easily accessible. Latrine access is high throughout the region, demonstrating the effectiveness of sanitation campaigns in Western Nepal. We also see variation in cookstove usage and access to electricity. Traditional cookstoves are particularly prevalent in the Karnali and Mahakali River Basins, where households also have lower access to electricity; liquid petroleum gas (LPG) and biogas cookstoves are more common in the Mohana River Basin.

Migration rates in the region reveal high levels of both temporary and permanent migration as important supplementary sources of employment and household income, which is consistent with the importance of remittances–by some estimates about 30%–in Nepal's GDP (World Bank, 2016). Migration rates are particularly high in the Mahakali River Basin with nearly half of households reporting having at least one migrant household member. Finally, the region is not immune to environmental or economic shocks, with households reporting experience of an average of two shocks in the past five years.[17]

Panel C displays descriptive statistics indicating a high reliance of households within the survey area on natural resources–particularly forest and water resources. Table 1 also reveals high reliance on natural resources within the sample as well as participation in community user groups to maintain and sustain forest and water resources. This reliance comes mainly in the form of subsistence. Over 90% of the sample reports using water and forest resources for consumption while only about 10% reports using these resources for income generation. Nearly 40% of sample households belong to a community user group for forest or water resource maintenance, and many households pay nominal fees for membership in these groups. Finally, households perceive ecosystem quality in their communities as ranging between “fair” and “good” on a scale from “below average” to “excellent”.

4. Empirical Methods

4.1. Analysis of Demand

We evaluate a household's demand for environmental quality through analysis of responses to the double bounded, dichotomous choice CV questionnaire. Demand for environmental quality (E_{ij}) depends on the cost of environmental quality preservation (B), and household characteristics, including both those unique to household i (X_{ij}) and those unique to the area j (Z_j). Thus, we characterize household demand for environmental quality

$$E_{ij} = f(B, X_{ij}, Z_j) \quad (1)$$

The household's WTP for environmental quality is represented by

[17] Shocks may include drought, untimely rains, irregular weather, hail, floods, animal disease, pest damage to crops, and market disruptions, among others.

Table 1
Descriptive statistics.

Variable	Karnali (N = 2250)	Mahakali (N = 600)	Mohana (N = 810)	All (N = 3660)
Panel A: Respondent characteristics				
% male	69.9	72.2	74.2	71.2
Age	42.1 (13.6)	44.1 (13.6)	42.3 (13.0)	42.5 (13.5)
Panel B: Household characteristics				
Highest education[a]	4.7 (1.3)	5.1 (1.4)	5.1 (1.4)	4.8 (1.4)
% children < 5	46.8	40.8	41.0	44.5
Household size	5.8 (2.4)	6.2 (2.6)	6.2 (2.7)	5.9 (2.5)
Drinking water source				
% private tap	14.8	22.7	6.9	14.3
% public tap	49.1	9.0	4.1	32.6
% tubewell	6.6	30.7	86.8	28.3
% river	11.9	4.0	3.2	8.7
% stone tap	18.6	33.3	0.9	17.1
Cookstove type				
% LPG	4.1	8.7	23.7	9.2
% biogas	2.6	11.5	24.4	8.9
% solar	0.2	0	0	0.1
% improved cookstove	13.8	1.2	1.1	8.9
% traditional cookstove	79.3	78.6	50.7	72.9
% Latrine	97.3	95.0	97.0	96.9
% electricity access	41.4	74.5	94.3	58.6
Reported monthly income[b]	19,185 (40,401)	20,620 (27,202)	36,738 (133,139)	23,305 (71,380)
% own land	98.2	96.5	98.4	98.0
% own motorbike	2.3	6.3	15.5	5.9
% own radio	34.7	37.5	17.2	31.3
% own cell phone	87.2	94.2	96.9	90.5
% migrant household member	38.1	45.3	29.9	37.5
Number of shocks	2.3 (1.5)	2.7 (1.8)	1.3 (1.5)	2.2 (1.6)
Panel C: Natural resource reliance				
% use water resources (personal)	90.3	96.7	83.5	89.8
% use water resources (income)	10.6	10.8	26.3	14.1
% use forest resources (personal)	96.8	92.0	83.2	93.0
% use forest resources (income)	7.2	3.7	8.5	6.9
Stated ecosystem quality[c]	0.5 (0.6)	0.1 (0.9)	0.3 (0.9)	0.4 (0.7)
% belong to user group[d]	44.4	23.7	57.5	37.5
User group fees[b,e]	4.8 (37.1)	12.7 (56.3)	6.7 (54.4)	6.5 (45.0)

Source: Authors' calculations.
Continuous variables displayed as mean (standard deviation) unless indicated otherwise.
[a] Refers to highest level of education reported in the household based on the scale: 1 = Illiterate, 2 = Just literate, 3 = Primary school, 4 = Secondary school, 5 = SLC complete, 6 = Intermediate, 7 = Bachelor's degree, 8 = Master's degree, 9 = PhD.
[b] Monetary values reported in Nepalese Rupees (2017 exchange rate of 103 NRs = 1 USD).
[c] Ecosystem quality measured on a scale of − 1 (below average) to 2 (excellent).
[d] Only includes user groups related to natural resources, that is drinking water, irrigation, or forest user groups.
[e] Only includes fees for natural resource-related user groups, zero fees included in calculation.

the area under the demand curve

$$WTP_{ij} = \int_0^{\infty} f(B, X_{ij}, Z_j)dP \quad (2)$$

We estimate the household's demand for environmental quality using a probit specification. This functional form assumes that

$$\mathbb{P}(E_{ij} = 1|\mu, B) = \Phi(\mu^T\beta + \gamma B) \quad (3)$$

where μ is a vector combining X and Z, and Φ is the cumulative distribution function of the standard normal distribution. Using the estimated parameters from the probit regression and assuming an exponential demand curve, we estimate household WTP for environmental quality as

$$WTP_{ij} = -(\alpha + \bar{\mu}^T\beta)/\gamma \quad (4)$$

where α is the regression constant, and $\bar{\mu}$ denotes the mean value of each component of vector μ.

As the WTP estimation in Eq. (4) does not take into account the double-bounded design of the CV questionnaire, we also use a maximum likelihood estimator that uses both the initial and follow up bid values to estimate WTP for comparison. We use the user-generated doubleb Stata command (Lopez-Feldman, 2010) for this calculation. Also for comparison we derive non-parametric estimates of WTP. We calculate the conservative Turnbull lower-bound estimates with 95% confidence intervals following the methods outlined in Haab and McConnell (2002) and the Kriström mid-point estimates with 95% confidence intervals following Kriström (1990) and Vaughan and Rodriguez (2001).

4.2. Linking Environmental Quality Valuation and Household Characteristics

In addition to eliciting WTP for environmental quality, we are also interested in the relationships between household characteristics and environmental valuations. To investigate this relationship, we use a fixed effects, OLS regression approach, estimating

$$PWTP_{ij} = \alpha + \beta A_{ij} + \lambda X_{ij} + \zeta_j + \varepsilon_{ij} \quad (5)$$

The left hand side, $PWTP_{ij}$, is the probability that a household responds affirmatively to the CV questionnaire based on the probit regression specified in Eq. (3). The right hand side includes the same household level (X_{ij}) covariates as included in the above WTP calculations as well as additional household characteristics (A_{ij}) including

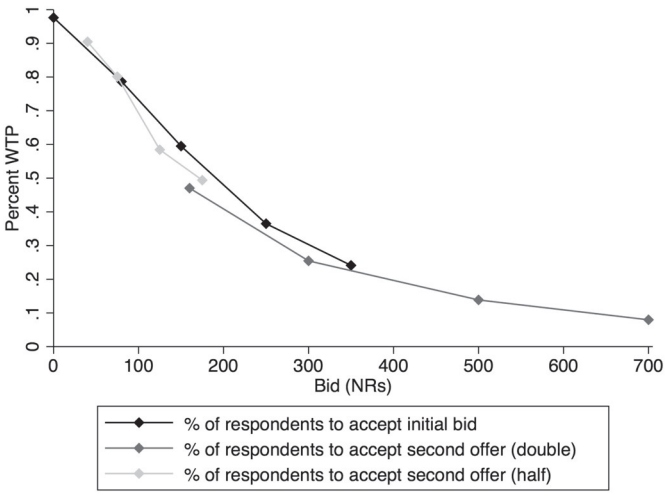

Fig. 2. Demand curve for environmental quality in Western Nepal based on initial and second round bids.

whether or not a household has at least one migrant member, land ownership, environmental shocks faced in the last 5 years, involvement in non-natural resource community user groups, familiarity with local NGOs, and participation in collective action. We also include a VDC-ward fixed effect, ζ_j, in our preferred specification to capture unobserved local factors that may affect the individual valuations within a location.

5. Results

5.1. Demand for Environmental Quality

Households in the Karnali and Mahakali River Basins in Western Nepal expressed their preferences for environmental conservation through their responses to the CV questionnaire. Fig. 2 shows the demand curve derived from responses to both the initial bid presented in the CV questionnaire as well as for the follow up half or double bid offers. Nearly 100% of respondents indicated their support of environmental conservation efforts at a price of zero. Given the tradeoff between environmental quality and development presented in the questionnaire scenario, this result suggests that environmental quality is a priority for respondents, even if it comes at the expense of development opportunities.[18] The derived demand curve demonstrates a mostly linear relationship between WTP for environmental quality and price among respondents in Western Nepal. Furthermore, demand at lower and higher bids, as reflected in the second round offers, largely extends this linear, downward sloping demand for environmental quality. Expanding the range of bids to a lower bound of 40 NRs (half of the lower bound 80 NRs initial bid) and upper bound of 700 NRs (double the upper bound 350 NRs initial bid) demonstrates nearly the entire range of WTP probabilities, from just over 90% of respondents willing to pay 40 NRs monthly for environmental conservation to less than 8% willing to pay 700 NRs.

Of course, Fig. 2 also demonstrates that while many respondents who were given low price bids indicated their willingness to pay for environmental conservation, it is clear that a large proportion of the sample was unwilling to pay the initial bid. While "no" responses can indicate that households' true valuations of environmental conservation are lower than the bid offered, they may also be protest responses (Meyerhoff and Liebe, 2006). To better understand the rationale behind these "no" responses, we consider respondents' specific reasons for being unwilling to pay the offered bid. Following Ramajo-Hernández and del Saz-Salazar (2012), Table 2 reports the reasons given for "no" responses, separated by rationales considered to indicate a true zero response and those considered to indicate a protest vote. Overwhelmingly, respondents cited budget constraints or distaste for monthly contributions as the reason for their "no" response, which we interpret as a true indication of a household's non-WTP at the offered bid. We also find, however, that respondents cite a lack of trust in local NGOs and a belief the proposal would be ineffective at relatively high rates. The latter two "no" responses could be considered protest votes. Importantly, however, respondents were permitted to indicate multiple reasons for their "no" responses. As panel B of Table 2 demonstrates, the prevalence of respondents giving only protest responses was low (only 3.9% of the sample). Furthermore, the near unanimity of respondents supporting the program at a price of zero suggests that many of these potential protests reflected beliefs that benefits would not be sufficient, or costs too high, to justify the bid offers they received. While there is precedent in the literature to omit protest votes from analysis of CV data (Ramajo-Hernández and del Saz-Salazar, 2012), we retain these respondents in our analysis to remove concerns about selection bias. Insofar as the 3.9% of the "no" response sample have actual valuations for environmental conservation, our WTP estimates will be biased downward, which would make them somewhat conservative (Calia and Strazzera, 2001).

Table 2
Reasons for an initial no WTP response.

Reasons	Number (%)
Panel A: Multiresponse rationale	
True zero response	
Land conservation is not a problem	132 (7.2)
Proposal is too expensive	1509 (83.2)
Do not want to contribute monthly	683 (37.7)
Benefits are not worth the cost	249 (13.7)
Protest response	
Do not trust local NGO	213 (11.8)
Proposal will not work	293 (16.2)
Would not benefit from proposal	41 (2.26)
Panel B: Distribution of response	
Only true zero response	1349 (73.6)
Only protest response	71 (3.9)
Both true zero and protest response	413 (22.5)
Total rejection	1834 (50.1)

Source: Authors' calculations.
Percentages calculated among the sub-sample that responded "no" to the initial WTP question. Multiple answers were permitted; distribution of multiple answers reported in Panel B.

Table 3
WTP estimates.

	Turnbull lower bound	Double-bounded MLE
Entire sample (N = 3660)	165.2 [155.0, 174.4]	201.8 [194.2, 209.4]
Karnali Basin (N = 2250)	162.2 [150.0, 174.5]	221.0 [208.7, 233.4]
Mahakali Basin (N = 600)	140.3 [115.3, 161.5]	157.4 [138.3, 176.5]
Mohana Basin (N = 810)	191.7 [169.8, 210.0]	252.1 [211.4, 293.6]
Mountains (N = 797)	210.6 [188.8, 228.4]	276.6 [255.2, 297.9]
Mid-hills (N = 1676)	142.1 [126.6, 157.3]	178.2 [161.0, 195.4]
Terai (N = 1187)	167.3 [150.8, 185.7]	240.8 [218.2, 263.4]

Source: Authors' calculations.
Results reported as mean [95% confidence interval]. Parametric estimates calculated with the following controls: respondent age, respondent gender, highest household education, household size, and presence of children under 5 in household, as well as controls for basin and geographic region, if applicable.

[18] The CV instrument reminded respondents that while the hypothetical conservation program would not alter current land use patterns, it would prevent additional development of forested land for agricultural purposes, roads, etc. As road access is a key factor in market access and economic development, this tradeoff was particularly salient for survey respondents.

Table 3 provides the willingness to pay estimates among the entire sample as well as divided by river basin and geographic region. Column 1 reports the non-parametric Turnbull lower-bound estimates; column 2 the double bounded dichotomous choice MLE estimates.[19] The confidence intervals of the Turnbull lower bounds were calculated using a bootstrapping method.

Among the entire sample, we find a lower bound on monthly WTP of 165 NRs (US$1.60) and an average monthly WTP of 202 NRs (US$1.96) for environmental conservation. Across the basins, these WTP values correspond to about 1% of a household's monthly income. Given the limited resources of many of the inhabitants of the Karnali and Mahakali River Basins, 1% of monthly income suggests a relatively high prioritization of environmental conservation. We see some variation in WTP estimates when dividing the sample by river basin. Valuation for environmental quality is highest in the Mohana River Basin and lowest in the Mahakali River Basin, regardless of the estimation method used. There is also variation in the WTP estimates across the Terai, hills, and mountain zones. Respondents in the mountain regions had the highest monthly WTP for environmental conservation, and respondents in the mid-hills had the lowest. While these results do demonstrate some variation in monthly WTP for environmental conservation based on location and terrain, they also reveal a consistently positive valuation for environmental quality among this representative sample of respondents.

While providing insight into conservation priorities in the Karnali and Mahakali River Basins, it should be noted that the valuation exercise indicates that value conditional on the mobilization of a community-wide conservation effort. Thus, considering the community-level WTP for environmental conservation is informative regarding the scale of conservation that could be feasible in the region. While 30 households from each of the 122 VDCs visited were included in the sample, VDCs vary considerably in both area and population; the smallest VDC has only 124 households, whereas the largest has over 34,000. Thus, comparisons of VDC-aggregated monthly WTP for environmental conservation are skewed based on population size and demonstrate substantial variation. Nevertheless, we find that the median VDC-aggregated WTP for environmental conservation is 32,707 NRs (US$318).[20] Of course, the natural land area available for conservation programs also varies by VDC; however, we can think of these aggregated values as the additional income that development would have to generate to fully compensate for loss of these preserved lands.

Fig. 3 depicts the spatial distribution of WTP for land conservation throughout the Karnali and Mahakali River Basins. Respondents in the mountainous regions of both the Karnali and Mahakali River Basins had higher WTP than those in the hill regions. Respondents in the Mahakali River Basin had lower WTP for land conservation efforts compared to those in the Karnali and Mohana River Basins. This locational variation in WTP demonstrates a need to consider regional heterogeneity in responses, as appropriate policy response may differ by region.

Analysis of the follow up questions included in the CV instrument to check for respondent understanding of the scenario presented reveals additional insight into demand for environmental quality. Over 80% of respondents reported being “very confident” in their responses to the initial bid, even at the maximum bid price of 350 NRs. Furthermore, less than 4% of the sample reported feeling only “somewhat confident”. These confidence checks suggest that respondents understood the scenario and that the questions were salient and realistic. As such, we are fairly confident that hypothetical bias was limited in this context.[21]

We also considered the rationale respondents provided for why they would support the proposal presented in the CV questionnaire. The most common reason respondents supported the proposal, regardless of initial bid price, was to preserve access to forest resources, with nearly 50% of respondents citing this rationale after an affirmative response to the initial bid. Other rationales for an affirmative response included concerns about water scarcity, erosion, and biodiversity preservation.

5.2. Environmental Quality Valuation and Household Characteristics

In addition to locational heterogeneity in WTP among respondents throughout the Karnali and Mahakali River Basins, household characteristics may be related to WTP for land conservation. We consider both standard household correlates of demand–assets, education, and household size–as well as additional variables that we thought would be relevant in this setting–migration, land ownership, experience with environmental shocks, and various forms of community participation.[22]

Table 4 reports bivariate regression results of the probability of a household being willing to pay for land conservation as a function of household characteristics. Each regression is reported with and without VDC fixed effects. Households with at least one migrant household member demonstrate a lower probability of WTP for land conservation programs. This could indicate that such households are more mobile or view migrant family members as a source of income outside of the community and are thus less dependent on natural resources as a form of insurance or less willing to invest in their community.

We also find a positive, statistically significant relationship between the amount of land owned by a household and WTP for environmental conservation. Households owning higher amounts of land in a village may exhibit higher WTP because they are more invested in the village and its resources. Alternatively, these households may have higher wealth, and environmental quality may be a normal good. Similarly, we find a positive, significant relationship between household WTP for environmental conservation and experienced negative environmental shocks. This positive correlation could be indicative of a better understanding among these households of the relationship between environmental degradation and development of natural lands and incidence of environmental shocks (ex., landslides or erosion resulting from road building or deforestation). While these correlations are not significant in all specifications, they are precisely measured in our specification with VDC-ward fixed effects.

We also consider relationships between household WTP for environmental conservation and various measures of community participation. There is a positive and statistically significant relationship between a household's membership in community groups not related to natural resource use or conservation and WTP as well as between stated participation in community collective action and WTP. These relationships provide suggestive evidence that households that participate more in community activities also place a higher value on land conservation. As the benefits of such a program would be shared by the community, these relationships demonstrate consistency between reported behaviors and stated responses to the CV questionnaire. We find a negative, statistically significant relationship between WTP and familiarity with local NGOs, which may reflect a lack of confidence in NGO-implemented conservation programs or a belief that existing NGO

[19] The non-parametric Kriström mid-point estimates and probit results are available in Table A.1 in the Appendix.

[20] VDC-aggregated WTP calculated by multiplying the double-bound dichotomous choice WTP estimate for each basin and geographical region by the population of the VDC.

[21] The same WTP analysis was conducted on the subsample of survey respondents omitting those who reported they were “somewhat confident” (the lowest confidence level provided) as well as on the subsample of respondents who reported being “very confident” (the highest confidence level provided) in their answer. The results using these subsamples were statistically indistinguishable from those using the entire sample population.

[22] We use an asset score as a proxy for socio-economic status in the analysis, as asset ownership remains fairly stable over time, whereas some income measures collected vary throughout the year. The asset score was developed using principle components analysis using roof type, electricity access, and motorbike, livestock, radio, and cell phone ownership.

Fig. 3. WTP for land conservation in Western Nepal. Values calculated using double-bounded MLE parametric approach.

Table 4
Bivariate regression results: WTP probability.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Migrant HH member	−0.066***	−0.027***										
	(0.011)	(0.0092)										
Land owned (ha)			−0.0084	0.025**								
			(0.012)	(0.0099)								
No. of env. shocks					−0.0030	0.007**						
					(0.0045)	(0.0031)						
Community group membership[a]							0.015	0.034***				
							(0.013)	(0.0099)				
Local NGO familiarity									−0.016***	−0.0094**		
									(0.0061)	(0.0042)		
Collective action											0.053***	0.039***
											(0.015)	(0.013)
Constant	0.53***	0.51***	0.50***	0.49***	0.51***	0.49***	0.49***	0.48***	0.51***	0.51***	0.487***	0.49***
	(0.0099)	(0.0035)	(0.011)	(0.0036)	(0.013)	(0.0066)	(0.013)	(0.0059)	(0.011)	(0.0026)	(0.010)	(0.0033)
VDC-ward FE	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Observations	3649	3649	3659	3659	3659	3659	3640	3640	3651	3651	3659	3659
R^2	0.016	0.003	0.000	0.002	0.000	0.001	0.001	0.004	0.005	0.001	0.008	0.004

Source: Authors' calculations. Standard errors, clustered at VDC level, in parentheses.
[a] Only refers to user groups not related to natural resources such as savings groups and women's groups.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

conservation programs already provide the necessary protection in their communities.

While the bivariate results provide insight into reduced form relationships between household characteristics and WTP for land conservation, these correlations are unable to account for the multiple correlated factors that may influence this relationship. Table 5 reports the results of multivariate regressions that control for a more complete set of observable household characteristics. Specifications 1 and 2 provide regression results including a basic set of household characteristics including asset ownership, education, gender, age, household size and composition, and the initial bid; we include VDC-ward fixed effects in the second specification. Households with more educated members and those with younger, male respondents reported higher willingness to pay. Asset ownership (as measured by the asset index) and the size and composition of households do not influence preferences for conservation. The relationships between household WTP for environmental conservation and asset ownership and household size and composition are not precisely measured.

Specifications 3 and 4 in Table 5 include the household characteristics from the bivariate regression analysis as well as some measures of household participation in ongoing conservation efforts. We include the basic set of household controls in both specifications and VDC-ward fixed effects in specification 4. The inclusion of these additional household characteristics does not alter the sign or significance of the relationships observed in specifications 1 and 2. Additionally, we find that payment of higher membership fees for natural resource-related user groups is associated with higher WTP and having a migrant household member, owning land, and familiarity with local NGOs are all negatively associated with WTP. This result demonstrates consistency between stated WTP for environmental conservation and reported conservation-related expenditures. While we do find statistically significant relationships in specification 3, the precision of the estimates is lost with the inclusion of VDC-ward fixed effects. The loss of statistical significance in these specifications is perhaps not surprising given that many of the relevant variables are highly correlated within communities rather than being individual or household-level factors; the fixed effects, therefore, likely absorb these relationships.

6. Discussion

The results of our analysis point to the importance of including environmental priorities in development planning for Western Nepal. While households and villages want access to roads and the economic activities afforded by markets, our results reveal that environmental

Table 5
Multivariate regression results: WTP probability.

	(1)	(2)	(3)	(4)
Asset score[a]	0.0011	0.00021	−0.0011	0.00025
	(0.0041)	(0.00047)	(0.0040)	(0.00048)
Highest HH education[b]	0.064***	0.064***	0.063***	0.064***
	(0.0025)	(0.00056)	(0.0025)	(0.00056)
Male respondent	0.11***	0.091***	0.099***	0.091***
	(0.0073)	(0.0014)	(0.0072)	(0.0015)
Respondent age	−0.0030***	−0.0028***	−0.0029***	−0.0028***
	(0.00018)	(0.000048)	(0.00017)	(0.000049)
Child < 5	−0.0014	−0.00090	0.0017	−0.00095
	(0.0049)	(0.0012)	(0.0047)	(0.0012)
HH size	−0.00016	−0.00016	0.0021*	−0.00010
	(0.0012)	(0.00025)	(0.0011)	(0.00027)
Initial bid	−0.0020***	−0.0020***	−0.0020***	−0.0020***
	(0.000010)	(0.0000079)	(0.000011)	(0.0000079)
Migrant HH member			−0.029***	−0.00077
			(0.0071)	(0.0013)
Land owned (ha)			−0.021**	−0.00078
			(0.0091)	(0.0011)
Number of environmental shocks			−0.0032	−0.000059
			(0.0039)	(0.00056)
Member of community group			−0.0057	−0.0013
			(0.0080)	(0.0013)
Familiarity with local NGO			−0.0080*	0.00079
			(0.0046)	(0.0011)
Collective action			0.018*	−0.00026
			(0.011)	(0.0014)
Natural resource user group membership			0.0021	−0.000028
			(0.012)	(0.0015)
Natural resource user group fees			0.000038	0.0000099
			(0.000060)	(0.0000081)
Constant	0.67***	0.67***	0.68***	0.67***
	(0.016)	(0.0029)	(0.019)	(0.0036)
VDC-ward FE	N	Y	N	Y
Observations	3655	3655	3607	3607
R^2	0.85	0.98	0.86	0.98

Source: Authors' calculations. Standard errors, clustered at VDC level, in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.001$.

[a] Asset score developed using principle components analysis using roof type, electricity access, and motorbike, livestock, radio, and cell phone ownership.

[b] Refers to highest level of education reported in the household based on the scale: 1 = Illiterate, 2 = Just literate, 3 = Primary school, 4 = Secondary school, 5 = SLC complete, 6 = Intermediate, 7 = Bachelor's degree, 8 = Master's degree, 9 = PhD.

conservation is a priority among inhabitants of the Karnali and Mahakali River Basins. We estimate that households are willing to pay an average of 202 NRs (US$1.96) per month to retain the natural state of undeveloped lands in and surrounding their villages, although variation in this WTP does exist based on river basin and geographical region. While this WTP appears low, it represents about 1% of monthly income, which is comparable to other estimates in the literature.[23] Furthermore, aggregation of WTP values at the VDC level demonstrates that inhabitants of the Karnali and Mahakali River basins attribute a high opportunity cost to environmental degradation. In the median VDC, development projects would need to generate over 32,000 NRs monthly to fully compensate for degradation to intact, undisturbed ecosystems.[24]

Households in the Karnali and Mohanna River Basins exhibit higher WTP for environmental conservation than those living in the Mahakali River Basin; households in the mountain and Terai regions similarly have higher WTP than those in the mid-hills. Additionally, we find that certain household and village characteristics are significantly related to WTP for environmental conservation. Households with higher levels of education and younger, male respondents report consistently higher WTP; additionally, those already participating in and paying for natural resource user groups report higher WTP. Households with migrant households members, high land ownership, and familiarity with local NGOs report lower WTP. These relationships are not consistent across all analyses: In particular, inclusion of VDC-ward fixed effects leads to less precisely estimated relationships, suggesting that village characteristics may also play a role in household WTP to pay for environmental conservation. This is consistent with a village level perspective on collective action for environmental preservation, whereby entire communities may be more or less willing to participate in conservation efforts.

From a policy perspective, the prioritization of environmental conservation over other development opportunities among respondents suggests that environmental concerns should continue to be an important factor in development planning in Western Nepal. Households rely on natural resources for household consumption and to maintain agricultural productivity and income, as well as for preserving ecosystem balance and reducing the instance and severity of hazards such as landslides. Infrastructure building and other development initiatives must take into account their potential environmental costs, if such livelihoods were to be displaced. Informed benefit-cost analysis of such projects would account for the nonmarket values associated with environmental impacts, as well as their distributional implications for local populations.

Importantly, we also found that WTP varies both spatially and according to household and regional characteristics. A single uniform conservation policy response for the region is thus unlikely to satisfy all inhabitants in all locations. Western Nepal remains a region poised to embark on a development trajectory that may include large scale development of water resources for energy generation or irrigation, smaller community-managed natural resource management, or ecotourism and industry based pathways. The economic net benefits of these various opportunities should be carefully considered alongside local inhabitants' willingness to pay for environmental conservation. Moreover, broad-based development should balance both vertical and horizontal equity concerns, supporting opportunities for locals with initiatives to protect those bearing higher costs, and especially protecting livelihoods needs among the poor who may have the lowest access to benefits from large infrastructure.

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[23] Barkmann et al. (2008) estimate WTP for hydrological ecosystem preservation in rural Indonesia to be 1% of monthly income.

[24] This estimate is calculated as the product of the regional basin WTP and the estimated number of households in the region.

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