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RESEARCH ARTICLE

Valuing ecosystem services from restoring ancient irrigation systems: An application comparing labor vs. monetary payments for choice experiments

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Abstract

The use of stated preference methods with monetary payments in developing countries can be problematic as barter and paying with labor are common in rural areas. In response, a growing number of stated preference studies explore using monetary and nonmonetary payment options. We contribute to this literature by exploring the impact of monetary vs. labor payment options on values elicited from choice experiment studies conducted in rural developing country settings. We also contribute to the literature by comparing data-gathering methods, specifically individual surveys vs. group information sessions. Our application is the restoration of an ancient irrigation system known as cascading tank systems in Sri Lanka. We conduct a choice experiment to understand the willingness to pay/willingness to contribute of rural households to restore these irrigation systems. We find that in the individual survey setting, there are no significant differences between monetary and labor payments. We also find that there is no difference between the group and individual survey settings for the monetary payment treatment. For the labor payment treatment, the group setting results in a positive payment coefficient for the labor payment attribute. This highlights that labor payments should be used cautiously in group evaluation settings.

Keywords: cascade tank systems; choice experiment; labor vs. money payment; Sri Lanka; willingness to pay

JEL Classifications: Q13; Q51; Q56

Introduction

The use of nonmarket valuation methods to value environmental goods and policies in developing country contexts is increasing rapidly with economic growth and the related increase in efforts to protect the environment. In most stated preference studies, the payment vehicle is typically presented in monetary terms. At the same time in developing country settings, especially in many rural areas, the use of cash is low and is often supplemented with barter and work exchange (Rai and Scarborough 2014; Gibson et al. 2016; Vondolia and Navrud 2019). In these contexts, the use of monetary payments may undervalue the resource or policy being valued (Abramson et al. 2011; Rai et al. 2015; Rai and Scarborough 2014). Most importantly, the undervaluing would systematically focus on low-income and vulnerable populations and thus increase social inequities (Gibson et al. 2015).

In response to these concerns, there is a growing nonmarket valuation literature exploring the use of nonmonetary payment vehicles in the context of rural settings in developing countries. Some of the earlier work focused on using nonmonetary payment options: use of labor for Tsetse fly control in Ethiopia (Swallow and Woudyalew 1994; Echessah et al. 1997), the use of rice to value tropical rainforest protection (Shyamsundar and Kramer 1996), and the use of beehives for PES programs (Asquith et al. 2008). A more recent literature is focused on comparing monetary and nonmonetary payments and the impact on efficiency and results (Hassan et al. 2018; Vondolia and Navrud 2019; Vondolia et al. 2014; Pondorfer and Rehdanz 2018; Abramson et al. 2011; Casiwan-Launio et al. 2011; Rai and Scarborough 2013; Rai and Scarborough 2014; Gibson et al. 2016; Rai et al. 2015; Eom and Larson 2006; Ando et al. 2020).

We contribute to this growing literature on two aspects. First, we add to the literature comparing valuation results under monetary and labor payments vehicles. Our study is novel as we do this comparison in a new context focused on valuing the ecosystem services from restoring ancient irrigation systems. Second, we explore how results of choice experiments are impacted by conducting group information sessions with individual surveys. Our second contribution is motivated by the fact that conducting in-person house-to-house surveys in rural settings is costly and one approach to minimize costs is to conduct valuation surveys in groups settings where there is a common provision of information, a question-and-answer session, and then respondents individually answer the surveys.[1]

Our application is the restoration of cascading tank systems, which are an ancient man-made irrigation system in South Asia developed to support agriculture and population expansion to dry/arid areas by collecting rainwater during the wet season for use in the dry season. The system, which has parallels to the Japanese land use system of Satoyama and was established and fostered by ancient ruling kings in Sri Lanka over 1500–2000 years ago, is designed to integrate with the hydro-ecological aspects of the natural environment (Panabokke 2009). Sri Lanka currently has over 15,000 ancient tanks that continue to provide irrigation for about 40% of the total irrigable area of the country, an astoundingly high percentage when considering that these were designed 2000–1500 years ago (Vidanage et al. 2005; IUCN 2016).

Knowledge about these tank systems and their integrated functions were lost during the colonial times. Over the last few centuries, the structure of the cascade tanks and the hydrologic system connecting the tanks have slowly deteriorated due to lack of maintenance and the disappearance of the traditional community institutions that were responsible for the cascade tank system. Given their importance to national agricultural output and local livelihoods, there is growing interest in studying and restoring these ancient irrigations systems. The FAO declared cascade tanks systems in Sri Lanka as a Globally Important Agricultural Heritage Systems (GIAHS) in 2016 and since there has

[1]It is important to note that we provided information in a group setting, but respondents conduct individual surveys. This is distinct from a group valuation exercise where a group comes up with values and priorities together.

been rowing interest from national international organization to restore these systems. Our application contributes to furthering these efforts to restore these ancient irrigation tank systems.

In this research, we use a choice experiment survey conducted in the *Pihimbiyagollewa* cascade tank system in Anuradhapura, Sri Lanka, to understand rural villagers' preferences and the willingness to pay (WTP)/contribute to restore cascading tanks systems. We use a 2 × 2 split sample design to estimate the values for cascade restoration using both monetary payments and labor participation and to compare individual surveys vs. surveys with group information session. The primary data collection was conducted in-person with trained enumerators and the sample consisted of 516 households in the *Pihimbiyagollewa* cascade tank system.[2]

We analyze the data using standard methods: conditional logit (CL) and mixed multinomial logit (MMNL) models. Results from the survey indicate that respondents value the availability of water for agriculture, water for household use, the cascade ecosystem health, and biodiversity. With regard to the core focus of this work, exploring the impact of labor vs. monetary payment options, we find that for the individual surveys, both labor and monetary payments are significant and as seen in some of the related literature we find similar values when payment is presented in term of labor contribution (by using the daily wage rate to convert labor willingness to contribute to monetary values). With regard to the group vs. individual surveys, for the surveys with payment expressed in monetary terms, there is no significant differences between the group and individual survey implementation.

We do find a somewhat surprising result for the labor surveys conducted in the group survey setting, specifically we find a positive coefficient for the labor payment variable (i.e., payments in terms of labor have a positive marginal utility). Based on anecdotal evidence from discussions with the respondents and local researchers, we believe it may be a function of perceived sense of community and communal responsibilities that were implicitly highlighted in the group setting. This result highlights that while using labor as a payment option for eliciting preferences in rural settings works well for individual surveys, if surveys are done in a communal setting that results may be influenced by other external factors.

The rest of this paper is organized as follows: "Literature review on non-monetary payments in choice experiments" provides a literature review on the use of labor and other nonmonetary payment vehicles in choice experiments, "Application – cascade tank systems" provides background information on the application, "Survey design" provides details of the survey instrument, "Data collection" Introduces the methods, "Model and estimation" presents the results, and "Results" concludes the paper with a discussion.

Literature review on nonmonetary payments in choice experiments

As noted in the Introduction, the payment vehicle in most stated preference studies is typically presented in monetary terms, but the use of cash is low and is often supplemented with barter and work exchange in developing country settings (Rai and Scarborough 2014; Gibson et al. 2016; Vondolia and Navrud 2019). The use of monetary payments in such contexts may undervalue the resource or policy being valued (Abramson et al. 2011; Rai et al. 2015; Rai and Scarborough 2014). In response to these concerns, there is a growing

[2]We conduct the study in one cascade system given the financial and time constraints in doing a national study. While the results are likely to be generalizable to communities in similar climatic zones, the north central areas in Sri Lanka, which also have similar sociodemographic characteristics to the cascade system being studied, we do not attempt to generalize the results to a national level.

nonmarket valuation literature exploring the use of nonmonetary payment vehicles in the context of rural developing country settings. Some of the earliest work focused on using nonmonetary payment options (Swallow and Woudyalew 1994; Shyamsundar and Kramer 1996; Echessah et al. 1997; Asquith et al. 2008), and more recent work compares outcomes like WTP and estimation efficiency across monetary and nonmonetary payments (Hassan et al. 2018; Pondorfer and Rehdanz 2018; Vondolia and Navrud 2019; Vondolia et al. 2014; Abramson et al. 2011; Casiwan-Launio et al. 2011; Rai and Scarborough 2013; Rai and Scarborough 2014; Gibson et al. 2016; Rai et al. 2015; Eom and Larson 2006). We provide a discussion of some of these key studies and findings below.

Overall studies can be broadly separated into studies that use labor or time payments as the nonmonetary payment and other forms of payment as the nonmonetary payment. Within the literature that uses labor/time, the studies consist of split sample studies where respondent see either monetary or a nonmonetary payment choice card or studies that include combined choice cards with both nonmonetary and monetary choice cards (Hagedoorn et al. 2021, 2020).

The following examples highlight the key results from the labor vs. monetary in split sample studies. Casiwan-Launio et al. (2011) use a split sample contingent valuation study that considers money and labor hours as payment vehicles that is conducted with three villages in the Philippines. They monetize the labor payment using one-third the value of the wage rate and find that the converted WTP using labor is between 3 and 8 times larger than monetary WTP. Rai et al (2015) study the WTP and preferences for watershed services in 12 village areas in central Nepal. The authors find that a larger proportion of the respondents are willing to pay using labor vs. a monetary payment (72% vs. 50%) and that the social benefits from environmental services are 1.4 to 2.2 times higher when using labor payments compared to monetary payments. Rai and Scarborough (2013, 2014) study the WTP and preferences for management of invasive plants among rural communities in Nepal, and they include both monetary and labor payments. Rai and Scarborough (2014) allow the respondents to choose between monetary and labor payment options and find that 65% opted for the labor payments and 35% opted for the monetary payment. Hassan et al. (2018) compare three different payment vehicles in a study on wetland conservation in Malaysia: incomes taxes, voluntary donations, and a reduction in government subsidies for consumer goods. The authors conduct the survey with respondents living in six rural villages and four urban towns adjacent to the wetland. They find that reduction is subsidies as a payment vehicle has a higher price sensitivity and small unexplained variance and that this may be a favorable payment vehicle in terms of improved payment consequentiality. Navrud and Vondolia (2020) study flood insurance among smallholder irrigation farmers in Ghana using a split sample with varying payment vehicles. They find that insurance uptake is lower when payments are required in labor compared to payments of money or payments using the rice harvest.

The existing literature finds mixed evidence about both the applicability and comparability of using nonmonetary payments vehicles in developing country valuation studies (Gibson et al. 2016; Navrud and Vondolia 2020). We contribute to this growing literature by conducting a study that compares valuation results under monetary and labor payments vehicles in a rural developing country setting. In our study, we use a random assignment of respondents to labor and monetary payments eliminating the confounding issues that can occur when respondents selected the payment option. We also conduct the study in a new context focused on valuing the ecosystem services from restoring an ancient irrigation system known as cascade tank systems in Sri Lanka. We also contribute to the literature on conducting choice experiment studies in developing countries by exploring how results of choice experiments are impacted by conducting group information sessions.

Application – cascade tank systems

Cascading tank systems are an ancient irrigation system of connected reservoirs found in South Asia. The water storage system is designed to collect rainwater during the wet season to use in the dry season to support agriculture and population expansion to dry/arid areas (Panabokke 2004; IUCN 2016; Dissanayake and Vidanage 2022). The cascading tank systems can be considered as an early application of Integrated Water Resources Management (IWRM) given the use of landscape-level planning and water and soil conservation aspects built into the landscape (Mendis 2002; IUCN 2016; Vidanage et al. 2005). The tanks (the term "tank" is derived from the Portuguese word "tanque" meaning a small man-made reservoir) are created by blocking the natural drainage system in a watershed using earth bunds in selected locations to enable storing of water and forming a series of tanks that allows the water to cascade from tank to tank (Panabokke 2004; IUCN 2016).

The system, which has paralleled to the Japanese land use system of Satoyama, was established and fostered by ruling Kings. The small tanks are found in South India, China, Thailand, and Indonesia (Plan Sri Lanka 2012) with some differentiation. Brohier (1934) in his monumental work on Ancient Irrigation Works referred to these clusters of tanks [cascades] in the following words:

> "So careful were the inhabitants in husbanding the liquid resources on which their very existence depended, that even the suMMNLus waters from one tank would spill to the next, when water was plentiful, were not allowed to escape. The tanks were built in an orderly method, at slightly varying elevations so that there often was a series of reservoirs to take the overflow from one above it . . . (Brohier 1934, p. 2.)"

These systems are hydrologically and socioeconomically interlinked (Sakthivadivel et al. 1996) and have evolved several millennia ago incorporating the principles of IWRM, and landscape approaches, and water and soil conservation aspects into planning and possibly also governance (Mendis 2002). Tennakoon states that small cascade-based tank systems had been a classic example of man's ability to maintain a long-lasting symbolic relationship of man with available water, vegetation, climate, soil characteristics, animals domesticated, and wild being a partner of a well-renowned hydraulic civilization (Tennakoon 2001).

In Sri Lanka, there are estimated to be about 15,000–18,000 tanks and about 13,000 anicuts, diversions from streams (Panabokke 2004; IUCN 2016). Recent works from the last few decades, led by Madduma Bandara (1985), have re-discovered that these tanks are not occurring randomly but rather were created to be spatially organized based on the natural landscape to collect rainwater from well-defined microcatchments (Madduma Bandara 1985; Panabokke et al. 2002).

The individual tanks are components of large systems or units called "cascades," defined as "a connected series of village irrigation tanks organized within a micro- (or meso-) catchment of the dry zone landscape, storing, conveying and utilizing water from an ephemeral rivulet" (Madduma Bandara 1985). Work by Dharmasena (2004) on small tanks indicates that the village tank systems have been developed to cater to diverse micro- as well as macro-land uses by having different components such as *gangoda*, *chena, welyaya, gasgommana, godawala, perahana, iswetiya, kattakaduwa*, and *kivul ela* (Fig. 1).[3] The cascading systems have ecological features and cultural customs to reduce erosion and improve water quality. These include planting specific tree species as wind breaks, a funnel-shaped tank design to reduce evaporation, the creation of waterholes/fields for animals to reduce human–wildlife conflict, the use of phyto-remediation plants along the interceptor to improve water quality and remove impurities, the presence of desilting water holes and cultural practices to manage silt, the use of conservation buffers, and management as a common pool resources with shared labor (Madduma Bandara 2007; Dharmasena 2004).

Even though many of the tanks were created over two millennia ago, they continue to provide irrigation for about 40% of the total irrigable area of the country, an astoundingly high percentage when considering that these were designed 2000–1500 years ago (IUCN 2016). Further, the tank systems provide multiple other ecosystem services beyond water for agriculture, including fisheries and livestock (Renwick 2001), flood prevention, control of soil erosion, improvement of water quality, water storage for use in the dry season (Schütt et al. 2013), climatic resiliency given changing climate patterns, human integrity, and retaining soil health (Senanayake et al. 2010).

At the same time due to various historical and sociocultural reasons, these systems were neglected over a long period of time and have slowly degraded due to lack of traditional governance and management structures, regular maintenance, and modern irrigation efforts that ignored the interconnectedness of the cascade system. With the growing understanding of these complex systems over the last few years, there is an increasing interest, nationally and globally, to better understand the cascade tank system, to restore the tanks to their original conditions, and to study the climate adaptation potential of the cascading tanks. Further, the restoration of degraded cascades has been identified as a key climate change adaptation mechanism in National Adaptation Plan for Sri Lanka (Ministry of Mahaweli Development and Environment [MMDE] 2016). The Food and Agricultural Organization of the FAO declared cascade tanks systems in Sri Lanka as a GIAHS in 2016 (FAO 2017). The HSBC-Global Water Program provided a $500,000 grant for the restoration of one cascade system in 2013. Most recently, UNDP and GCF co-funded a $52 million effort to restore 300 tanks to "strengthen the resilience of smallholder farmers, particularly women, in the Dry Zone through improved water management to enhance lives and livelihoods."

Even though there is a growing interesting in restoring the cascading tanks and the surrounding ecosystems, there is a lack of knowledge about preferences and values of the stakeholders for the cascade restoration and scientifically determined impact evaluations of cascade restoration. We use a choice experiment survey to study the preferences for cascade restoration (and restoration of ancient irrigation systems in general). The main choice experiment was conducted in a cascade tank system in Anuradhapura, Sri Lanka, among rural villagers (Fig. 2).

[3]"*Gangoda*" (home garden), "Chena" (shifting cultivation), and "*Welyaya*" (lowland paddy cultivation). Micro-land uses include "*Gasgommana*" (the upland land strip above the tank bed, where water stagnates only when spilling and also as a wind barrier), "*Godawala*" (a water hole to trap silt before water enters the tank bed), "*Perahana*" (a meadow developed under the "*Gasgommana*" to filter sediment coming from upstream "Chena"), "*Iswetiya*" (upstream soil ridge on either side of tank bund to prevent entering eroded soil from upper land slopes), "*Kattakaduwa*" (reserved land below the tank bund consisting of diverse vegetation to absorb salinity), and "*Kivul ela*" (natural stream utilizes as a common drainage) Dharmasena (2004).

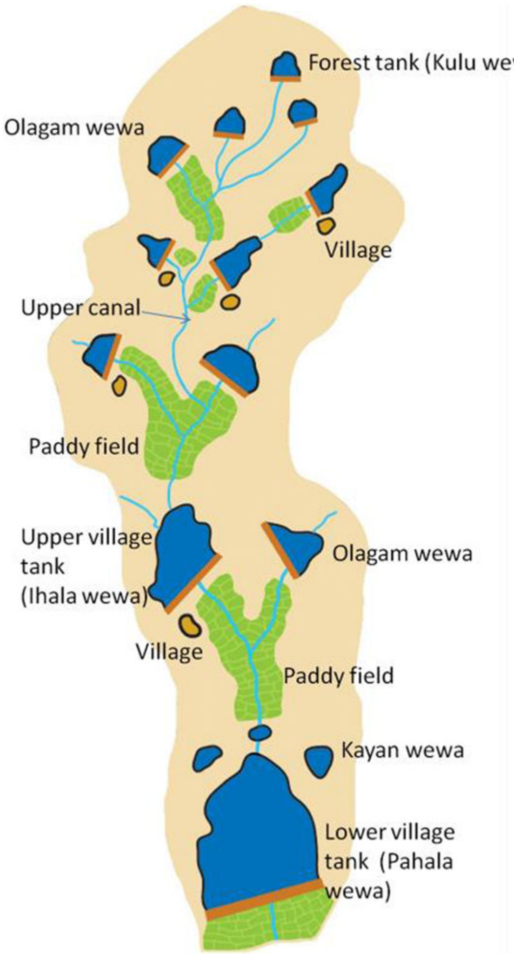

Figure 1. Schematic diagram of a STCS. (Source: IUCN, 2016).

Survey design

Selecting attributes for the CE questionnaire

The key task in any CE exercise is the selection of the attributes and their levels (Kragt 2009). The attributes chosen to describe the change have to be relevant to both decision makers and the respondents of the questionnaire. For this study, the relevant attributes were identified through an extensive process that included a broad literature review, consultation with experts/scientists working on cascades, use of google maps, and focus group discussions of cascade-dependent stakeholders were utilized (for details, see Vidanage 2018; Dissanayake and Vidanage 2022). The attributes to describe the outcomes of the cascade restoration process and the levels we identified through this process are presented in Table 1 and Fig. 3.

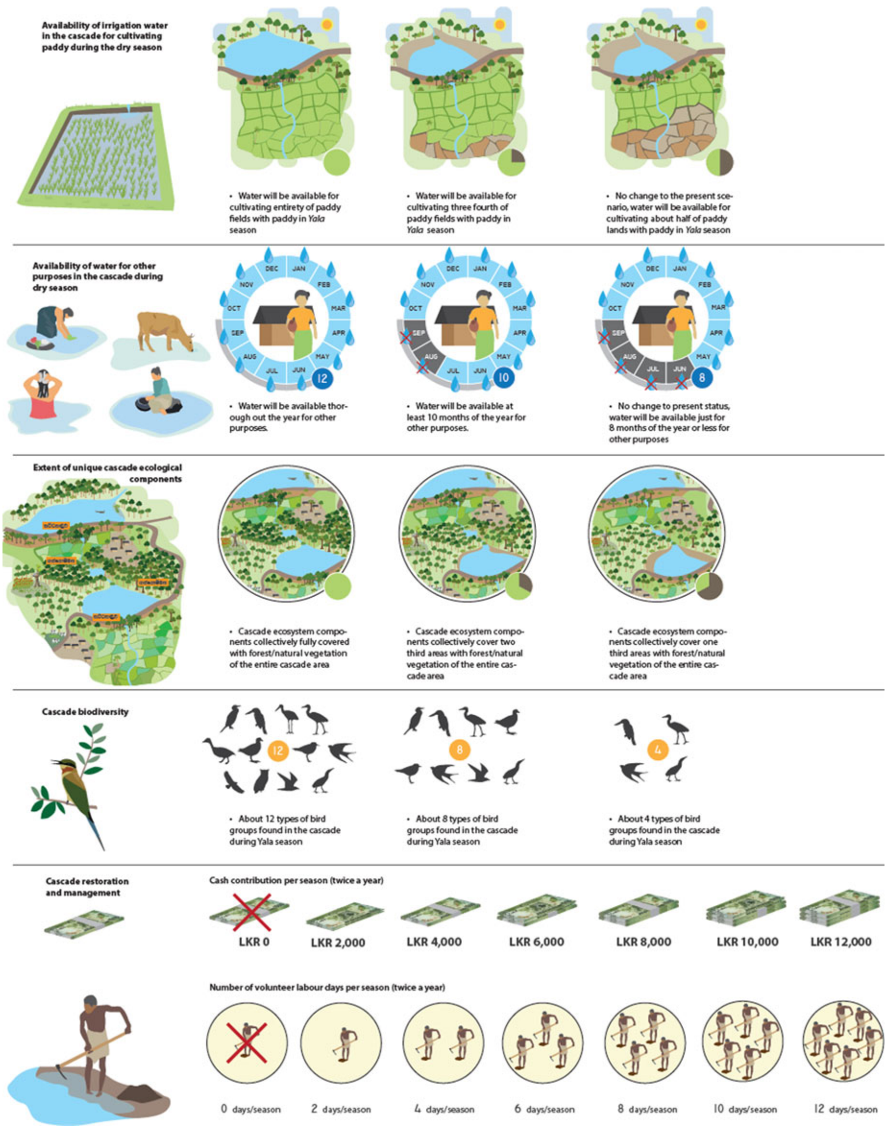

Figure 2. Attributes and their levels as depicted in the survey instrument.

Experimental design

Discrete choice models describe respondents' choices among a set of alternatives. In this research, the alternatives are the different cascade restoration options. One of the alternatives to choose from will be the present status of the cascade (Alternative A, the status quo or business as usual) for which the respondents do not have to pay any additional payment if they wish to select that as their choice. Alternatives will have different levels of the five attributes, designed as add-ons to Alternative A.

Table 1. Attributes and the levels

Attribute name	Attribute levels in a normal year
Availability of irrigation water in the cascade for cultivating paddy during the dry season (*Yala*[4])	1. Water will be available for cultivating entire paddy fields in the cascade. 2. Water will be available for cultivating three-fourth of paddy fields in the cascade. 3. Water will be sufficient to cultivate for about half of paddy fields in the cascade.
Availability of water for other purposes in the cascade during dry season (*Yala*)	1. Water will be available throughout the year in cascade for other purposes. 2. Water will be available for at least 10 months of the year in cascade for other purposes. 3. Water will be available for at least 8 months of the year in cascade for other purposes.
Extent of unique cascade ecological components	1. Cascade ecosystem components collectively fully covered with forest/natural vegetation of the entire cascade area. 2. Cascade ecosystem components collectively cover two-third of areas with forest/natural vegetation of the entire cascade area. 3. Cascade ecosystem components collectively cover one-third of areas with forest/natural vegetation of the entire cascade area.
Cascade biodiversity	1. About 12 types of bird groups found in the cascade during Yala season 2. About 8 types of bird groups found in the cascade during Yala season. 3. About 4 types of bird groups found in the cascade during Yala season.
Respondent contribution to cascade restoration and management (per season)[5]	For cash – in LKR/season/household 2,000, 4,000, 6,000, 8,000, 10,000, and 12,000. For labor – in days/season/household 2, 4, 6, 8, 10, and 12. (level 0 was used for cash and labor only in business as usual case).

Levels of attributes for other two alternatives were generated in an experimental design. A design with four attributes with three levels and a six-level payment attribute will result in a full factorial design with 486 ($3^4 \times 6$) different combinations of attributes. Therefore, a manageable orthogonal fractional factorial design was created using the SAS statistical package following Kuhfeld (2010). The resulting experiment design was 100% D-efficient and generated 54 unique choice profiles. The 54 sets of choice profiles were blocked into

[4]Rice is grown in two seasons that correspond to the two monsoon rainfalls, the *yala* and *maha* seasons, which are everyday terms that get used to divide up the year. Also, the goal of the tank system is to store water to be used during the dry season (the second monsoon season), so the local communities are aware that a well-functioning tank system would be essential to enable agriculture in the dry/second season.

[5]The labor contribution was described as full days of work focused on maintaining/restoring the tank system. This type of work is a fairly common occurrence, and the respondents would know that the work would involve tilling/moving the soil, removing plants, etc.

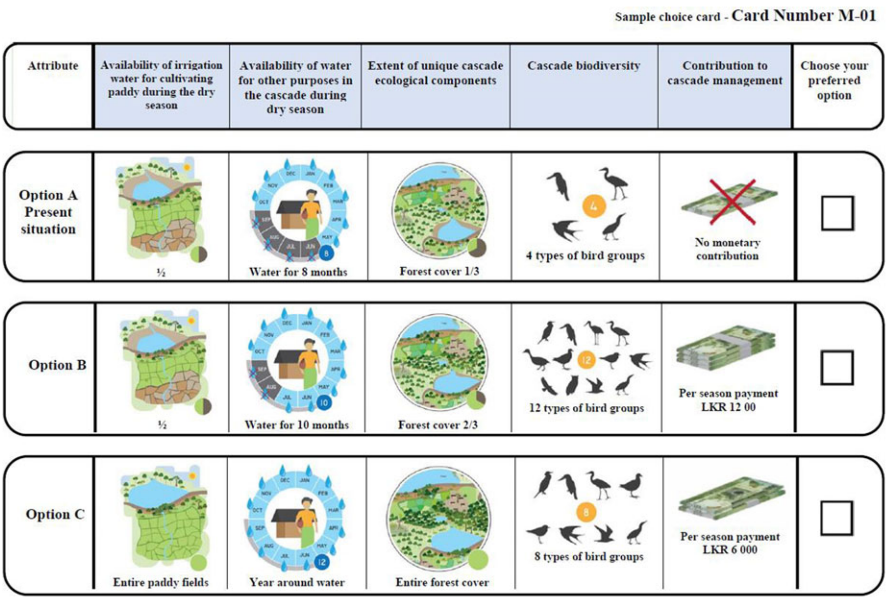

Figure 3. Sample choice card.

9 sets with 6 choice profiles in each set. As found in literature and to account for learning, the first and the second choice profiles in a set were repeated at the end as the seventh and eight choice profiles (Carlsson et al. 2012). Therefore, each respondent answered eight sets of choice profiles/questions.[6] In the analysis, the first two choice responses were dropped to account for learning.

These attribute levels were illustrated graphically and used in producing printed color cards of choice profiles to be given to respondents to make their choices. A respondent only answered either cash or labor choice cards as determined in the survey design. In the survey, the nine sets of choice cards are repeated among respondents in a way that each set is equally distributed among the sample in both cash and labor versions where applicable. Sample choice set used in CE is given in Fig. 4.

The questionnaire comprised of four sections. The first section is about the general information on the survey, which included the confidentiality of the information collected, the consent of the respondent, and that the respondents can leave the survey at any point and finally, a detailed background to the issues to be addressed in the survey. Section two was devoted to introducing the attributes and their levels and graphical representation of them in the choice cards, and the third section was on the choice cards and getting choice responses. The final and the fourth section was on the respondent's socioeconomic information.

[6]Having each respondent answer eight choice questions may raise questions about fatigue and attention to the survey instrument. One of the seminar studies that explored learning and fatigue used a study with 16 choice sets (Carlsson et al. 2012). Also, we conducted a series of pilots and focus groups, and the issue of fatigue did not come up. This may be because these were in-person surveys being done in the presence of enumerators that led to a more interactive survey process (unlike online or mail surveys where the respondent may be more likely to get fatigued).

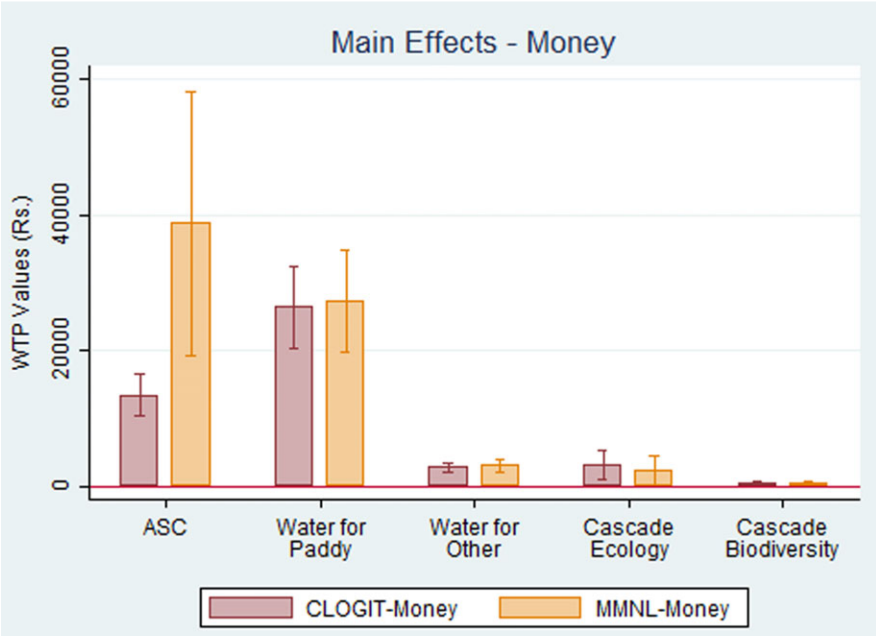

Figure 4. Willingness to pay for the money treatment for the full sample.
*Note: Coefficient estimates for the main effects analysis for the money sample. The WTP values are provided per season. The daily wage rate is approximately LKR 1000.

Data collection

The tool for primary data collection of the research was a structured survey questionnaire, drafted with preliminary research undertaken and improved through expert and field consultations. The survey instrument was field-tested with the enumerators in the *Kapiriggama* Cascade, a cascade adjoining the sample cascade, the *Pihimbiyagollewa* cascade.

As the choice experiment surveys are somewhat complex, the enumerators were provided with detailed training. The training covered an introduction to the subject of STCS (enumerators were taken to the cascade as part of the training), training on the CEs, survey methods, and on field testing of the survey for them to get a better understanding before they undertook the survey. They were also given a chance to role-play by administering few surveys among themselves before they were exposed to field testing. In addition to the survey questionnaire, a set of color printed materials were provided to the enumerators as a survey aid. It included the materials for introducing the survey, complete set of labor, and cash choice cards ($72 \times 2 = 144$) methodically arranged in hardcover ring binder folders. During the data collection, the enumerators went over each of the attributes with the respondents before the respondents answered the choice questions to ensure that the respondents were aware of the details of each of the attributes before answering the choice questions. Two images from the field work highlighting the individual surveys and the group surveys are presented in the Appendix (Figs. A1 and A2).

Field surveys

The primary data collection surveys were conducted with 10 final-year undergraduate students as enumerators from the faculty of Humanities, Rajarata University of Sri Lanka, supported by an experienced survey coordinator. A stratified random sample of 516 households was selected from residents of the *Pihimbiyagollewa* cascade covering six Grama Niladhari divisions in two Divisional Secretariat divisions of the Anuradhapura district.[7] The six Grama Niladhari divisions has a population of 5265; within the cascade itself, we sampled about 50% of the population. Stratification was done to capture variability in upstream, mid-catchment area, and the downstream of the cascade. The respondents were split with 60% (approximately 300) taking the survey in the group information setting and 40% (approximately 200) taking the survey individually.[8] The assignment of respondents/groups to the monetary vs. labor treatments was done randomly so that half of the respondents completed the monetary payment survey and half of the respondents completed the labor payment survey. Table 2 presents the summary statistics of full sample.[9]

Model and estimation

The analysis we use is based on random utility theory which lays the foundation for analyzing choice decisions (Lancaster 1966; Hensher et al. 2015; Johnston et al. 2017). In this theoretical framework, the utility derived by individual (i) from an alternative/choice profile (j) is a function of the attributes (x) presented in the choice cards, and unobservable factors can influence utility, which are captured by a random component (ϵ). Consistent with the random utility theory (Hensher et al. 2015), the random and unobservable terms are assumed to enter the utility function additively. Therefore, individual (i)'s utility (U) from choosing alternative (j) is expressed as follows:

$$U_{ij} = x_{ij} + \varepsilon_{ij} \ldots \tag{1}$$

In order to ensure internal consistency, a CE 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) alternatives scenarios, noting that each alternative identifies different levels of a number of attributes. Therefore, individual (i) selects

[7]We identified respondents through using the master lists of residents in each of the communities within the cascade area and randomly selecting respondents for the individual and group surveys. We also worked with a field coordinator that had extensive connections and experience in this area, and the enumerators came from a regional university and had local knowledge and familiarity. Further, the organization that was helping to conduct the study (IUCN-Sri Lanka) had previous experience conducting field work in adjacent communities in neighboring cascades, and they were able to use that prior experience to facilitate the field work.

[8]The issue of elite dominance can influence preference surveys and decision-making in general in rural village communities when decisions are being made in a group setting. In our context, given that the respondents in the group setting complete the survey away from other respondents, we do not believe that elite dominance would have impacted the outcomes as they might in a group valuation setting where community members discuss and answer the valuation questions together.

[9]While the cascade tank communities are diverse, exploring socioeconomic differences in preferences for cascade tank restoration is not the goal of this study. Given that we have four treatments in a 2x2 experimental design to explore the payment vehicle and the group and individual settings, we do not have sufficient statistical power to expand to explore other aspects of socioeconomic variation like income, gender, and age. We acknowledge this is a limitation of the study design. At the same time, we use the mixed multinomial model (the random parameter model), a model that accounts for heterogeneity in preferences among the respondents for the main analysis.

Table 2. Sociodemographic characteristics of the sample

Characteristic	Subdivision	Count	Percentage
Age ($n = 501$)	0–19	6	1.2
	20–34	85	16.9
	35–49	172	34.2
	50–64	178	35.4
	65–79	57	11.3
	80 and over	5	1.0
Gender ($n = 501$)	Male	206	41.1
	Female	295	58.9
Education ($n = 499$)	No formal education	17	3.4
	Primary education	112	22.4
	Secondary education	361	72.3
	Tertiary education	8	1.8
Monthly income ($n = 495$)	Less than LKR 10,000	86	17.4
	LKR 10,000–20,000	123	24.9
	LKR 20,001–50,000	200	40.4
	LKR 50,001–100,000	75	15.2
	LKR 100,001–150,000)	9	1.8
	LKR 150,001–200,000	2	0.4
	More than LKR 200,000	0	0.0

Notes: Sample average income is Rs 69,284 per month. The average income for the population of the Anuradhapura district is Rs 64,400 per month in 2019 (DCS 2019). The administrative units that overlap the sample has a population of 5265 and gender distribution of 50.12% male and 49.87% female. Within the cascade system itself, we sampled 50% of the households (a population of roughly 1000).

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:

$$\Pr(j \backslash R) = \Pr(U_{ij} > U_{ij'} \text{ s.t.} \forall j' \in \text{R, and } j \neq j') \ldots \tag{2}$$

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), then equation (2) can be estimated with a CL model (McFadden 1974).

CL model

CL model (McFadden 1974; Greene 2012) assumes that the observable utility function would follow strictly additive form (Birol et al. 2006). The model was specified so that the probability of selecting a particular cascade restoration and management scenario was a function of attributes of that scenario and the alternative-specific constant (ASC). The

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 when either management scenario B or C was selected, and as 0 when neither management scenario option was selected. The CL model is expressed as:

$$V_{ij} = \mathrm{ASC} + \beta_{ij}x_{ij}\ldots \tag{3}$$

where V refers to indirect utility obtained by the i^{th} individual for the j^{th} alternative and β is the coefficient of the attributes (x) included in the experiment.

The CL model assumes the Independence of Irrelevant Alternatives (IIA) property, which states that the relative probability of the two options being chosen are unaffected by the introduction or removal of other alternative. If the IIA property is violated, then the CL will be biased, and hence, a discrete choice model that does not require IIA property such as MMNL model should be used instead.

MMNL model

A MMNL model, also known as a random parameter logit (RPL) model, can also be estimated by relaxing some of the constraints associated with the IIA assumption in the CL model. In addition to IIA, one other limiting assumption that CL assumes is that the homogeneous preference across respondents which usually does not hold. Therefore, in MMNL model both IIA and the preference homogeneity are relaxed. As per Greene (1997), accounting for IIA and preference heterogeneity enables MMNL to produce unbiased estimates of individual preferences of demand, participation, marginal, and total welfare. Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account. An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such change is necessary (Boxall and Adamowicz 2002). The RPL model (Train 1998), which accounts for unobserved, unconditional heterogeneity, should be used in order to account for the preference heterogeneity in a pure public good (Kontoleon 2003).

In the MMNL model, the observed component (βx) is decomposed into two parts: the sum of the population mean (Υ) and the individual deviation of the random parameter (η). In this model, socioeconomic variables (s) are introduced to detect sources of heterogeneity. Further, the interaction terms in γ identify the impacts of individual-specific characteristics on selected alternatives and the ASC. The MMNL model is expressed as:

$$V_{ij} = \mathrm{ASC} + \Upsilon x_{ij} + \eta x_i + \gamma s_i \ldots \tag{4}$$

Applications of the MMNL model have shown that this model is superior to the CL model in terms of overall fit and the welfare estimates (Kontoleon 2003; Morey and Greer Rossmann 2003). However, as Lancsar et al. (2017) highlighted, in choice modeling, it is natural to start with classical logit model. Hence, we present results for both the CL model and the MMNL model. The analysis was conducted using STATA and the *clogit* and the *mixlogit* functions (Hole 2007).

Estimation equations used are provided below:

1. For CL,

$$\mathrm{U}_j = \sum_{k=1}^{K} \beta_k x_{kj} + \beta_p p_j + \varepsilon_j \tag{5}$$

The marginal value of attribute k is the ratio between the parameter β_k and β_p:

$$MWTP = -\frac{\beta_k}{\beta_p} \tag{6}$$

2. For MMNL,

$$U_j^i = \sum_{k=1}^{K} \beta_{ki} x_{kj} + \beta_{pi} p_{ij} + \varepsilon_{ij} \tag{7}$$

The choice experiment data were coded using the level of each attribute (see table notes for Table 3 for details). Next, we present the results from the estimation and then discuss the policy implications. We analyze the data using standard CL and MMNL models (Hole 2007; Hensher et al. 2015).

Results

The coefficient estimates for the CL and MMNL models for the full money and labor samples for both individual and group treatments are provided in Table 3.[10] Coefficient estimates for the samples separated by group and individual for just the MMNL model are provided in Table 4. The corresponding WTP calculations are presented in Tables 5 and 6. We first discuss the results with the money treatment, then the labor treatment, and finally the results comparing the individual and group surveys formats.

The attributes were level-coded as indicated in the attribute table and therefore can be interpreted directly as marginal values: paddy area – percentage of the area that can be cultivated in the dry season ranging from 0.5 to 1 of the field area, water for other uses – number of months of water availability ranging from 8 to 12, cascade ecology – the area with functioning and intact ecological cascade components ranging from 1/3 to 1 of the cascade area, cascade biodiversity – number of bird species groups ranging from 1 to 2, the contribution – coded as contribution in Rupees per season or contribution in days of labor per season for the monetary and labor surveys, respectively. For the MMNL model, we specify all the attributes to have random coefficients which are modeled as having a normal distribution to allow for the full range of preferences including a negative preference to be detected.[11]

Focusing on Column 1 and Column 3 of Table 3, the CL and the MMNL for the money sample, we see that the results are as theoretically expected with cascade attributes having a positive marginal utility. In particular, the respondents have positive and significant coefficient estimates for the ASC, and the attributes of the restored cascade indicating

[10]We include the results that combine the individual and group treatments as we can see that the results for the CL and the MMNL models are similar and allow interpreting the average impacts across both of these treatments. In Table 4, we focus on just the MMNL model and expand the analysis to separate both money and labor samples and the individual and group treatments.

[11]Based on reviewer's suggestions, we now conduct a robustness test by specifying the contribution/payment variable as lognormal. The results are in Appendix 1. We do want to note that the natural log of WTP is used to require/force a positive marginal utility of income. In our study, we are finding that a significant percentage of respondents, especially for the labor-group sample, have the opposite coefficient. As is discussed in the conclusion, there is a feasible economic explanation for this result (i.e., providing labor may provide positive utility if some respondents view a labor payment has engaging in a duty or performing an obligation). Therefore, we believe it is important to allow for a flexible price parameter so that main results we focus on assume a normal distribution for the payment coefficient.

Table 3. Coefficient estimates for CL and MMNL models for the money and labor samples

	(1) CL-Money	(2) CL-Labor	(3) MMNL-Money	(4) MMNL-Labor
Main				
ASC	1.363***	1.427***	7.242***	2.106***
	(0.175)	(0.222)	(1.955)	(0.426)
Water for paddy	2.694***	2.261***	5.090***	4.354***
	(0.252)	(0.235)	(0.636)	(0.581)
Water for other uses	0.280***	0.345***	0.574***	0.618***
	(0.0338)	(0.0327)	(0.0802)	(0.0686)
Cascade ecology	0.320**	0.499***	0.422*	0.763***
	(0.134)	(0.129)	(0.238)	(0.214)
Cascade biodiversity	0.0548***	0.0646***	0.0949***	0.0829***
	(0.0116)	(0.0109)	(0.0211)	(0.0192)
Contribution (price)	−0.000102***	−0.0159	−0.000187***	−0.0205
	(0.0000118)	(0.0112)	(0.0000290)	(0.0186)
SD				
ASC			4.816***	−0.658
			(1.352)	(0.688)
Water for paddy			4.384***	5.133***
			(0.740)	(0.716)
Water for other uses			0.615***	0.488***
			(0.0888)	(0.0716)
Cascade ecology			−1.390***	1.404***
			(0.480)	(0.366)
Cascade biodiversity			−0.0963**	0.142***
			(0.0471)	(0.0347)
Contribution (price)			−0.000275***	0.133***
			(0.0000402)	(0.0271)
Observations	4338	4626	4338	4626
Log lik.	−1001.7	−961.9	−824.7	−866.9
Chi-squared	1173.9	1464.4	354.0	189.9

Standard errors are in parentheses $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Note: The attributes were level-coded: paddy area – percentage of the area that can be cultivated in the dry season ranging from 0.5 to 1 of the field area; water for other uses – number of months of water availability ranging from 8 to 12; cascade ecology – the area with functioning and intact ecological cascade components ranging from 1/3 to 1 of the cascade area; cascade biodiversity – number of bird species groups ranging from 1 to 2; and the contribution – coded as contribution in Rupees per season or contribution in days of labor per season for the monetary and labor surveys, respectively. All attributes are specified as having a normal distribution. The daily wage rate is approximately LKR 1000.

Table 4. Coefficient estimates for the individual and group samples for the MMNL model

	(1) Money-Individual	(2) Money-Group	(3) Labor-Individual	(4) Labor-Group
Mean				
ASC	4.586***	7.560***	3.213***	3.349***
	(0.861)	(2.545)	(0.947)	(1.059)
Water for paddy	5.924***	4.910***	3.345***	4.627***
	(0.946)	(0.962)	(0.770)	(0.744)
Water for other uses	0.647***	0.613***	0.510***	0.669***
	(0.120)	(0.139)	(0.0952)	(0.0933)
Cascade ecology	0.354	0.722*	1.204***	0.426
	(0.312)	(0.406)	(0.301)	(0.273)
Cascade biodiversity	0.0767**	0.113***	0.103***	0.0752***
	(0.0307)	(0.0332)	(0.0280)	(0.0252)
Contribution (price)	−0.000211***	−0.000202***	−0.0921***	0.0322
	(0.0000444)	(0.0000462)	(0.0260)	(0.0225)
SD				
ASC	−2.959***	5.428***	2.399***	−2.143**
	(0.512)	(1.705)	(0.597)	(1.008)
Water for paddy	−4.192***	4.537***	3.764***	5.159***
	(1.157)	(1.074)	(0.881)	(0.864)
Water for other uses	0.702***	−0.768***	0.374***	0.519***
	(0.122)	(0.174)	(0.124)	(0.0974)
Cascade ecology	0.363	−2.276***	0.964	1.417***
	(0.936)	(0.666)	(0.622)	(0.505)
Cascade biodiversity	−0.0874	0.137**	0.102**	0.139***
	(0.0746)	(0.0638)	(0.0465)	(0.0401)
Contribution (price)	0.000294***	−0.000321***	0.0586	0.0762
	(0.0000570)	(0.0000592)	(0.0510)	(0.0529)
Observations	2160	2178	1728	2898
Log lik.	−398.7	−418.7	−344.1	−505.6
Chi-squared	203.1	148.3	70.43	118.1

Standard errors are in parentheses $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Note: The attributes were level-coded: paddy area – percentage of the area that can be cultivated in the dry season ranging from 0.5 to 1 of the field area; water for other uses – number of months of water availability ranging from 8 to 12; cascade ecology – the area with functioning and intact ecological cascade components ranging from 1/3 to 1 of the cascade area; cascade biodiversity – number of bird species groups ranging from 1 to 2; and the contribution – coded as contribution in Rupees per season or contribution in days of labor per season for the monetary and labor surveys, respectively. All attributes are specified as having a normal distribution. The daily wage rate is approximately LKR 1000.

Table 5. Willingness to pay estimates. Full sample – labor and money

	(1) CL-Money	(2) **CL-Labor***	(3) MMNL-Money	(4) **MMNL-Labor***
ASC	13342.9***	89.93	38821.2***	102.5
	(1864.3)	(60.40)	(11838.7)	(89.95)
Water for paddy	26368.0***	142.5	27284.2***	211.9
	(3702.9)	(102.1)	(4524.0)	(193.6)
Water for other uses	2736.9***	21.74	3076.6***	30.09
	(428.8)	(15.30)	(562.8)	(27.26)
Cascade ecology	3132.3**	31.45	2263.8*	37.15
	(1348.9)	(23.92)	(1307.8)	(35.09)
Cascade biodiversity	536.6***	4.071	508.6***	4.037
	(123.1)	(2.912)	(124.7)	(3.737)
Observations	4338	4626	4338	4626
Log lik.				
Chi-squared				

Standard errors are in parentheses *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
*Note: The WTP values are provided per season. The daily wage rate is approximately LKR 1000.

Table 6. Individual and group samples – labor and money

	(1) Money-Individual	(2) Money-Group	(3) **Labor-Individual***	(4) **Labor-Group***
ASC	21761.9***	37380.9***	34.91***	−104.0
	(4994.3)	(13989.0)	(13.26)	(82.74)
Water for paddy	28115.3***	24276.8***	36.34***	−143.8
	(6037.0)	(5818.4)	(12.51)	(101.2)
Water for other uses	3068.2***	3032.0***	5.540***	−20.79
	(757.5)	(796.3)	(1.615)	(14.66)
Cascade ecology	1680.2	3571.5*	13.08***	−13.24
	(1484.5)	(2120.5)	(4.644)	(12.42)
Cascade biodiversity	364.1**	560.6***	1.119***	−2.336
	(150.8)	(184.6)	(0.395)	(1.818)
Observations	2160	2178	1728	2898
Log lik.				
Chi-squared				

Standard errors are in parentheses *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
*Note: The WTP values are provided per season. The daily wage rate is approximately LKR 1000.

cascade restoration and higher values of each of the attributes increase the utility. We also see that the contribution is significant and negative as would be theoretically expected for the payment/contribution attribute.

The corresponding WTP values, in Table 5 Column 1 and 3, are fairly similar between the CL and MMNL model.[12] Going with the superior model, the MMNL model, we find that respondents are WTP about LKR 27,000 (≈$190) for water for paddy for 1/3 of a field, about LKR 3,100 (≈$22) for water for household uses for each month of the dry season, LKR 2,200 (≈$16) for cascade ecology, and LKR 500 (≈$3.5) for biodiversity per bird group. The ASC of approximately LKR 39,000 (≈$280) highlights that irrespective of the specific outcomes highlighted in the attributes, the respondents value cascade restoration significantly. The results are also highlighted in Fig. 4.

The results for the labor treatment for the full sample are less well behaved. Focusing on the MMNL model, Column 4 of Table 3, while the ASC and the main attributes have expected signs and significance (positive and significant for the ASC and the attributes), the payment contribution is not significant. This poses an issue as it implies that on average across the sample, the respondents were not significantly affected by the amount of labor they were expected to provide to receive the benefits of cascade restoration. As the next step to explore preferences more, we expand the analysis to separate out the individual and group treatments.

First, we discuss the standard deviation (SD) estimates from Table 3. As noted previously, an advantage of the MMNL model is that it accounts for heterogeneity in preferences. A significant SD estimate for an attribute highlights that the preferences for that attribute are heterogeneous across the sample. The results from Table 3 show that for both the money and the labor sample, the SD estimates are significant for all attributes indicating that preferences for the attributes are heterogeneous. As a result for the remainder of the analysis, we use an MMNL.

The results in Table 4 present the analysis. Conducting the survey as an individual survey vs. as a group information survey does not impact the results for the money treatment significantly. The main coefficient estimates are presented in Column 1 and Column 2 of Table 4, and the corresponding WTP values are presented in Column 1 and Column 2 of Table 6 and Fig. 5. While the coefficient on the ASC is higher for the individual treatment and the coefficient on the cascade ecology attribute switches from insignificant to significant between the individual and group settings as highlighted in Table 5 and Fig. 5, the overall WTP values are very similar and are statistically not significantly different (the 95% CIs are overlapping). This result highlights that conducting group information sessions with individual survey responses is a valid option and could reduce the cost of conducting in-person surveys in rural settings.

At the same time, if the payment is presented as a labor payment, then we find significant differences between the individual and group settings. The main coefficient estimates are presented in Column 3 and Column 4 of Table 4, and the corresponding WTP values are presented in Column 3 and Column 4 of Table 5 and Fig. 6. The ASC and the cascade attributes have similar coefficient estimates, indicating that respondent's preferences for cascade restoration attributes are not affected by the elicitation format.

Even though the coefficients on the attributes are similar, the payment attribute is insignificant for the labor payment treatment in the group elicitation setting. While the payment attribute is significant in the labor treatment for the individual elicitation, the lack of significance in Column 4 leads to insignificant WTP estimates for the labor treatment in

[12]The WTP values are in LKR per season, and the willingness to contribute values are in days per season. The daily wage rate is approximately LKR 1000.

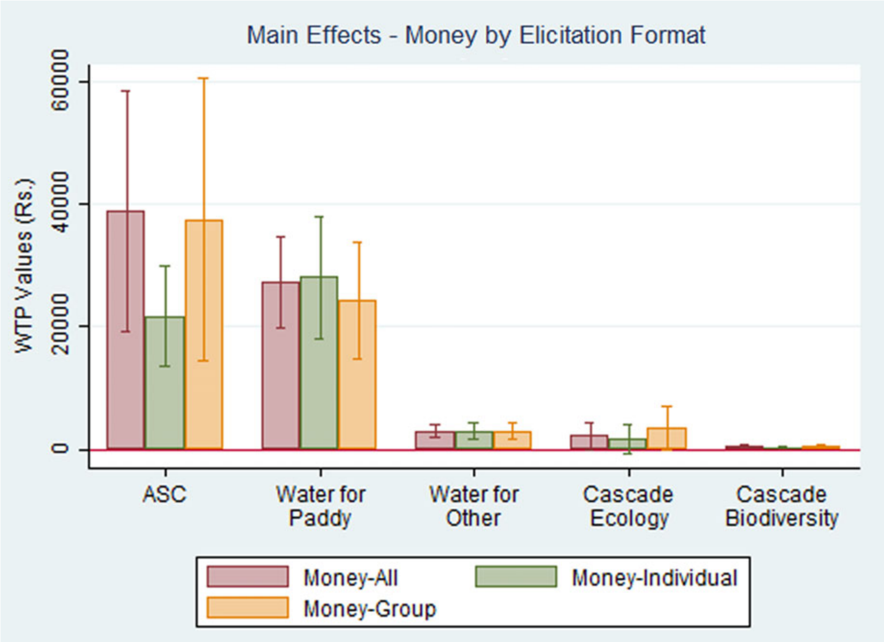

Figure 5. Willingness to pay for the money treatment for the individual sample. *Note: Coefficient estimates for the main effects analysis for the money sample. The WTP values are provided per season.

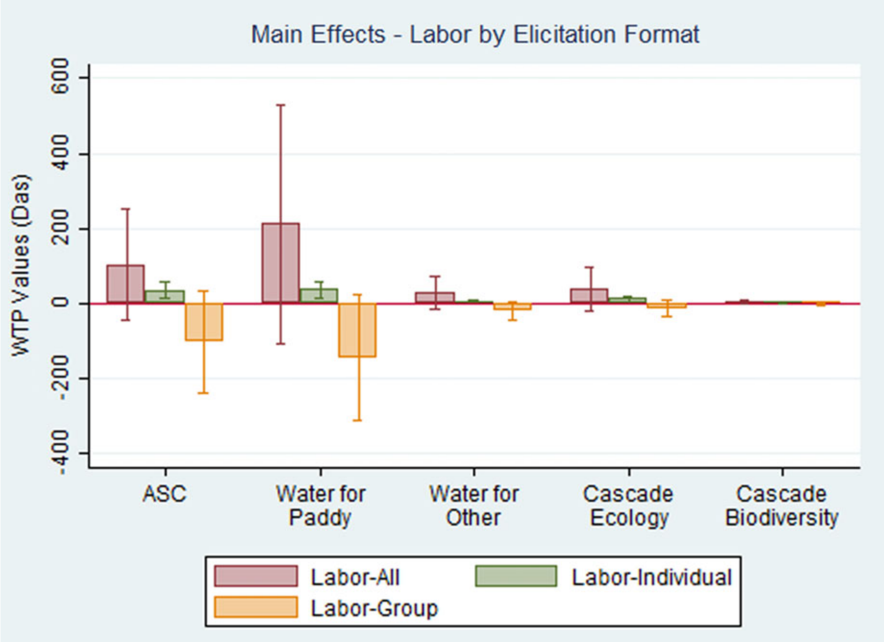

Figure 6. Willingness to pay for the money treatment for the group sample. *Note: Coefficient estimates for the main effects analysis for the labor sample. The WTP values are provided per season. The daily wage rate is approximately LKR 1000.

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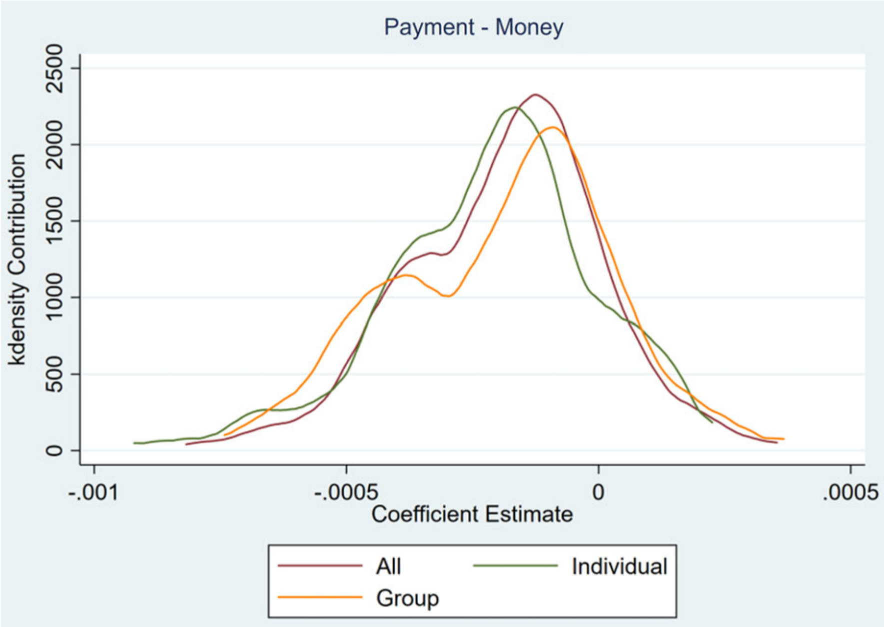

Figure 7a. Individual coefficient estimate for monetary payment attribute by elicitation type. Note: Individual coefficient estimate for monetary payment attribute by elicitation type based on the main effects estimation. The monetary payment is denoted in Sri Lankan rupees.

the group elicitation setting (see Table 6 and Fig. 6). This created an issue as (1) this implies that respondents have zero WTP and (2) this contradicts the results in the other treatments.

Next, we discuss the SD estimates. The results from Table 3 show that for all four treatments, both the money and the labor samples for group and individual treatments, the SD estimates are significant for all attributes except for Cascade Ecology and Cascade Biodiversity for the money-individual treatment (Columns 1) and for Cascade Ecology for the labor-individual treatment (Column 3). This significant SD indicates that preferences for the attributes are heterogeneous for most attributes, highlighting that preferences vary. We do find that for the nature/ecological structure and biodiversity ecosystem service attributes, the preferences are heterogeneous under the labor payment options but not under the monetary payment options. We discuss this more in the discussion section.

In an effort to better understand the results, we next generate the individual coefficient estimates for the payment attribute following Train (1998). Figures 7a and 7b present the results by elicitation type for money attribute and the labor attribute, respectively. Aligning with the WTP estimation results discussed above, the distribution of individual coefficient estimates is very closely aligned for the monetary payment variable (Fig. 7a). For the labor payment variable, we find very distinct distributions by elicitation type. In particular, a majority of respondents have a positive WTP with labor, and this result goes against economic theory; in that, we would expect the payment variable to have a negative coefficient. We discuss some potential explanations for this result in the Discussion section.

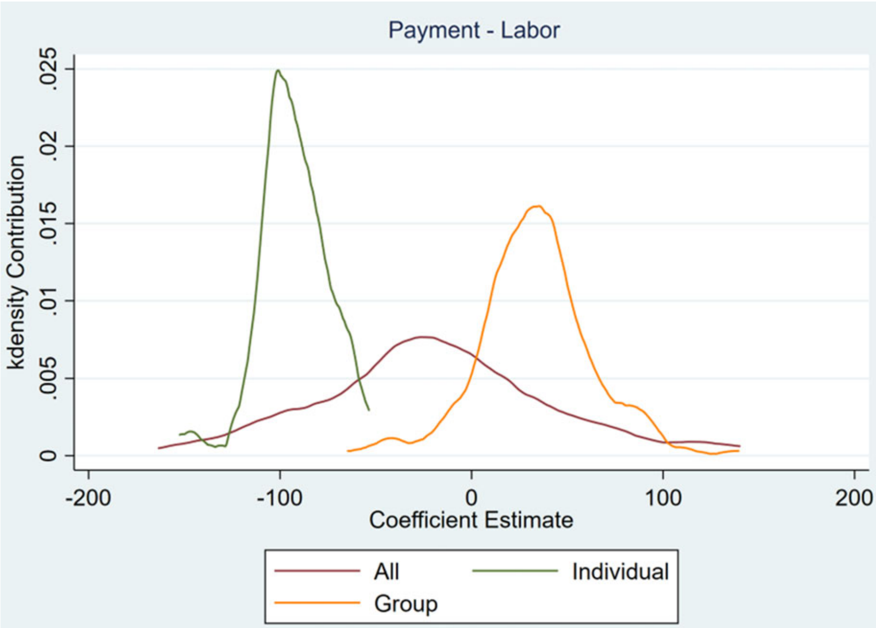

Figure 7b. Individual coefficient estimate for labor payment attribute by elicitation type. Note: Individual coefficient estimate for monetary payment attribute by elicitation type based on the main effects estimation. The daily wage rate is approximately LKR 1000.

Discussion

As noted in the literature review, there are mixed findings in the literature with regard to the comparability of WTP values using labor and monetary payment options. In contrast to studies that find that the WTP differs based on payment type, we find that for surveys conducted individually, both labor and monetary payments provide similar WTP results (by using the daily wage rate to convert labor willingness to contribute to monetary values). One key reason that is suggested as a cause for potential differences in WTP with monetary and labor is the low use of money in some rural developing country communities. Given that we conduct the survey on restoring an irrigation system with rural households that would use the water for growing and then selling rice, it is feasible that the respondents are able to think about the value of the restoration in monetary terms as they would be familiar with market prices and would regularly sell the harvest on the market.

For the group survey setting, for the survey with money as the payment vehicle, we again find similar WTP values to the individual survey. This is a promising outcome as it indicates that surveys can be done with a group information session (followed by individual surveys) which is typically cheaper than conducting individual surveys. For the labor surveys, we find a somewhat surprising result in the group survey setting; we find a positive coefficient for the labor payment variable (i.e., payments in terms of labor have a positive marginal utility). While we do not have a direct explanation for this finding, based on anecdotal evidence from discussions with the respondents and local researchers, we believe it may be a function of perceived sense of community and communal responsibilities that were implicitly highlighted in the group setting. As noted previously, historically the tank management aspects were conducted as a shared common pool resource management activity or as duty to the king. While these practices eroded with the passing of ancient kingdoms and the recent European colonization, this result highlights that while using labor as a payment option for eliciting preferences in rural settings works well for individual surveys, if surveys are done in a communal setting that results may be influenced by other external factors.

Conclusion

Using monetary payment vehicles and estimating a WTP can be problematic in rural or low-income areas in developing countries. Many respondents in these areas regularly engage in barter and paying with labor and do not use monetary payments for all transactions. This distinction from urban areas with a monetary economy and with most settings in developed countries can impact results from valuation studies as the WTP elicited from rural and low-income areas is likely to be low, even though respondents may have a high value and be willing to pay through other means. In response to these concerns, a growing number of stated preference studies explore using both monetary and nonmonetary payment options. We contribute to this literature by exploring how the use of monetary vs. labor payment options can impact values elicited from choice experiment studies conducted in rural developing country settings. We also explore if the data collection format, individual surveys vs. group information sessions, and individual surveys provide similar results.

Our application is the restoration of an ancient irrigation system known as cascading tank systems in Sri Lanka. The system was established by ancient kings over 1500–2000 years ago and currently provides irrigation for about 40% of the total irrigable area of the country. We use a choice experiment survey to understand rural villagers' preferences and the WTP/willingness to contribute to restore cascading tanks systems. We use a 2 × 2 split sample design to estimate the values for cascade restoration using both monetary payments and labor participation and to compare individual surveys vs. surveys with group information session.

Results indicate that respondents value the availability of water for agriculture, water for household use, the cascade ecosystem health, and biodiversity. At the same time given that we conduct the study in just one cascade system given the financial and time constraints, we do not attempt to generalize the results to a national level. The results are likely to be generalizable to communities in similar climatic zones, the north central areas in Sri Lanka, which also have similar socio-demographic characteristics to the cascade system being studied,

With regard to the core focus of this work, exploring the impact of labor vs. monetary payment options, we find that for the individual surveys, both labor and monetary payments provide similar WTP. We also find that for the surveys with monetary payment vehicles, both individual and group survey setting provide comparable results. This is an important finding as it is cheaper to conduct the surveys in group setting.

At the same time we find that when using the labor payment vehicle in a group survey setting, we find a negative WTP (or a positive marginal utility for the payment using labor). This result highlights that while using labor as a payment option for eliciting preferences in rural settings works well for individual surveys, if surveys are done in a communal setting that results may be influenced by other external factors.

Data availability statement. Data and replication code for this study can be obtained by contacting the corresponding author.

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Competing interests. The author(s) declare none.

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Appendix 1

Figure A1. Example of an individual respondent taking the survey (in this instance, two enumerators worked with one respondent, the person facing away from the camera).

Figure A2. Example of group information session where a group of respondents were provided information in one location (and then the respondents subsequently answered the surveys individually).

Table A1. Coefficient estimates for the individual and group samples for the MMNL with lognormal contributions

	(1) CL-Money	(2) CL-Labor	(3) MMNL-Money
Mean			
ASC	5.211***	2.548**	6.049***
	(1.256)	(1.004)	(1.429)
Water for paddy	5.053***	3.295***	4.711***
	(0.827)	(0.787)	(0.884)
Water for other uses	0.560***	0.491***	0.535***
	(0.101)	(0.0889)	(0.121)
Cascade ecology	0.298	1.157***	0.630*
	(0.274)	(0.297)	(0.382)
Cascade biodiversity	0.0677**	0.0987***	0.116***
	(0.0269)	(0.0267)	(0.0323)
Contribution × −1 (price)	−9.486***	−3.249***	−9.357***
	(0.411)	(0.607)	(0.369)
SD			
ASC	2.355***	1.489	2.522***
	(0.753)	(0.934)	(0.779)
Water for paddy	3.311***	4.237***	−4.254***
	(1.042)	(1.016)	(0.980)
Water for other uses	0.509***	0.263*	0.639***
	(0.115)	(0.144)	(0.135)
Cascade ecology	0.0241	0.876	2.260***
	(0.742)	(0.620)	(0.613)
Cascade biodiversity	0.0701	0.0963*	0.138***
	(0.0723)	(0.0511)	(0.0520)
Contribution (price)	1.864***	−1.329***	1.455***
	(0.231)	(0.277)	(0.196)
Observations	2160	1728	2178
Log lik.	−394.3	−341.6	−417.2
Chi-squared	211.9	75.42	151.3

Standard errors are in parentheses *$p < 0.1$.**$p < 0.05$. ***$p < 0.01$.
Note: The attributes were level-coded: paddy area – percentage of the area that can be cultivated in the dry season ranging from 0.5 to 1 of the field area; water for other uses – number of months of water availability ranging from 8 to 12; cascade ecology – the area with functioning and intact ecological cascade components ranging from 1/3 to 1 of the cascade area; cascade biodiversity – number of bird species groups ranging from 1 to 2; the contribution – coded as contribution in Rupees per season or contribution in days of labor per season for the monetary and labor surveys, respectively. All attributes except for Contribution (price) is specified as having a normal distribution. The Contribution (price) is specified as having a log-normal distribution. The daily wage rate is approximately LKR 1000.

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