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Willingness to Pay for Water Quality Improvements of River Jhelum: A Contingent Valuation Method

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ABSTRACT

Management of water and sanitation is one of the important sustainable development goals. It has become a top priority of all nations to achieve goals by 2030. However, the urban stress in many developing countries has deteriorated the quality and extent of freshwater bodies which in turn affected the welfare of the people. The River Jhelum in Jammu and Kashmir, a fragile ecosystem in the north-western Himalayas, is deteriorating due to growing anthropogenic pressures, primarily from untreated urban sewage and drainage that flow directly into its waters. There is a need to provide critical inputs to policymakers about the benefits of water quality improvements of River Jhelum for its sustainable management. Therefore, this paper tried to estimate the economic benefits of water quality improvements of River Jhelum using the Contingent Valuation Method (CVM). The construction of community sewage pits as a scenario with monthly cleaning fee/donations as payment vehicles were used to estimate the willingness to pay of 280 respondents selected from the on-the-bank user population of Kashmir division across the course of River Jhelum. A binary logistic regression model was used to analyze the CVM survey data. The mean willingness to pay estimated from the results was ₹401.19 per month per household by utilizing the single-bound dichotomous CV question format. The respondents revealed their preference for improving the water quality of River Jhelum and the results are very substantial for policymakers in choosing an appropriate policy for sustainable management of River Jhelum in Kashmir.

Keywords: River Jhelum, water quality improvements, contingent valuation method, willingness to pay.

1. Introduction

Water is the life-sustaining ingredient of this planet. However, over a period of time, various anthropogenic pressures and urbanization have led to the shrinking of water bodies and declining water quality. Deterioration in the water quality of surface water ecosystems has resulted in the widespread loss of ecosystem services that these water bodies provide. The rising population affects the per capita water availability, deteriorating water quality which in turn affects biodiversity and water ecosystems (Dwivedi et al., 2018). Furthermore, the unfavorable impacts of urbanization on river ecosystems are more extreme in developing countries. This is due to the challenges faced by developing nations in maintaining water quality and likewise allowing for economic development and population growth (Kunwar et al., 2020). In the Indian subcontinent, 30 percent of the major Himalayan rivers are biologically dead, making them unsuitable for fishing or human consumption. Although the rivers have the capacity for self-purification, this capacity is altered as a result of anthropogenic activities in the river catchment, leading to the destruction of this important ecosystem (V. H. Smith, 2003). In addition, the river ecosystems deliver various types of goods and services to society. These goods and services are both marketed as well as non-marketed. Water used for recreation, drinking, and fishing is considered as a marketed service. In contrast, water's role in supporting biodiversity, religious and cultural values, aesthetic qualities, and aquatic habitats is categorized as non-marketed benefit (Katuwal, 2012). Though these services are very significant to life, however little is known about how people value these specific benefits in developing nations like India. Therefore, the current study estimated the benefits associated with water quality improvements of River Jhelum in Kashmir, India.

Jhelum, is a Himalayan river in Jammu and Kashmir, with rich biodiversity, flora, and fauna. It has ecological and economic importance. However, over the past three decades, sewage pollution levels in the River Jhelum have steadily increased, as evidenced by rising Biological Oxygen Demand (BOD) and declining Dissolved Oxygen (DO). BOD levels at key sites such as Bijbehera, Baramulla, Khannabal, Panthachowk, Sopore, and Zero bridge exceed 2 ppm, surpassing the Indian Standards for drinking water quality. In contrast, the water at the river's source in Verinag remains crystal clear. In addition, DO levels from the Anantnag to Chattabal Vier fall below the optimal level of 6 ppm, indicating significant habitat stress. Total Dissolved Solid (TDS) also shows an upward trend as river flows downstream. The ever-increasing anthropogenic pressure has severely degraded the water quality of River Jhelum (Rashid & Romshoo, 2013).

The deterioration of water quality in the River Jhelum not only threatens its rich biodiversity but also has led to a significant decline in two major fish species: Schizothorax sp (Algaad) and Botia Birdi (Ramgurun). Although the River Jhelum and its tributaries contribute 19.9 thousand tons of fish annually, local fishermen report a continuous decline in fish production. The Pollution Control Board, Srinagar, J&K (PCB), has classified the water quality of River Jhelum as Class B, indicating it is only safe for swimming and boating. A 2019 PCB survey revealed nearly 100 drains and 500 toilets are directly connected to the Jhelum. The PCB warned that without regular freshwater inflow from the Lidder River and other tributaries, the Jhelum would essentially become a giant drain for sewage from across the Kashmir Valley.

To address this issue, the J&K government plans to install Sewage Treatment Plants but financial constraints have stalled progress. An alternate solution proposed to improve the water quality of Jhelum involves constructing community-based sewage treatment pits, where households would pay for the regular maintenance and cleaning of the pits. The present paper attempts to estimate the willingness to pay for such a program using the Contingent Valuation Method, emphasizing the importance of monetizing the benefits of water quality improvements of River Jhelum for informed policy decisions. The next section provides a brief literature review.

1.1. Valuing Water Quality Improvements: A Review

Both revealed and stated preference methods are used to value non-marketable goods and services. Revealed preference techniques, such as using travel costs to restored river sites as a proxy for the recreational value visitors derive or examining the impact of restored rivers on house prices (Lee et al, 2016). More frequently than revealed preference, stated preference (SP) methods are utilized to measure the total economic value of river restoration (Dai et al, 2021). Water quality is a non-marketable environmental good, its valuation has traditionally relied on directly stated preference techniques, particularly the Contingent Valuation Method (CVM) (Del Saz-Salazar et al., 2009). Numerous studies have used CVM to evaluate the benefits of water quality improvements. This section will review previous studies that focused on valuing these improvements.

For example, Mitchell & Carson, (1981) used CVM to assess the benefits of water quality improvements, which include the increase in native fish species, safer water for bathing, swimming, and drinking, additional recreational opportunities, and a boost in tourism activities. Similarly, both CVM and the Travel Cost Method (TCM) were applied to estimate the benefits of water quality enhancements for the river Monongahela. These techniques are appropriate for measuring the benefits of recreation. In the Chesapeake Bay, the largest estuary in the U.S., the CVM was used to value the water quality improvements. The study found that aggregate estimates ranged from $10 million to over $100 million. Although the authors claimed that these estimates are not entirely precise, they suggested that they are plausible for the annual cleanup of the Chesapeake Bay, which falls within the same range (Bockstael et al., 1989).

Further, the Stated Preference Methods have been applied to value the improvement in water quality as outlined in the European Water Framework. These methods have provided valuable insights with significant policy implications and have been incorporated into cost-benefit analyses (Brouwer, 2006). Le Goffe, (1995) applied CVM to assess the improvements in coastal water quality for Brest Natural Harbor, developing values for both water salubrity improvement and ecosystem preservation of the ecosystem from eutrophication. Ready et al. (1998) applied CVM to assess willingness to pay (WTP) for river and drinking water quality improvements in Sigulda, Latvia.

Atkins & Burdon, (2006) estimated the benefits and costs of reduced eutrophication of the Randers Fjord in Denmark using the CVM. Their survey revealed positive monetary support for a plan to restore the Fjord to its original condition. Brox et al. (2003) also utilized CVM to evaluate willingness to pay for water quality improvements in the Grand River, employing various CV questions with a 'payment card' approach. Their findings highlighted a correlation between respondents' decision to answer a CVM question and their stated

WTP, suggesting that CVM estimates could be biased and inconsistent if based on a single question or limited to observed WTP responses.
Ramajo-Hernández & del Saz-Salazar, (2012) applied CVM to measure the benefits derived from improvements in the water quality of Gudian River. The study looked into the issue of zero WTP reactions while tending to the conceivable presence of self-selection bias brought about by the responses of protesters. The results revealed the WTP for water quality improvements is ($2.2) monthly (Kwak et al., 2013). Similarly, Jianjun et al., (2016) attempted to elicit the WTP for drinking water quality improvements using CVM as an addition to the water bill that they were already paying. Interestingly, another study O'Connor et al., (2020) explored the Italian resident's WTP for restoring Dohrn Deep-Sea Canyan Bay of Naples.
The Contingent Valuation Method (CVM) has been widely used to assess the benefits of river water quality improvements in various contexts. However, to the author's knowledge, there are no existing studies that measure the benefits of water quality improvements for the River Jhelum in Kashmir. This study aims to address this gap by using CVM to estimate the willingness to pay (WTP) for water quality improvements.

1.2. Study Area

River Jhelum is one of the primary waterways in Kashmir, India, originating from Verinag spring at the foothills of the Pir Panchal range in Anantnag (J&K). The river flows from South to North, serving about 25 percent population in Kashmir. Stretching approximately 203 kilometers, the river flows into Wular Lake and then through Baramulla before entering Pakistan. Jhelum basin has a total of 24 watercourses. The main tributaries on the left bank of the Jhelum basin are Visav, Romshi, Rambaira, Sukhnag, Ferozpura, Dodhganga, Ninagal Nallah, Vij-Dakil Nallah, and Gundar. Likewise, the tributaries on the right side of the Jhelum basin are Lidder, Bringi, Aripath, Sandrin, Arpal, Sindh, Dachigam, Erin, Mahmumati, and Pohru. Large numbers of the channels from the sideways of the Pir Panchal join the stream on the left bank and a few from the Himalayas join the river on the right bank. The Jhelum River spans approximately 100 kilometers from the top of the Pir Panchal range to the Great Himalayan range. The total catchment area up to the Line of Control, where it enters Pakistan, covers about 1,585 square kilometers.
The River Jhelum is renowned for its crucial role in the livelihood of Kashmir. Nearly a century ago, it was the backbone of internal trade and commerce in the region. Its waters irrigate agricultural lands, including orchids, rice fields, and vegetable farms. Its source, Cheshma Verinag, is a major tourist attraction in the valley, celebrated for its crystal-clear, cold waters. Additionally, the River Jhelum is essential for irrigation, hydropower, drinking, and recreation for the millions of residents in the valley. After Wullar Lake, River Jhelum is the second-largest fisheries asset of the valley as it harbors a wide variety of fish fauna. Apart from this, the River Jhelum has cultural, spiritual, and religious importance to the residents of Kashmir. Jhelum (Vistata) is mentioned in Rigveda as one of the greatest rivers of all time. But, over time, it has become the main source of sewage dumping and sand extraction in Kashmir.

2. Materials and Methods

2.1. Contingent Valuation Method

The need to value numerous non-market goods has led to the development of various valuation methods (Halkos et al., 2022). This study focused on the Contingent Valuation Method (CVM) to evaluate the non-traded benefits associated with water quality improvements of River Jhelum. The use of stated preference information for the valuation of natural resources has come to be known as CVM. It is one of the most widely used methods to measure the economic value of environmental goods and has gained extensive acceptance among policymakers and researchers as a flexible and comprehensive approach for estimating benefits (Mitchell & Carson, 1989, 2013), (Sebo et al, 2019). This method utilizes designed survey tools to reveal information on public preferences and their Willingness to Pay (WTP) for hypothetical improvements in the good or service undervaluation (O'Connor et al., 2020).
CV relies primarily on respondent's assertions and statements rather than their behavior in real market situations. This reliance is seen as both its greatest disadvantage and advantage (Amirnezhad et al., 2006). Although there are disagreements, the National Oceanic and Atmospheric Administration (NOAA) blue-ribbon panel recommended that CV can provide sufficiently reliable measures for administrative and judicial decisions, offering various recommendations (Arrow et al., 1993). Additionally, CV has proven to be an effective method for evaluating household's willingness to pay for environmental improvements in both developed and developing countries (Vásquez & de Rezende, 2019). In this study, a well-designed CVM questionnaire was utilized, following NOAA panel recommendations (Mitchell et al., 1989). This approach measures the value that respondents place on the water quality improvements of River Jhelum, as reflected in their WTP for the hypothetical Community Sewage Treatment Pits Program.

2.1.1. Payment Vehicle in CV Survey

The Contingent Valuation (CV) method is defined by several parameters, depending on the researcher's needs and objectives. These include the period of payment (monthly, yearly), payment vehicle (Donation, Fee, Tax), and the design of Willingness to Pay question (open-ended, payment card, or dichotomous choice (Orlowski & Wicker, 2019). The impact of the payment vehicle on WTP in CVM has been widely studied (Ivehammar, 2009). Cummings, (1986) emphasized that the payment vehicle must be realistic, reflecting how the proposed initiative would be funded if implemented. The issue of incentive compatibility is consistent with the payment formats used, that is respondents may not have an incentive, to tell the truth. However, Carson & Groves, (2007) recommends that the payment format utilized while valuing a public good should be compulsory to be incentive compatible. When the payment vehicle is voluntary (e.g., Donation), respondents might overstate the willingness to pay and then "free ride" (Ivehammar, 2009). Researchers have used various payment vehicles, including annual taxes, increased fees, higher prices, water bills, and donations (Desaigues et al., 2011; Lindhjem & Navrud, 2009; Menges & Beyer, 2014; Ramajo-Hernández & del Saz-Salazar, 2012). In this study, two Payment Vehicles (Donation and Sewage Treatment Fee) were used as funding mechanisms for the water quality improvements of River Jhelum.

2.2. Theoretical Framework of the Contingent Valuation Approach

The method of CV is well-established in welfare economics, specifically within the neoclassical theory of economic value, which focuses on maximizing individual utility. In addition, CV survey instruments are capable of straightforwardly attaining Hicksian monetary measure of welfare. This is linked with a discrete variation in providing an environmental good for the other or the marginal substitution of various attributes of an existing good (Hoyos & Mariel, 2010).

Hicks (1946) divided the consumer surplus measure into two categories: compensating variation and equivalent variation. The CV method attempts to assign values to public goods by determining maximum Willingness to Pay (WTP) for acquiring goods and services not sold in the market or minimum Willingness to Accept (WTA) to compensate for the loss of environmental resources (King and Mazzotta 2000). The Hicksian compensating surplus is defined as the maximum willingness to pay, indicating that an individual is better off in a new situation if the compensating variation is positive (Chipman & Moore, 1980). A value measurement is considered a compensating surplus if two conditions are met: the older utility level (U_0) and an improved environmental quality (Q_1). Another question arises "What is the minimum compensation the individual is willing to accept (WTA) to forego the increase in environmental good?" The response to this question is an individual would need an expansion in the level of combined consumption good to such an extent that the person accomplishes the new utility level (U_1) that would have been achieved if the environmental good had increased from Q_0 to Q_1. Thus, the minimum willingness to accept (WTA) is the Hicksian compensating surplus. Moreover, two conditions must be satisfied for the measurement of an 'equivalent surplus': the new utility (U_1) and (Q_0) the older level of the environmental good. This is the willingness to pay measure (WTP) (Turner et al., 1993).

A divergence exists between WTP and WTA measures, influenced by various factors such as the substitution effect, income effect, transaction costs, and broad-based preferences. This divergence has been widely recognized in the Contingent Valuation Method (CVM) literature, with empirical and theoretical studies confirming its presence (Adamowicz et al., 1993). As a result, WTP is generally recommended over WTA for use in CV studies (Cummings, 1986; Arrow et al., 1993). In this study, the Hicksian WTP measure was used to estimate consumer surplus for water quality improvements in the River Jhelum.

2.3. Contingent Valuation Survey Design

This section presents a brief overview of the CVM questionnaire design, focusing on the target population and the administration of the final survey. The most significant thing in designing a CV survey instrument is setting the appropriate scenario for the valuation of a good or service. Further, to enhance the reliability of the CV survey, the context of the hypothetical scenario must be meaningful, credible, and understandable (Lee, 2014).

The CV survey tool was used to reveal the WTP value that respondents in Kashmir assigned to water quality improvements of River Jhelum. Following the recommendations given by Arrow et al., 1993, a CV survey was generated for this study. Focus Group Discussion (FGDs) and survey pretesting were conducted to refine the final survey tool and to gather information on the different aspects related to water quality improvements of River Jhelum. The final CV questionnaire comprised three sections with a brief cover letter. Section 1 comprised questions related to the general environment and activities on River Jhelum. This section also assessed respondent's familiarity with the 'good' being evaluated, which enhances the validity and accuracy of CV studies (Lee, 2014). Section 2 of the questionnaire covered the current status of River Jhelum and the hypothetical benefit scenario to improve the water quality.

The Community Sewage Treatment Pits Project (CSTPP) outlined below was proposed as part of the Benefit Scenario: Assume that the Pollution Control Board will not allow any household to drain any kind of sewage directly into Jhelum. Instead, Community Sewage Treatment Pits will be constructed by the local Municipal Corporation/Committee for every ten households in urban areas. At the end of each month, they will clean those community pits. This will prevent sewage inflow and help to improve the water quality of River Jhelum. However, the local Municipal Corporation/Committee will charge every household in the form of a Sewage Treatment Fee. The Government will provide one-time funds for constructing these pits; however, for cleaning pits, households have to pay a necessary fee for sewage treatment. This CSTPP will go ahead only if 50 percent of the households vote for this. Imagine that if the project is not implemented, the river water will

be dirty and smelly, and may lead to loss of biodiversity and ecological functions. The fee paid by all the urban households in Kashmir will be used only for cleaning sewage pits.
Following the hypothetical scenario, respondents were asked if they would be willing to pay a monthly sewage treatment fee/donation for 10 years to improve the water quality of River Jhelum, with a yes or no response in the CV question (Carson et al., 2001; Champ et al., 2002). Considering the importance of the CSTPP, each respondent was asked if they supported the project and if they would be willing to pay a monthly sewage treatment fee/donation of ₹'X' for 10 years from six possible randomly assigned bid values (₹150, ₹200, ₹300, ₹500, ₹1000). If the respondent stated 'no' to the bid, then it was followed by an open-ended question about the amount they would be willing to pay to the project. Section 3 of the questionnaire focused on respondents' personal information and socio-economic characteristics, which was crucial for analyzing the impact of these factors on WTP for water quality improvements of River Jhelum.
Two versions of the CV questionnaire were administered in three districts of Kashmir using split sampling. The River Jhelum flows through three key districts of Kashmir including Anantnag (South), Srinagar (Centre), and Baramulla (North). The water quality deterioration of the Jhelum directly affects residents in these districts, making them the target population for this study. A multistage stratified random sampling method was used to select representative household heads. The representative sample above the age of 18 years was interviewed. Before the final survey, a pilot survey of 30 respondents was done using an open-ended question format, which was helped to design bids offered in the final survey. A total of 300 face-to-face interviews were conducted, as this method is widely recommended for general and stated preference surveys (Mitchell et al., 1989; Arrow et al., 1993; Lazaridou & Michailidis, 2020), and typically yields higher response rates than mail or phone surveys (Halkos et al., 2020). Two hundred and eighty completed questionnaires were retained for the final analysis.

2.4. The Empirical Model Description

Developing a theoretical model for estimating values is crucial in any CV study (Boyle, 2017). Within the utility framework, welfare changes are measured as the difference between the current level of utility say 'U_0' under the present condition of environmental good and the new level of utility 'U_1' that is attained after improvement in the quantity or quality of the goods undervaluation. The welfare of an individual is improved if the new level of utility exceeds the old utility ($U_1>U_0$).
Following Flores (2017), the theoretical model for the water quality improvements in the River Jhelum can be described as:

$$V(P^0, Q^0, Y) = V(P^0, Q^1, Y - WTP) \quad (1)$$

In equation (1), V represents the indirect utility function, P is the price of Jhelum's water quality, and WTP indicates the respondent's willingness to pay for water quality improvements. Likewise, Q^0 denotes the current water quality and Q^1 represents the improved water quality of River Jhelum if the proposed Community Sewage Treatments Pits Project (CSTPP) is implemented. The CSTPP is intended to improve the water quality of River Jhelum (where $Q^1 > Q^0$).
In CV studies, responses vary with the format of the CV question (Flores, 2017). Common formats include Open-Ended questions, Payment Cards, and Dichotomous Choice questions. This study employed the DC format, also known as a referendum or closed-ended format, recognized for its 'incentive compatibility,' which prompts respondents to reveal true preferences, and simplifies their cognitive task. The single-bounded DC question mirrors real market situations (Hundie & Abdisa, 2016). Econometric analysis is required to estimate WTP in the DC format, based on the function depending on the definitions of value (Boyle, 2017).
The general function for estimating willingness to pay can be expressed in the following form

$$\log(WTP) = x'_i \, \alpha + e_i \quad (2)$$

In equation (2), x'_i signifies the vector of opinions that affects respondent's WTP, α displays the vector of preference coefficients that will be estimated in the equation and e_i shows the random error term that may be assumed to follow the normal distribution with a mean of zero and standard deviation σ\sigma.
In the DC question format, respondents were asked if they would support the Community Sewage Treatment Pits Project and whether they would be willing to pay ₹'X' as sewage treatment fee or donation to improve the water quality of River Jhelum. A respondent will answer "yes" to the offered bid of ₹'X' if the new level of utility is higher or equal to the older level of utility, following Richardson et al., (2006).
The probability of a YES answer is given as:

$$P(YES/Rs.X) = P(f(wtp = 1, Y - Rs.X) \quad (3)$$

In addition, a probabilistic component e_i is linked with the utility as given in equation (2).
The probability function can be written as

$$p(yes/Rs.X) = p(v(wtp = 1, Y - Rs.X) + e1 \ \geq (wtp = 0,1) + e2 \quad (4)$$

In equation (4), distribution of the deviation between the random error, terms follows the logistic function (Loomis, 1987; Hanemann, 1984).

2.4.1. The Logit Model

Primarily, Logit and Probit Models are used for data estimation in CVM literature since the dependent variable is binary (Hoyos & Mariel, 2010; C-K. Lee & Han, 2002). Given the dichotomous nature of the dependent variable, a 'Binary Logistic regression Model' was employed to estimate the respondent's WTP for water quality improvements in the River Jhelum.
The probability (Pi) represents the likelihood that a respondent is willing to pay ₹X for the River Jhelum's water quality improvement program.
The linear expression for the logit model can be expressed as:

$$WTP(Yes/1) = f(Bidvalue + Marst + Empst + rivkno5 + Menvorg + PV + HHincome) \quad (5)$$

A description of all socio-economic variables is given in Table 3. Employing the Loomis, 1987; Hanemann, 1984 specification for the standard logit function

$$Pi = Fn(\Delta V) = 1/\{1 + \exp(-\Delta V)\} \quad (6)$$

$$= 1/\{1 + \exp\left(-(\beta_0 + \beta_1 Si + \beta_2 M_{envorg} + \beta_3 PV + e\ \right) \quad (7)$$

In equation (6), the probability of a "Yes" response to the WTP question is represented by Pi and $Fn(\Delta V)$ is the Cumulative Distribution Function (CDF). This explains the behavior of the predictor dichotomous variable using a standard logistic function, which also incorporates socio-economic determinants. Si signifies the socio-economic factors of the individual i, including Bid Value, Marital Status, Employment Status, River know-how, and Household Income. M-envorg indicates if the respondent is a member of any environmental organization, and PV is the payment vehicle used in the study. $\beta_1, \beta_2, \beta_3$, refer to the number of coefficients that will be estimated in this equation β_0 is the intercept term. The coefficients $\beta_0, \beta_1,\ \beta_2, and\ \beta_3$ in the logit model were assessed through maximum likelihood estimation using statistical software STATA.

2.4.2. Marginal Willingness to Pay

As discussed already in this study dichotomous choice question format of the CV was utilized in the survey (Cameron & Quiggin, 1994). Further data was analyzed by employing the standard logistic function. The mean willingness to pay was calculated using the following formula (Hanemann, 1984).

$$\text{MeanWTP} = \frac{\{\ln(1 + \exp(\alpha))\}}{|\beta|} \quad (8)$$

In this equation (8), α represents the summation of products of β coefficients multiplied by the average values of the corresponding explanatory variables (except the bid value coefficient) plus the summation of the constant term (Hanemann, 1984).

3. Results and Discussion

Table 1 highlights the percentage of "Yes" responses for each bid offered to respondents in the survey. Table 2 outlines the reasons why some respondents were unwilling to pay (WTP) the proposed bid.

Table 1 Percentage of yes responses on each bid offered to the respondents in the CVM question

Bid Value	**₹150**	**₹200**	**₹300**	**₹500**	**₹1000**	**₹1500**
Yes response Percentage	72.3	65.11	65.11	50.98	36.73	30.61

Out of the total 280 responses, 51.79 percent of the respondents accepted the bid value offered, while 48.21 were not WTP and were reluctant to pay for the water quality improvements of River Jhelum. The mean WTP for lower bids increases slightly between ₹150 and ₹200 and displays marginal change among the two other bids ₹300 and ₹500. However, as the amount of bid value increases from ₹150 to ₹1500, the acceptance percentage declines.

Table 2 Reasons for why most of the respondents are not WTP the bid offered (WTP=₹0)

Reason for ₹0 WTP	**Frequency**	**Percent**	**Type**
Income Constraint	42	66.67	Real negative
The amount offered is too high	7	11.11	Real negative
Don't trust the government or any organization	2	2.17	Protest Bidders
Already paying taxes	1	1.59	Protest Bidders
Don't care about River Jhelum	2	3.17	Real negative
Government should pay from the Budget	9	14.29	Protest Bidders

3.1. Respondents Socio-demographic characteristics

A brief description of the socio-economic characteristics of the respondents and key variables used in the analysis is presented below. Table 3 describes variables along with their units, while Table 4 presents descriptive statistics of respondents. On average, households reported 112 visits to the Jhelum River annually. Regarding river uses, 45.36 percent use it for irrigation and agriculture, 44.64 percent for recreation, 30.71

percent for fishing, 37.54 percent for drinking and 22.14 percent for sand extraction. Additionally, forty-six percent of respondents were married, and the average number of employed persons was 51.9 percent. Notably, seventy-two percent of respondents were aware of the water quality problems of River Jhelum. Only a small fraction, with a mean of 6.8 percent, were members of an environmental organization. The mean value of the percentage of respondents who accepted donation as the payment vehicle as against fee payment is 52.1 percent. Household Income was classified into 9 groups: 58.93 percent were in groups 1 to 4, 22.86 in groups 5 to 7, and 18.22 percent in income groups 8 to 9.

Table 3 Description and units of variables

S.No.	Variables	Description and Units of variables used model
1	Bid value	Bid offered in rupees for improving the water quality in the River Jhelum
2	Mar_st	Marital Status of the respondent (1=if a person is married, 0=otherwise)
3	WTP	Willingness to pay for the Bid offered to the respondent (if yes=1, if no=0)
4	Emp st	Employment status of the respondent (1= if the respondent is employed, 0= unemployed
5	Rivknow5	If the respondent is aware of the water quality problems of the River Jhelum(1=yes,0=no)
6	m_envorg	If the respondent is a member of any Environmental Organization (1=yes, 0=no)
7	Pv	Payment Vehicle used in the study (Donation=0 and Fee Payment=1)
8	hh_income	Annual Income of Household (1=Under ₹50000; 2=₹50000-₹100,000; 3=₹100,000-₹200,000; 4=₹200,000-₹300,000; 5= ₹300,000-₹400,000, 6= ₹400,000-₹500,000; 7=₹500,000–₹600,000;8=₹600,000-₹700,000; 9=Above₹700,000)

Table 4 Descriptive Statistics (N=280)

Variable	Obs	Mean	Std. dev.	Min	Max
Mar_st	280	.460	.499	0	1
WTP	280	.519	.500	0	1
Emp st	280	.592	.492	0	1
Rivknow5	280	.721	.449	0	1
m_envorg	280	.068	.252	0	1
Pv	280	.521	.521	0	1
hh_income	280	4.278	2.741	1	9

Table 5 Logit Model results

Variable	Coef.	Std. Err.	Z	P>|z|	[95% Conf.Interval]	
Bidvalue	-.0015253	.000299	-5.10	0.000*	-.0021115	-.0009392
Mar_st	.7759176	.3013521	2.57	0.010*	.1852785	1.366557
Employment Status	.5634407	.2900399	1.94	0.052**	-.0050269	1.131908
rivkno5	.4093899	.3011324	1.36	0.174	-.1808188	.9995986
m_envorg	1.311097	.6924272	1.89	0.058**	-.0460353	2.66823
Pv	-.0925693	.2668779	-0.35	0.729	-.6156404	.4305017
hh_income	.0351972	.0514827	0.68	0.494	-1.335383	.99621
Cons	-.1695864	.594805	-0.29	0.776	-1.335383	.99621

Note: *, **, denotes the statistical significance at the p<0.05 and P<0.01 respectively

Logit regression results in Table 5 highlight the determinants of WTP for a hypothetical CSTPP aimed at improving the water quality of the River Jhelum. The analysis shows that bid value, marital status, employment status, and membership in an environmental organization significantly influence WTP. However, factors such as river know-how, payment vehicle, and household income were found to be insignificant.

The significant negative coefficient for “bid value” indicates that as the bid amount increases, WTP for water quality improvements decreases, which aligns with expectations. This suggests that as the price of the evaluated good rises, the utility derived from it diminishes, a finding consistent with previous studies (O’Connor et al., 2020; Lazaridou & Michailidis, 2020).

The coefficient for “marital status” is positive and statistically significant, indicating that married individuals are more willing to pay than unmarried residents, likely due to higher household expenditures. This finding is consistent with previous studies (Eridadi et al., 2021; Brouwer, 2008). Employment status is another key predictor of WTP, showing a positive and statistically significant relationship at the 5 percent level. Full-time employed respondents are more inclined to support water quality improvements in the Jhelum, aligning with other research (Halkos et al., 2022; Ahmad & Hanley, 2009; O'Connor et al., 2020).

The variable "rivkno5," representing awareness of the Jhelum's water quality issues, has a positive but statistically insignificant coefficient, suggesting a preference for improvements among knowledgeable respondents. Additionally, "M_envorg," indicating membership in an environmental organization, is positive and statistically significant at the 5 percent level. This finding underscores that respondents with environmental awareness are more likely to support measures to improve the Jhelum's water quality, a result consistent with other studies (O'Connor et al., 2020).

This study also examined the impact of the payment vehicle (Donation vs. Sewage Treatment Fee) on respondent's WTP. The negative coefficient for the payment vehicle suggests that WTP decreases when respondents are asked to pay through a coercive method (fee), indicating they are less willing to fund improvements in the River Jhelum's water quality. However, this coefficient is statistically insignificant, consistent with findings from other studies (Campos et al., 2007; Bergstrom et al., 2003).

The positive relationship between household income and WTP implies that higher-income individuals are more likely to pay for water quality improvements, though this variable is also statistically insignificant. Similar insignificance of household income has been observed in other studies (Campos et al., 2007; Lazaridou & Michailidis, 2020).

In addition, the socio-economic variables age, gender, education, and distance were consistently non-significant in all models therefore they were excluded in the final model.

The mean willingness to pay was estimated using the formula provided in equation (9), based on Logit Model parameters. Calculating marginal willingness to pay is crucial for the estimation of public goods like water quality (Khan et al., 2019). The estimated mean willingness to pay is found to be ₹401.196. This mean value was calculated without removing the protest responses. Halstead et al., (1992) discussed that the removal of protest bidders in CV data may also lead to a significant bias in WTP measures.

The aggregate welfare estimates can be calculated using the following formula:

$$aggWTP = WTP * N$$

In this equation, WTP represents the estimated mean WTP, and N in the equation is the size of under impact. This study estimates the lower bound of aggregate benefits by selecting the user's population within 5km of River Jhelum. The calculated monthly mean WTP of users ₹401.196, with a total of 124,101 households within this range, based on the census 2011. The resulting total benefits from the user households in Srinagar, Anantnag, Baramulla, and Pulwama are approximately ₹49.79 million per month for 10 years. This suggests significant welfare gains from improving the water quality of River Jhelum via the Community Sewage Treatment Pits Project.

Table 6 summarizes the Logit regression model results. The logit model applied is the best-fit model with higher values of Log-likelihood -166.72, aligning with studies on water quality improvements (Choe et al., 1996). It is statistically significant with a chi-square value of 52.83 (8 degrees of freedom) at a 1 percent significance level, comparable with other studies, and a Pseudo R square of 0.1482, indicating goodfit for the cross-sectional data. These findings agree with other CVM studies (Choe et al., 1996; Vásquez et al., 2009; Cooper et al., 2004). The Hosmer- Lemeshow Chi-square test value is 11.35 (p-value of 0.1824) with eight degrees of freedom further confirms model's good fit.

Table 6 Users Logit regression model: Summary results

Statistics	**Result**	**Degrees of Freedom**	**Significance**
Total observations (280)			
LR Chi-Square	52.83	8	.000
Log-likelihood	-167.49	-	-
Pseudo R square	.1482		
Hosmer-Lemeshow chi-square test	11.35	8	.1824
Correctly Specified	70%	-	-

4. Conclusions and Public Policy Implications

The demand for water is expected to undergo significant changes due to rapid urbanization, industrialization, anthropogenic pressures, and other economic activities. As water scarcity strains many countries, sustainability of water resources has become a global concern. Developing nations witness the deterioration and depletion of freshwater reserves. In India, water quality of most of the rivers deteriorated over time and significantly affects human health, biodiversity, ecological functions, and economy. Preservation of these freshwater ecosystems will generate huge welfare gains and valuation studies attempt to quantify these benefits of preservation. As environmental issues and preservation benefits are time, case, and context-specific therefore, valuation of water quality improvements of River Jhelum is important for environmental accounting, damage assessment, making cost-efficient decisions, and public policy evaluation.

This study estimated the public preferences for water quality improvements of River Jhelum using the Contingent Valuation technique. The economic valuation of water quality improvements is expressed by the respondent's willingness to pay for the hypothetical Community Sewage Treatment Pits Program (CSTPP) which is expected to improve water quality of the river. A notable finding is the broad support for CSTPP among the user households of River Jhelum. The Logit Model results show that households near River Jhelum in Kashmir are willing to pay ₹401.196 per month per household for the hypothetical CSTTP project. Total welfare benefits for all user households are ₹49.79 million per month for 10 years, confirming significant benefits associated with water quality improvements of River Jhelum. A key issue in stated preference surveys is the choice of Payment Vehicles. This study used two common Payment Vehicles (Donation vs. Fee) to examine their effect on respondent's WTP. The Sewage Treatment Fee for cleaning pits is coercive and theoretically credible and realistic. However, findings reveal that Payment Vehicles did not significantly impact WTP. This analysis offers preliminary benefit estimates for user households of River Jhelum in Kashmir and makes a significant contribution to the Contingent Valuation literature on river water quality in developing nations.

This study provides valuable inputs and proposes critical suggestions for policy formulations. First, the welfare benefits motivate the policymakers to initiate preservation strategies and interventions which due to scarcity of funds particularly in developing countries need to be justified in terms of benefits. This study justifies public budget outlays specified for the preservation of water quality, as the benefits of preservation are considerably large. Therefore, this study can be useful for conducting a cost-benefit analysis of any preservation policy intervention. As it enumerates the welfare implications of the conservation.

Second, a major factor contributing to the deterioration of river water quality is a direct inflow of untreated sewage, which requires serious attention in preservation policies. The existing sewage drains constructed by municipal corporations that directly flow into the river are not in compliance with environmental laws. The urban drainage system has to be sustainable and key alternate infrastructural facilities need to be provided. The establishment of sewage treatment plants in the river catchment areas needs to be prioritized in public policy and budgetary outlays.

Third, using river Jhelum for waste disposal should be strictly restricted, as it will have serious environmental and economic implications. Therefore, agencies responsible for enforcing environmental laws must address violations at all levels. The town planning agencies should enforce households to manage sewage at household level. For marginalized and poor households, public policy should prioritize providing incentives and subsidizing the construction of household sewage pits in the river catchment areas, similar to 'Swachh Bharat Mission'. Given urban congestion, community sewage treatment pits are a viable option to start as a pilot project to mitigate the severe environmental damages to river ecosystem.

Fourth, preservation of river water quality not only ensures sustainability of river ecosystems which leads to ecological and economic benefits but also is critical for attaining sustainable development goals. The sustainable development goals of clean water and sanitation (SDG-6) and sustainable cities and communities (SDG-11) can not be achieved without ensuring the sustainability of urban river water ecosystems. Therefore, public policy should lay much emphasis on preserving rivers to attain sustainable development goals by 2030. A development with sustaining rivers is not sustainable in any way, therefore river management and sustainability should be a top policy priority, particularly in developing countries like India.

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