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Contingent Valuation Application for Environmental Values of Rivers in Sri Lanka – The Case of the Kelani River

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Abstract

The lack of values for non-market goods such as water presents fundamental challenges for evaluating the environmental services of important river basins such as the Kelani River in Sri Lanka. Researchers have endeavored to develop methods to value such goods and stated preference-based Contingent Valuation ("CV") has now emerged as an accepted application in mainstream economics. Despite certain limitations, CV has been applied in multiple evaluations globally and has been accepted in courts of law as a basis for determining monetary values for environmental situations. This study discusses the application of CV to assess the environmental values of water quality in river ecosystems. It defines the key determinants for a successful CV application in the context of the Kelani River. This paper explores the steps taken in the study design, methodology, development of the survey instrument, setting up of the contingent scenario, data gathering process, the assumptions of the hypothesis and any inherent biases. The study will help improve the validity, credibility and reliability of CV applications in developing economies while improving methodological rigour and precision. The pilot study estimated a mean WTP of LKR 552.38 per household, equivalent to LKR 32.86 per cubic meter, suggesting that households may be open to an additional surcharge for the Kelani River conservation. However, given the limited pilot sample size, this estimate is preliminary and indicative only. The pilot CV study provides insights to guide questionnaire refinement and methodology improvement for the implementation of the full survey. The full Kelani River CV application can support policymakers making more informed decisions, leading to better cost-benefit analysis, trade-off of policy decisions and the inclusion of public preferences in the decision-making process.

Key Words:

Contingent Valuation, Willingness to Pay, Stated Preference, Total Economic Value, Study Design, Survey Instruments, Econometric Models

JEL Classification: C25, C83, D12, D61, Q51

Foreword

River systems are a critical environmental resource that provides key benefits in consumption, agriculture, energy, transportation, recreation, and ecosystem services among many others In Sri Lanka, the Kelani River is the most important river providing water for the capital city of Colombo and the main industrial base of the most populous Western Province. The increasing urbanization and industrialization along the riverbanks have raised water pollution levels, posed serious health and environmental concerns and increasing the cost of water treatment and purification.

Estimating the economic cost of environmental pollution in rivers presents methodological challenges given the non-market nature of water quality as an environmental service. Contingent Valuation within a welfare economics framework has now emerged as an acceptable methodology to value environmental services. Academics and researchers globally are contributing to the development of the Contingent valuation applications to help improve the theoretical framework, methodology of application and interpretability of the results.

This working paper on *Contingent Valuation Application of Environmental Values of Rivers in Sri Lanka – The case of the Kelani River* provides a framework for the application of the Contingent Value approach in the case of Kelani River. The study explores and discusses the theory, methodology and the practical application of Contingent valuation drawing upon a pilot survey in the selected areas in the Kelani River Basin. The study provides insights and strategies to improve the effectiveness and reliability of the application of contingent valuation in the case of Sri Lankan River ecosystems. The study makes valuable contributions to the body of existing knowledge and adds a further reference point for studies in developing markets, an area with limited contributions to data.

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Contingent Valuation Application for Environmental Values of Rivers in Sri Lanka – The Case of the Kelani River

Sharhan Muhseen[1], S. P. Premaratna[2], and Wasantha Illangasinghe[3]

1. Introduction

"Water has an economic value in all its competing uses and should be recognized as an economic good. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resource."

(United Nations, Dublin statement on water and sustainable use, 1992[1])

The efficient allocation of water resources, taking into consideration, the role of water as a life sustaining basic human-right as well as its characteristics as a public shared good has become an increasing area of focus for economists, policy makers and other stakeholders The implications of improper management as well as the lack of a holistic approach pose significant economic costs as well as major risk factors for the welfare of society. In recognition of the high importance and risks, the United Nations in its the 2030 agenda for sustainable development has set its sustainable goal number six (SDG6) as 'Ensure availability and sustainable management of water and sanitation for all"[2].

A river basin is the area drained by a river and all its tributaries, or the area of land in which all flowing surface water converges into a single point. In the river basins, economic value is determined by the intrinsic factors of water quality and water availability, along with other relevant factors such as river basin land use, navigation, and transportation, as well as institutional and governance frameworks.

Young & Loomis (2014) have captured well the overarching and complex role of water in the economic systems. Besides health-sustaining human consumption and some noneconomic values, water has value as: a commodity and input into various instream and off-stream production processes, as a diluter and transporter of waste, recreational space, and ecological habitat (Young & Loomis, 2014). The economic role of water has evolved dramatically from early human civilizations where water was treated as a public good with limited private property rights, to situations where water now exhibits significant characteristics of a private good broadly defined as a common pool resource. Common pool resources like water resources exhibit characteristics of lack of excludability and subtractability i.e., usage by one party reduces access to another. This transition of the water ecosystems from an early development state to a more advance one is aptly described as the transition from an 'expansionary water economy' to a 'mature water economy'[3] (Randall, 1981).

The economic benefits of water are now looked at from the concept of Total Economic Value (TEV) framework. TEV estimates the full value of a natural resource, environmental asset, or ecosystem by considering all the benefits they provide, incorporating both use and non-use values. There is at present a considerable body of knowledge developed over several decades on the valuation of the many uses of water based on market or non-market methods drawing on the theoretical principles of Willingness To Pay (WTP) or Willingness To Accept (WTA) (Heinz et al., 2007). WTP is the maximum amount a person is willing to pay to obtain goods, gain a benefit or avoid a loss while WTA is the minimum amount a person is willing to accept as compensation for giving up a Good or losing a benefit. Both measures indicate how much value individuals place on goods, services, or changes in their environment. These theoretical principles have subsequently been incorporated into various economic welfare models for the management of water resources and have proven to be effective in supply allocation and demand management of water resources. However, these models have historically ignored environmental factors

[1] United Nations sustainable development goals https://sdgs.un.org/goals
[2] United Nations website for sustainable development `goals https://sdgs.un.org/goals
[3] Mature water economies are characterized by inelastic supply of water, aged infrastructure, externalities, degraded water quality and competition between users compared to expansionary water economies

or provided for limited influence within these models. Economic Welfare models[4] are in recent times progressing to incorporate environmental values into the range of variables to effectively demonstrate economic values of ecosystems.

The economic research community has developed some methods in the estimation of WTP and WTA with Contingent Value (CV) approach being applied more broadly, given the strong theoretical basis for the application. The application of CV methodology is done mostly by a WTP field survey. A study from the Asian Development bank has noted that most WTP field surveys contingent valuation studies in developing countries have been conducted with inadequate knowledge of theory and have generated poor quality data (Asian Development Bank, 2013)

Water quality is the key driver of the environmental values of river basin ecosystems providing the foundation for the health and the integrity of the ecosystem. Water quality can be classified under three parameters as physical, chemical, and biological. Physical quality contains temperature, color, taste, turbidity, odor, total solids, total suspended solids and total dissolved solids. The chemical parameter includes dissolved oxygen, biochemical, oxygen demand, PH, hardness, and electrical conductivity. Total coliform is considered under biological parameters The Central Environmental Authority (CEA) the primary government regulator for water quality has introduced ambient water quality standards for monitoring water quality.

This study aims to provide a practical framework for the successful application of CV studies in the context of a Sri Lankan River basin ecosystem by discussing the learnings from the pilot application of a CV study in the Kelani River Basin (KRB). The KRB in the Western Province of Sri Lanka is selected as a representative river basin to study the effects of water quality welfare impacts. The objective of the study is to establish insights into the methodology and procedures for the successful application of a CV study for the estimation of TEV of the KRB conducted via a field survey questionnaire. The survey is conducted in selected divisional secretariat areas to elicit WTP. Previous application of CV studies is reviewed to establish commonality in methods applied as well as for comparative purposes to assess effectiveness in appropriately representing outcomes.

The previous CV studies in Sri Lanka have covered topics including conservation of rain forests (Sinharaja), wetland eco systems including watershed areas and wetlands (Mudun Ela, Kalu Oya, Maduganga and Kirale Kale), freshwater lakes (Bolgoda), safe food attributes and cultural and historical spaces (Sigiriya). These studies have demonstrated public willingness to pay for environmental protection and the feasibility of applying CV in the Sri Lankan context. The studies have also indicated a high component of non-use values in the elicited WTP values and the significance of socio-economic factors There has not been a publicly accessible published study of the CV application for the Kelani River. Previous Kelani River studies have had a non-economic orientation, focusing on streamflow trends, water quality variance, soil erosion, saltwater intrusion and flood hazard. A CV study of the Kelani River is highly appropriate given its environmental significance and from the river being under significant stress from human impacts.

1.1 The Kelani River Basin

The Kelani River can be considered the most important river in Sri Lanka providing the drinking water requirements of 80% of the population living in the Western Province (home to more than 25% of all Sri Lankans) and having the main industrial base with over 10,500 factories situated near the river, including the two main export processing zones (Wickramaratne, 2019). In addition, the river is also used for transport, fisheries, sewage disposal, sand mining, and hydroelectricity. The KRB is the second largest watershed and is considered the most polluted river in Sri Lanka due to rapid industrialization and urbanization.

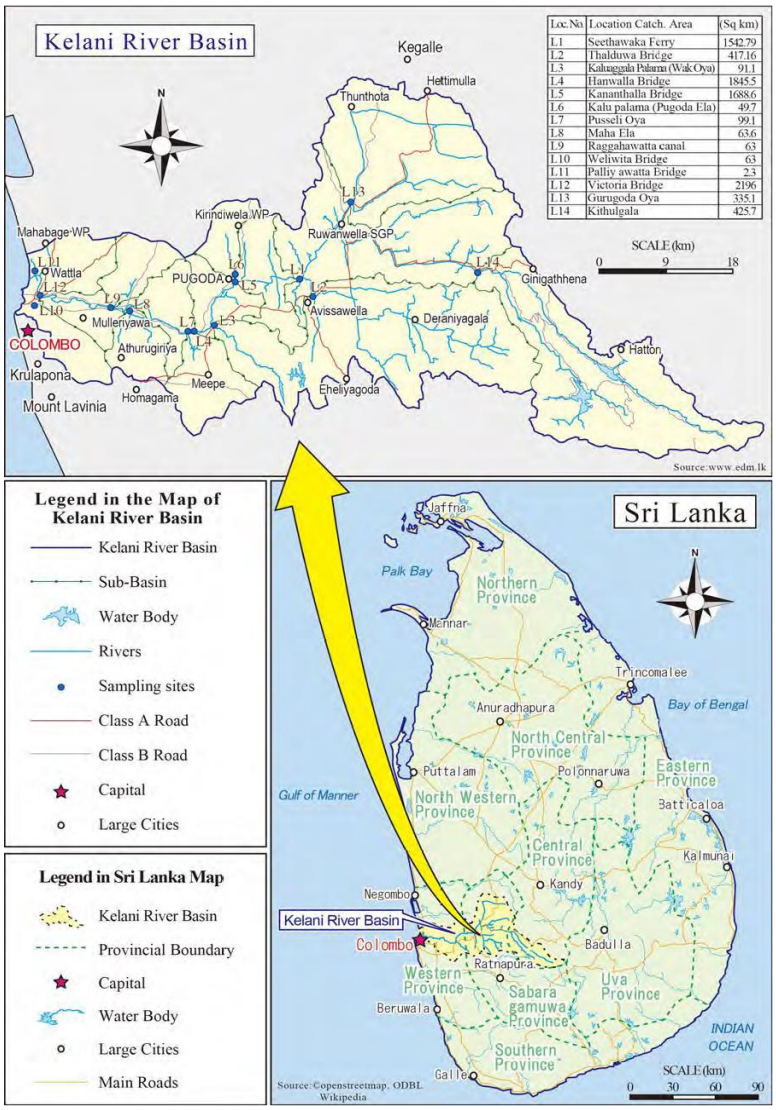
The Kelani River is 145 Km in long covering an area of 2,292 sq km, stretching from the Sri Pada mountains in the center to the city of Colombo. The KRB area is spread across 36 divisional secretariats in seven districts across the three provinces of Western, Central and Sabaragamuwa. The river is fed by two main tributaries, the Kehlgamu Oya and Masekeli Oya in its upper reaches and the We Oya, Urugoda Oya and Seethawake Ganaga in the lower

[4] Economic Welfare models study the allocation of resources and goods in evaluating the overall welfare of society

reaches and ends with the Colombo outfall. The river has an annual water mass of 7,019,000-acre feet of which about 64% flow to the sea. The river flow varies from dry season to monsoon season with a flow of 20 m^3s to 800 – 1,500 m^3s, respectively.

Significant concerns have been raised by various stakeholders with regards to the water quality degradation of the Kelani River in particular, the Environmental Audit Report on the water pollution of the Kelani River by the Auditor General's Office of the Government of Sri Lanka observed that the water of the river is being promptly polluted due to massive urbanization and industrialization. (Wickramaratne, 2019). The report also concluded that existing laws, rules, and regulations are not sufficiently followed and the intervention and monitoring to control the environmental damage is not sufficient.

Figure 1 – Kelani River Basin Ecosystem



Source: Project for monitoring the water quality of major water bodies, JAICA 2018

1.2 Water and Ecosystem Services

The earliest assessment of the economic value of water in classical economics was over two hundred years ago, when Adam Smith faced the challenge of reconciling *value in use* versus *value in exchange* in dealing with the 'diamond-water paradox.' The diamond water paradox addressed the high value of certain non-essential items such as diamonds in comparison with the low value of certain essential items such as water in his seminal work 'The Wealth of Nations.' Since then, there was only a limited discourse on the economics of water resources until about a century ago.

More serious attention to water resource economics began in the 1930s with the application of theoretical welfare economics to water resources. This has successfully addressed the diamond water paradox and provides a framework for the rapid advancement of water resource economics. The role of economics in water policy has then morphed from typically benefit cost analysis of proposed single-use infrastructure supply development projects, to analysis of optimal allocation of water across multiple uses (instream and off stream) and different water sources over larger hydrologic regions along with the further integration of hydraulic, economic, and environmental factors (Booker et al., 2012). Rapid globalization and industrialization over the last few decades have led to a greater impact and role of environmental factors in economic systems leading to the detailed study of economic implications of environmental quality. An early break-through of these studies was the Safe Drinking water act of 1974[5] in the United States setting the

[5] Safe drinking water act of 1974 was enacted by the U.S. Congress to ensure safe drinking water

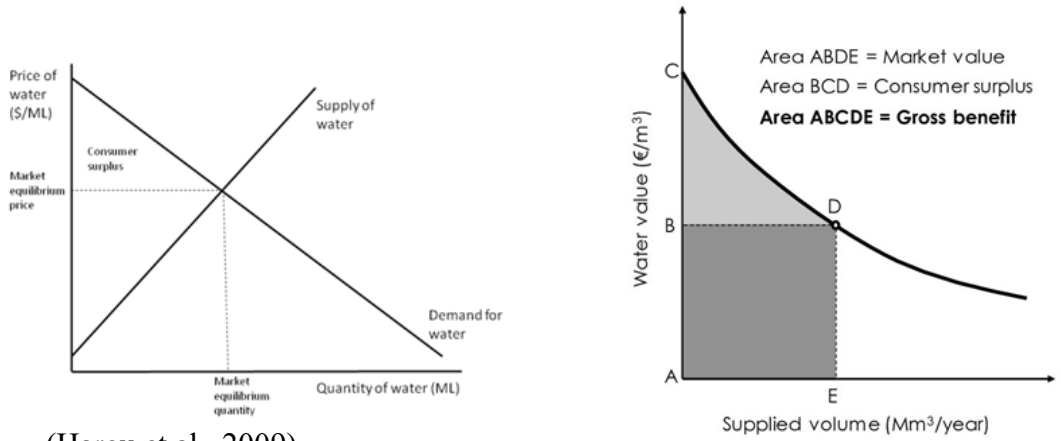
regulatory standards for the acceptable quality of water.

In the traditional sense, the economic value of water was based on a supply curve perspective, built on the investments and operating costs associated with the provision of water services. These costs were historically viewed as fixed in relation to the quantum of water supplied. Economists have, in recent times, looked at water resources from specific use and demand perspectives. The particular use of water as an intermediate or a consumption good is the key consideration in selecting the relevant economic theory to determine the economic values of water from a specific use perspective. These differences in uses have important implications for valuation method selection, since different economic theories of consumer and producer demands are applicable in each case.

In cases where water is an intermediate good used as production input for irrigation, energy or industrial use, water demand is estimated from a production function and referred to as *derived demand*. Derived demand depends on the demand for the final outputs and the technology of the production process. It is determined by the marginal contribution of water to the total output value or residual value. Water used for residential or recreational purposes is final consumption demand, where demand is influenced by consumer preferences and provides utility to consumers willing to pay monetary value for it. This behavior can be well explained under the Theory of consumer demand and the average revenue and marginal price relationship.

One of the key challenges in establishing the economic value of water is a lack of competitive markets for the efficient allocation of water resources. Establishing competitive markets is particularly difficult due to the lack of associated water property rights, free ridership, excessive cost of exclusion, ineffectiveness of institutions for policing, etc. Thus, competitive markets seldom are the chosen allocative mechanism for water (Booker et al., 2012). In the absence of efficient markets[6] for estimation of economic value of water, alternate non-market approaches have been developed. In the development of non-market valuation theories, resources are deemed to have economic value whenever users willingly pay a price for their use or be compensated for not having their use. These principles have led to the concepts used in measuring the demand and value of water from WTP and the WTA. The gross economic benefits of water are estimated by combining the consumer surplus and producer surplus determined by a water demand curve. The water demand curve is derived from the water demand function of price and water quantity where price is determined based on WTP.

Figure 2 – Water Demand Curve



Source: (Harou et al., 2009)

The economic benefits function is achieved by the integration of the demand curve. (Harou et al., 2009). The concept of marginality and the equimarginal principle[7] is applied in the exercise for the optimization of the net benefits of water resources. In this sense, net benefits are maximized when marginal net benefits are equal among

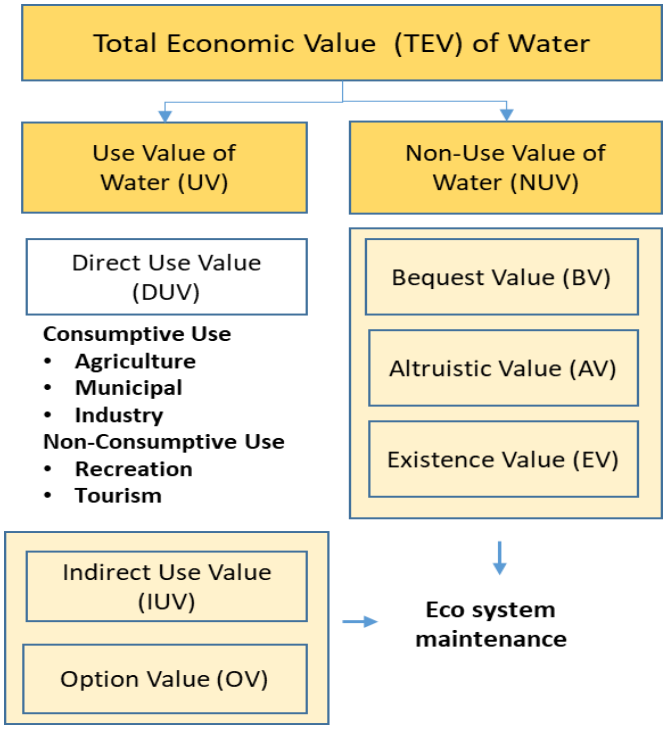
[6] Efficient markets is a hypothesis that market prices reflect all available information
[7] The equimarginal principle states that consumers will choose a combination of goods to maximize their utility

all users Haneman in his 1984 seminal work integrates the normative framework of neoclassical welfare economics with positive microeconomics modeling to show how utility theory can underpin WTP estimates.

1.3 Total Economic Value

The TEV of an environmental resource could be calculated based on the amount of money the individual household would be Willing To Pay (WTP) to conserve them. The concept of TEV is applied to estimate consumer surplus for nonmarket goods such as water quality improvements. TEV can be attributed to two sources: Use Value (UV). i.e. the value that individuals derive from using the environmental resources, and Non-Use Value (NUV) i.e. the value that individuals derive from the environmental resources even if they do not use it. UV can be further broken down into Direct Use Value (DUV), Indirect Use Value (IUV) and Option Value (OV). NUV can be further broken down into Bequest Value (BEV), Altruistic Value (AV) and Existence Value (EV): TEV = UV + NU = (DUV+IUV+OV) + (EV + AV + BV).

Figure 3 – Components of Total Economic Value



Both use and non-use values can be estimated using direct and indirect methodologies. Direct methods are Revealed Preference (RP) methods while indirect methods are Stated Preference (SP) methods. RP Method is an economic concept introduced by Paul Samuelson, that infers consumer preferences from observed choices (purchasing behavior). RP looks for similar or related markets in which the environmental good has a traded indicator of value and tries to apply it to alternative study sites. RP methods have their main advantage in reflecting actual market prices reflecting utility maximization behavior under conditions of true costs and benefits. Established RP methods include the Travel Cost method, Random Utility methods, the Hedonic Pricing method, the Replacement Cost method and the Averting behavior method. SP method is a family of techniques that use individual respondents' statements about their preferences to estimate the change in utility associated with a proposed increase in the quality or quantity of an ecosystem service or bundle of services. The SP is a survey-based method that is based on data that reflects actual market choices where individuals would bear the actual costs and benefits of their actions. RP methods are more effective to study traded market goods (or when surrogate markets are observable) with availability of historical data while SP methods are better for valuing public market goods where market data is not available.

SP provides effective estimates of the value of environmental resources that are not traded in any market, including surrogate markets. In addition to their ability to estimate the use values of environmental goods, the most important feature of these survey-based methods is that they can estimate the non-use values, enabling estimation of each component of TEV. The two primary approaches in SP method are the CV method and the Choice Experiment (CE) method. CV has been more commonly used for several decades to measure ecosystems values and is most effective when applied from a wholistic perspective. CE has a more recent history and is more effective in estimating the value of separate components in a wider scenario. Both methods have certain limitations, in terms of bias in the stimulated market in the case of CV and limitations in aggregation of a total value in the case of the CE approach (He et al., 2017).

1.4 Valuation Methods and CV Applications

The CV methodology has been selected post comparison with other methods discussed in the previous chapter given the CV ability to capture the full range of values associated with the economic good including non-use values of the KRB ecosystem which are difficult to measure under other methods. This is particularly true for water quality where no observable market or behavioral data exists. CV methodology facilitates the flexibility to tailor the study to specific environmental goods using a hypothetical scenario. The CV study uses a direct elicitation method asking WTP questions allowing for a monetary measure of value.

CV is a stated preference approach that used survey questions to elicit peoples preferences for public and common pool goods by finding out what they would be WTP for specified improvements in them (Mitchell & Carson, 1989). The CV method directly obtains individuals' preferences, in monetary terms, for changes in the quantity or quality of non-market environmental resources, where valuation is contingent upon a hypothetical situation or scenario. A sample of the population is interviewed and asked to state their maximum WTP or minimum WTA compensation for an increase, or decrease, in the level of an environmental factor. The CV is hypothetical direct valuation technique requiring the engagement of respondents and commonly used to estimate non-use values of the environment. (Awad & Hollaender, 2010). The CV surveys also have the flexibility to vary the degree of complexity depending on the objectives and constraints of the research.

1.5 CV applications in the Sri Lanka context

The first published application of the CV studies in Sri Lanka was the 1994 valuation of the conservation commodity of the Sinharaja forest which found an average WTP of LKR 664 per year per person with a payment vehicle of a conservation club membership (Ekanayake & Abeygunawardena, 1994). A subsequent CV study in 2008 to measure the WTP of fish, mangrove and water conservation in the wetland area of Muthurajawela and Negombo had an estimated median WTP of Sri Lankan Rupees (LKR) 264 (Wattage & Mardle, 2008), while a 2010 CV study of the Maduganga wetland had a WTP of LKR 164 per month per household (M Sumanadasa, 2010). The more recent 2019 CV study of Kirale Kale found a WTP of LKR 136 (Jayamuni & De Silva, 2019) and a 2019 study of the Bolgoda lake found a WTP of LKR 517 (Jayasekara & Gunawardena, 2020). The studies have demonstrated an awareness and WTP for conservation related issues and the appreciation of the importance of sustainability of environmental products and services. Recent studies have indicated that higher income households have a positive WTP relationship. Several challenges were observed in CV applications including the questionnaire design in relation to the framing of the hypothetical market and respondents' difficulty in attributing value to non-use components.

Table 1 – Summary of previous CV studies in Sri Lanka

Study (year)	Service valued	WTP estimate(s)	Key influencing factors
Valuation of Conservation Commodity of the Sinharaja Forest (1994)	Wet-zone rainforest - Sinharaja Forest Reserve	LKR 664 per person/year	General environmental attitude; users' awareness of conservation value
Willingness to pay for urban water body recreational facilities (2017)	Recreational development - Diyatha Uyana	LKR 447 per household/month for 5 years	Income and occupation status positively associated; budget constraint main reason for zero bids
Willingness to pay for conservation of wetland ecosystem (2018/2019)	Wetland ecosystem - Mudun Ela and Kalu Oya	Median WTP ~ LKR 264.26	Higher education positively affects WTP; agricultural users had negative effect
Willingness to pay for Participatory	Wetland management	LKR 136 per	Significant positive

Wetland Management of Kirala Kele…" (2019)	- Kirala Kele	person/month	relationship with age and education
Willingness to Pay for Water Quality: A Contingent Valuation Approach for Bolgoda Lake (2020)	Water-quality improvement to lake - Bolgoda Lake	LKR 514 - 1,550 household / month;	Higher dependency, higher WTP. Income, user type significant
Economic Value of Water Quality Improvement … Kandy Lake (2022)	Water quality improvement – Kany Lake	LKR 239 person/ month to Reduce odor	Most value placed on indirect uses rather than direct uses

1.6 Research Gaps and Significance

The review of the past body of literature demonstrates that environmental values such as water quality have been less effectively incorporated into the existing analytical frameworks for the analysis of water resources. Water quality was rarely explicitly modeled in eco-system valuation studies because of the perceived limited contribution of environmental values to economic welfare. The added complexity, computational cost, and the difficulty of quantitatively assessing economic effects have also made this more challenging. The more recent welfare models, attempts to incorporate environmental values into the existing economic framework have highlighted deficiencies in this process with gaps and inconsistencies as well as limited range in dealing with rapid environmental changes particularly in the case of developing markets.

The inadequate treatment of environmental services such as water quality in economic welfare models have led to poor decision-making frameworks and inefficient allocation of a scarce resource of water. This study is significant in further enhancing this framework by providing views towards the development of a robust CV application and methodology. The study also provides insights and explores methods for reducing biases in the methodology and process. An efficient approach is particularly relevant in developing countries where resources and data availability for primary research are limited. A more robust application of CV will provide a deep understanding of the trade-off associated with economic variables in water models and support better quality decision making. The integration of economic ideas, objectives and methods into the analysis of river basin management can yield new approaches and insights to governance, management, and technical performance. (Heinz et al., 2007).

In particular, the study looks to address key challenges in relation to the KRB area. Several studies have been undertaken on levels of pollution in the KRB with alarm bells been sounded by the government audit report of the Kelani River conducted in 2018 by the Auditor General of the GOSL (Wickramaratne, 2019). However, to date no study has been done to quantify the economic cost of the overuse and misuse of the KRB. This research looks at approaches and methodologies to assess and quantify the loss of economic value to the KRB ecosystem by the changes in water quality. The study provides insights into a less well-studied area of the potential loss of economic benefits of KRB due to deteriorating water quality

1.7 Conceptual Framework

The theoretical foundations discussed earlier are built on welfare economics and the Random Utility Theory (McFadden, 1974) where utility maximizing behavior is assumed in modeling the choices of individuals among discrete sets of alternatives. This theoretical base is applied to the concept of TEV. TEV of the policy site, the KRB in Sri Lanka is established using the principle of WTP, where WTP is determined by using the Stated Preference approach of CV survey. The full scope of the research attempts to estimate the economic values of various levels of water quality in a defined river basin ecosystem by assessing the changes in TEV of such benefits. TEV incorporates use value and non-use values of water. The study looks at how environmental values relevant for eco system maintenance impacts TEV.

The TEV of a good or service is determined by the aggregate of all individuals WTPs. This research studies changes in TEV of a river basin ecosystem arising from changes in the Water Quality.

2. Methodology

2. 1 Research Methods

This section discusses the methodology applied in the study, including the study design, data collection, application, and interpretation. The study also reviews previous CV applications to discuss the effectiveness and advancement of economic approaches in the development of the CV application. In this study the TEV of the KRB is estimated using a CV method based on a pilot survey. In addition to the pilot survey conducted at the policy site of the KRB, analysis is undertaken of secondary data collected from the National Water Supply and Drainage Board (NWSDB) the main water utility of Sri Lanka and the CEA.

Economic models used by Hammit et al. (2001) and Johnston et al. (1999) as cited by Sumanadasa with modifications (Sumanadasa, 2010) to localize for the Sri Lankan context have been used for the analysis. The study also relies on previous work done by Ian Bateman et. Al. on the application of the CV methodology (Bateman & Carson, 2002). The research follows the stages in CV analysis as laid out by NOAA panel (Arrow et al., 1993).

The pilot CV study was conducted as in-person interviews to effectively communicate issues related to the KRB to the respondents. This gives a better mechanism to understand the views of the respondents. The unit of analysis has been selected as households; this is determined by the selected payment vehicle of the Kelani River Basin Conservation Fund (KRBCF)

2.2 Sampling Strategy and Data Gathering

Prior to the implementation of the questionnaire, the sampling process needs to be carefully considered and structured. The sampling strategy included defining the Target population, specifying the sampling frame, determining the sample size, the unit of analysis and selecting the sampling method. The sampling design starts with the identification of the Target population.

The Target population is determined in alignment with the research objective. i.e., that is relevant to the research question. The target population is the residents of the areas affected by the Kelani River, i.e., the KRB area, who will benefit from the findings of the survey. The KRB area is spread across 36 divisional secretariat offices in seven districts across the three provinces of Western, Central and Sabaragamuwa in Sri Lanka. The beneficiaries of the services of the KRB ecosystem may be WTP for benefits or accept compensation for not damaging when using the site.

Previous studies have highlighted the importance of having both users and non-users included in the target population. Whilst users tend to be captured well, non-users are more challenging given the possibility that an individual living far from the study site may derive some value from public goods. All Sri Lankans (including non-residents of the KRB) may have non-use benefits in the improved water quality in the KRB. The inability to capture non-use values outside the study site of the KRB can lead to underestimation of TEV, biases in policy recommendations and raise issues of excluding certain stakeholders. However, leaving out the KRB non-residents can be justified based on policy relevance being more directly applicable to the KRB residents, payment vehicle targeted at local KRB residents and budgetary considerations. Furthermore, the extent of value contribution from KRB non-residents is expected to be small in relation to KRB residents. The population profile of the KRB region is included in Appendix I.

After determining the target population, the next step is to compile a list of the target population; this is known as the sampling frame from which the sample is drawn. The decisions regarding the survey method and payment vehicle should be determined before proceeding with the sample frame. The voters registered in a city or the number of houses within a city can be used as a sample frame of population. The sampling framework should be consistent with the target population. Individuals or households can be selected as the unit of analysis. Whilst separate studies propose the use of individuals or households, the decision on the selection of the unit of analysis

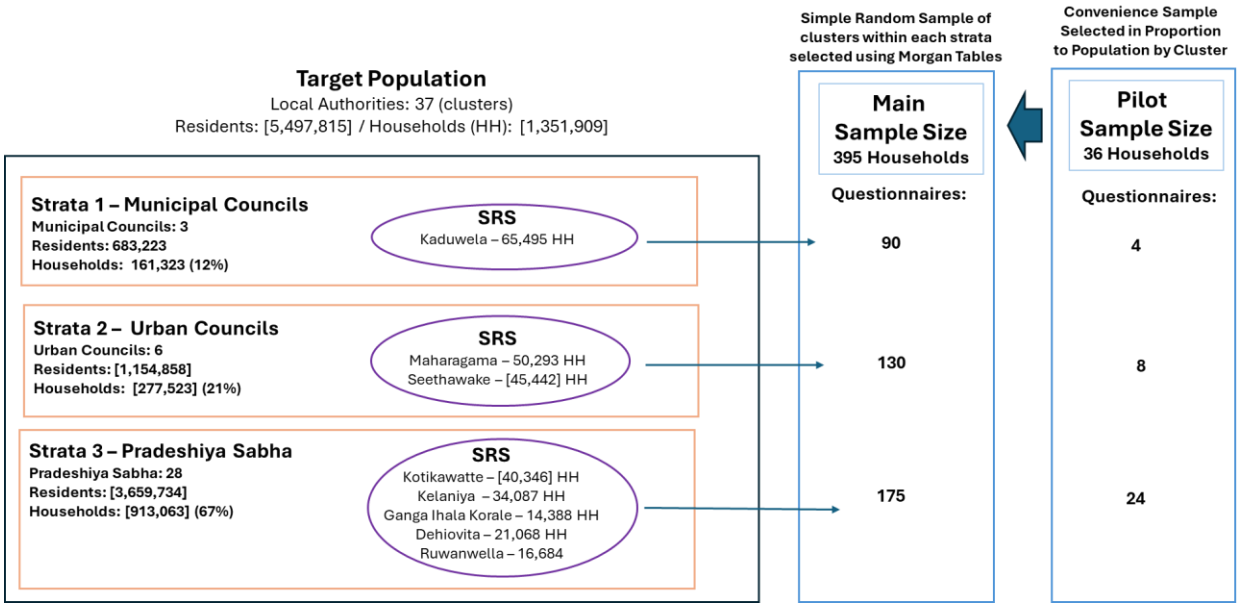
depends on the payment vehicle. This study uses the water bill as the proposed payment vehicle and accordingly households have been used as the unit of analysis.

A two-stage stratified cluster sampling[8] procedure is used to select households from the KRB population to reflect all relevant economic activities. This probabilistic sampling procedure is selected for a more systematic statistical application and easier generalization to the study population.

The Target population of 5,497,815 individuals and 1,351,909 households is identified from the data from the latest available Household Income and Expenditure survey done in 2012 by the Department of Census and Statistics. This population is separated into three Strata consisting of Municipal councils (MC), Urban councils (UC) and Pradeshiya Sabha (PS). The three different administrative units were selected to capture key socio-economic, geographic, pollution levels and institutional variations that may influence WTP. The densely populated MC and UC areas have a high level of pollution while the PS areas tend to be sparsely populated with greater ecological importance. This classification also helps spatial coverage and balance between upstream zones which would be captured by the PS areas while downstream zones would be captured by the MC and UC areas.

A Simple Random Sample (SRS) is selected from each of the Strata. Accordingly, Kaduwela MC, Maharagma and Seethawake (UCs) and Kotikawatte, Kelaniya, Ganga Ihale Korale, Dehowita, Ruwanwella (PSs) have been selected for the surveys. The pilot study data was conducted to test the questionnaire and train the interviewers. In the process data was collected from 36 households selected from the random sample of 8 local authorities. The pilot study is to be expanded to 395 households for the field survey. A sample size of 395 was determined by Morgan Tables[9]. The field survey sample size is selected to be statistically acceptable at a 95% confidence level and 5% margin of error.

Figure 4 – Total Population, Sampling Frame and Sample Size



Source: Developed by the authors

The data gathering exercise for this pilot survey is conducted in an in-person interview format using a questionnaire at the selected locations within the KRB policy site. The pilot survey is supplemented by meetings with residents in the KRB as well as responsible government authorities. The survey is developed post discussions with statisticians, econometricians, and Researcher with experience in the application of CV to enhance the accuracy of the survey. The survey is designed to obtain answers that reflect the true maximum WTP of the

[8] Two stage stratified cluster sampling creates strata to represent key subgroup and splits the population strata into clusters and from each cluster members are randomly selected to be included in the survey

[9] Morgan tables are statistical tables developed by Robert V Krejcie and Daryle W Morgan for determination of sample size for a given population in survey research

respondent. In addition to the main data source, information from the NWSDB and CEA will be utilized for analytical and interpretation purposes

The community was approached by 3 selected interviewers who were tasked with visiting the 36 households selected in the 8 local authorities. The three interviewers consisted of recent University graduates to ensure sufficient understanding of the survey objectives and sampling procedures. The interviewers were well briefed prior to the engagement with the respondents in an in-person session including Q&A. The study keeps in mind several statistical challenges arising from the low sample size of 36 respondents not being representative of the population. The low sample size can lead to higher margin of error, wide confidence intervals and weak hypothetical testing.

The survey was designed to address interviewer bias which occurs when the particulars and behaviors of the interviewer, in this case consisting of recent university graduates, unintentionally influencing respondents' answers leading to inaccurate data. Interviewer bias may arise in relation to age, authority, educational privilege gaps and confirmation bias. Age and authority considerations may lead to older respondents being dismissive of the interviewers while the privilege gap may lead to miscommunication with less educated individuals. Confirmation bias may also lead to interviewers favoring responses in-line with educated opinions. Interviewer bias was minimized by adopting several methods including standardized training, use of neutral tones, avoiding leading questions, and maintaining consistent body language. The interviewers also need to stick to scripted protocols and project confidentiality and neutrality in the respondent engagements.

2.2.1 Ethical Considerations in CVM survey

The research has incorporated ethical considerations; prior to the study, participants are informed of the purpose and benefits of the study. The questionnaire is made available in three languages. Participants are also informed about any potential risks or risks of participation through the use of an Information Sheet. In addition, through Informed Consent participants are voluntarily engaged in the study. Samples of both the Information Sheet and Informed Consent forms are included in the Appendix III and IIV respectively. The minimization of any psychological discomfort during the interview process is an important consideration and several steps are taken to reduce possible psychological discomforts.

2.2.2 CV Questionnaire Design and Structure

The CV study design and questionnaire are developed taking into consideration several factors including previous project relevant reports, statistical population data, geographical maps and available water sources, water use and water quality data of the study site. In addition, the current water regulatory framework and pricing are also considered. This helps to develop the framework discussed above on the sampling strategy and survey instrument development.

The study follows the guidelines of the NOAA Panel[10] on CV applications. The measures recommended by the NOAA were followed in the study. (1) a probability sample, (2) face to face interview, (3) measured WTP, (4) Questionnaire was pre tested, (5) questionnaire phrased in the form of the hypothetical referenda and asked to cast a simple yes or no answer (6) Provided a would not vote option (7) breaking down the WTP by a variety of respondent characteristics such as income, interest and attitudes, and (8) reminding the respondents of their actual budget constraints when considering the WTP. (Arrow et al., 1993)

The CV study is designed to have 'face validity'[11], where a clear description of the environmental good and the circumstances under which it will be provided as well as the trade-off respondents are asked is plausible. The CV questionnaire is designed to collect and subsequently analysis the data to meet the research objectives as well as ensure the validity and reliability of the instruments. The CV questionnaire is pre-tested and intelligently drafted to effectively represent the relevant aspects of the marketplace. In preparation for the survey, the study undertook

[10] National Oceanic and Atmospheric Administration panel of economists convened to evaluate the use of CV methods in the early 1990s

[11] Face validity is the extent to which a test is subjectively viewed as covering the concept it claims to measure in essence covers the relevance of the test

Focus Group Discussions (FGD) and Key Informant Interviews (KII). The process is carefully designed to ensure a high level of credibility thereby not weakening the research study. The questionnaire structure is used to elicit information on the use of Kelani River products and services and to evaluate them separately in terms of knowledge of products and services, environmental services and economic benefits. The questionnaire is designed in three parts. The first and second parts of the questionnaire are designed to gather both qualitative and quantitative data and the third part presents the hypothetical market scenario.

Section one covering general questions and environmental affairs, consisting of questions #1 up to #12 gather data on perception and attitudinal characteristics. The questions cover opinions on the importance of environmental preservation, current water quality and benefits of improvements in water quality. The New Ecological Paradigm (NEP)[12] is applied to determine the attitudinal aspects (Dunlap, n.d.). Respondents' water quality perceptions are also addressed as part of the Questionnaire.

Section two covering Socio-economic and demographic characteristics consisting of questions #13 up to #25 which gather demographic data, both qualitative and quantitative, including items of age, household income, gender, marital status, employment, family members as well as qualitative perceptions on housing conditions, etc.

In section three, the respondents are first provided with an information folder about the KRB water quality situation, so they have adequate context to understand what they are paying for. A hypothetical market scenario or contingent market is then presented, and respondents are asked how much they are WTP for the water quality improvements. In the CV study, the dependent variable is WTP while the independent variables are socio-demographic, attitudinal and perceptional. Sociodemographic and economic variables are commonly used co-variables in valuation studies, independent variables that have item-scale[13] and adopted from previous studies are discussed below.

The CV question is framed as a referendum with a proposed management plan for the KRB, the Kelani River Basin Management Program (KRBMP) is offered to respondents to address the main water pollution challenges. The KRBMP has been structured to be credible from the perspectives of the respondents.

2.2.3 Kelani River Basin Management Program and Fund

The Kelani River water quality has degraded due to industrial and untreated wastewater discharge leading to risks to public health, ecological impacts and higher water treatment costs. To address this the KRBMP will be established. The main guidelines for the operations of the KRBMP are

- Managed by a private foundation of various stakeholders
- The foundation would decide on the activities of the Fund.
- Fund will not be used for any other purposes

The KRBMP is to be managed and implemented by an independent professionally managed fund, the Kelani River Basin Conservation Fund (KRBCF). The KRBCF will be an independent body with experienced professionals including environmental experts and community stakeholders The main objectives of the KRBCF are listed below with all funds collected used exclusively for these activities.

1. Development of a KRB wide water and land use plan
2. Increasing the capacity of Effluent Treatment Plants (ETP) and Sewerage Treatment Plans (STP) currently in place
3. Construction and use of best management practices within the KRB
4. Strengthening the monitoring and enforcement of industrial discharge

[12] New Ecological Paradigm is framework developed in the 1970s by Riley Dunlap and colleagues for measuring environmental attitudes and level of adherence to ecological worldviews

[13] Item scale are structured measurement tools that captures and quantifies subjective and objective economic data, providing insights into economic conditions, behaviors and attitudes

5. Setting aside areas of the KRB critical to the protection of water quality

Once implemented the KRBMP would improve the river water quality standard to nationally accepted levels, reduce contamination from industrial and domestic sources and lower long term water treatment costs. The program will also improve reliability and safety of drinking water supply and reduce pollution related risks.

The contingent market will be described as one way of improving water quality is to implement the KRBMP. In this circumstance would you be willing to pay an extra amount for the implementation of the KRBMP and improve the water quality of the Kelani River. The KRBMP is offered at different price levels ranging from LKR 25 to LKR 75 per 1,000 Liters.

A dichotomous choice format[14] has been selected for the survey where respondents are asked their WTP at predetermined price for the quality of water in the KRB. From the WTP responses, information regarding consumer preferences towards water quality improvements in the KRB can be estimated parametrically. These methods have been applied in similar situations in other locations globally including Maduganga Wetland in Sri Lanka 2010. (M Sumanadasa, 2010) and Buriganga River in Dhaka Bangladesh 2019 (Islam, 2019)

For the purposes of anonymity and confidentiality all information will be managed in secure formats while personal information will be restricted to the primary investigator only. The questionnaires used in the survey is numbered with a Unique Identification Number (UID) so that personal information can be masked. All computer data will be stored in password protected files in a password protected laptop. A copy of the questionnaire is included in Appendix II

2.2.4 The Contingent Market Hypothesis

The next key step in the CV process is developing the contingent market. Water quality has no defined market therefore a hypothetical scenario or contingent scenario is constructed and presented to the respondents. The respondents are provided with detailed descriptions, so respondents are fully aware of the current circumstance and the improvements they are paying for. Under the welfare economics concept, households maximize utility subject to an income constraint by selecting a bundle of market and non- market goods. The hypothesis is that these variables are conditioned by various demographic characteristics including income, education, age, etc. It is assumed that one of the non-market goods is the water quality of the KRB. In which case, WTP will be the price of maintaining KRB water quality subject to other variables.

2.2.5 Willingness To Pay Estimation

There are two main approaches used to estimate WTP from the survey respondents. In the approach originally suggested by Hanemann Random Utility model (RUM) the mean WTP value is estimated directly from the Probit or Logit model (Hanemann, 1984). The second approach is based on Turnbull, where a mean WTP is calculated from the changes in percentage of votes at each price level (Bruce W Turnbull, 1976). This is a non-parametric estimation, with a mean WTP aggregated over the relevant population to get the total economic benefits.

Following Hanemann, in the case of a representative consumer with an indirect utility function V (P,M,Q,S) the level of consumer preference depends on Price of Product (P), Income of the consumer (M), quality of the product (Q) and Socio-characteristics of the consumer (S). The respondent is asked if he or she will help to conserve the KRB. The response will be positive "Yes' if his or her utility derived from improved KRB water quality (Q^1) and paying the price (P) is higher than not having improved KRB water quality (Q^0) and not paying the price (P=0)

$V (M-P, Q^1, S) > V (M-0, Q^0, S)$ - Equation 1

Respondents of the survey, with income level M will have a WTP of X if their utility with better water quality and lower income LKR M-X is at least as great as their utility without better water quality.

If V (P,M,Q,S) is the observable component of the utility, the probability of a positive 'Yes' response is as below

[14] Dichotomous choice format is closed end questions where survey respondents are only offered two possible answers

where e_1 is the unobservable component of the utility

Prob (yes) = Prob [V(M-P, Q^1, S) + e_1 > V (M-0, Q^0, S) +e_0] - Equation 2

Assuming that the random variable *e* follows a logistical distribution

$$prob(yes) = 1/(1 + e - \Delta V)$$

Where – ΔV = V(M-P, Q^1, S) > V (M-0, Q^0, S) – Equation 3

The environmental and economic benefits of the hypothetical market to improve water quality of KRB are measured as WTP and defined as

V (M-WTP, Q^1, S) > V (M-0, Q^0, S) – Equation 4

Hanemann shows that if V(M-P, Q^1, S) is linearly specified then the probability of the respondent saying yes is

$$\log\ [prob(yes)/(1 - prob(yes))] = \alpha 0 - \beta 1P + \beta 2Q + \sum \beta 1S1$$ - Equation 5

Parameters will be estimated parametrically. This means the maximum WTP for KRB water quality improvement can be calculated using

Mean Max*imum* WTP = $\frac{1}{\beta 1}[\ln(1 + e^{\alpha 0 - \beta 1P + \beta 2Q + \sum \beta 1S1})$

The utility function is treated as a random variable with a given parametric probability distribution. Multivariate statistical methods are used to estimate the valuation function that relates the hypothesized determinants to WTP responses of existence values. The hypothesis is that the respondents' WTP are conditioned by a variety of socio-economic characteristics that can be evaluated by the regression model. CV provides a continuous measure of WTP for the improvement in water quality of the KRB. Ordinary Least Squares[15] is used to explain the variation in the WTP bids (the dependent variable). To establish the TEV of the KRB, WTP is estimated as a linear function by fitting Hanemann RUM models with and without the KRMP. The linear function assumes a payment vehicle of the proposed KRBCF fund.

Hanemann has modelled a simple utility function U that includes variables for environmental attributes, attributes of the payment vehicle, net income, and demographic characteristics. The study has designed a simple utility function U(.) to model respondents preference adopting the above two models with suitable changes relevant for the KRB. The function includes variables for environmental attributes of the KRB, attributes of the KRBCF, net income and demographic characteristics

$$U_w = U[X^w + (Y - F^w) + G^w + D] = V[X^w + (Y - F^W - G^w) + D] + \varepsilon_w$$

U(.) – function representing the empirically measurable components of utility

X^w – vector of variables describing the characteristics of the wetland with KRMP in place

Y – Household income minus KRBCF management fee

F^w – Change in mandatory fee under Conservation Financing Mechanism (CFM) "w"

G^w – vector of variables describing the CFM used to fund water quality change leading the KRB attributes set X^w

D – Vector of variables describing respondent specific characteristics, and

Ɛw – Standard Econometric Error

If respondents compare the utility generated with the KRMP in place to be Plan "A" (w= A) and the utility generated without KRMP as Plan "B" (w =B). Plan B represents the status quo or as is situation (where $F^B +$

[15] OLS is a method used in liner regression to estimate the relationship between one or more independent variables and a dependent variable

G^B below are both equal to zero).

Respondents compare

$$U(X^A + Y - F^A + G^A + D) > U(X^B + Y - F^B + G^B + D)$$

In the CV survey ecosystem, a selected number of X attributes are arranged into range of options grouped under environmental benefits and ecosystem benefits for elicitation by the respondents. The responses with a preference in ranking indicative relative importance of the attributes. Socio economic characteristics of the respondents are included in the estimation. The information is then used to calculate the value of each attribute at the marginal rate of substitution between ecosystem attribute and money.

2.3 Econometric Models

In designing mathematical formulation and selecting a solution algorithm, general rules and best practices should be applied. The selected model should be capable of answering questions and providing insights to resource managers, stakeholders, and policymakers. Previous CV studies have used Tobit, Probit and Logit models. The table below illustrates several models that have been typically used in the past.

This paper evaluated several econometric models. and the Tobit model was eliminated, given that the survey is based on a Yes or No response (dichotomous choice) format to the stated bid value (i.e. dependent variable is binary). The Logit model and Probit models are based on the logistic and normal distribution respectively. The WTP tends to be normally distributed so there is a preference to use the Probit model for a better fit for the data and this model is also recommended by the NOAA panel (Arrow et al., 1993).

Setting the bid level is an important consideration in the CV survey process. This has to be done in the context of statistical efficiency, economic realism and respondent comprehension. Prior to the selection of the bid levels discussions with industry players and review of previous bid levels of contingent studies were taken into consideration. The bids were also considered in the context of average household monthly income levels of LKR 76,414.00 from the HIES survey in 2019; and the average water bill cost of LKR 61.3 m^3 based on average water consumption of 16.81 m^3 and an average household water bill of LKR 1,030.88 in the Western Province. (*NWSDB Annual Report 2022*, 2022). The initial bid level was selected at LKR 50 per m^3 (or one liter) and the upper bid level of LKR 75 per m^3 and lower bid level of LKR 25 per m^3.

Table 2 – Comparison of Econometric models used in CV studies

Type	Best For	Use Case	Advantages	Disadvantages
Tobit Model	Continuous WTP data with censorship [16]	WTP is continuous, but some observations are censored	Manages censored data, models continuous WTP.	Assumes normal error distribution, more complex.
Probit Model	Binary WTP decision (Yes/No)	Respondents are asked whether they are WTP a specific amount (Yes/No decision)	Models' probability of a binary outcome.	Does not capture continuous WTP, only probability.
Logit Model	Binary WTP decision (Yes/No)	Same as Probit, but uses a logistic distribution	Easier to compute and interpret than Probit.	Like Probit, does not manage continuous WTP.

[16] Censoring occurs when we have only partial information about the value of a variable, generally because the value lies above or below a known threshold

3. Findings

3.1 Study Identification & Characteristics

The study follows the findings of a pilot survey conducted in the KRB on 3rd March 2025. The study in parallel reviews past application of CV in Sri Lanka and other developing and developed markets to discuss methodologies employed and possible improvements in survey design, sampling procedure, data gathering, contingent scenario, econometric modeling, and data analysis.

The pilot survey was conducted for 36 households in the study site of the KRB and analyzed using the SPSS Computer Package. This section reviews survey findings based on statistical tables containing averages and frequencies computed using SPSS. The analysis is within the framework of TEV of the KRB based on CV. The TEV of KRB is defined as the sum of use and non-use values for the KRB products for the residents of the KRB separated as economic benefits and environmental services. Individual WTP contributions are assessed to estimate the relative importance of the various components of the TEV. The pilot survey will be expanded to a full survey as the next stage of the study.

The KRB survey responses will be analyzed for general attitude and behavior, socioeconomic characteristics, as well as awareness of the economic and environmental benefits. The value of WTP and conservation and management arrangements are examined. The survey covers both qualitative and quantitative data gathering. The qualitative aspects will primarily focus on environmental perceptions and demographic characteristics while the primary objective of the quantitative data will be to estimate WTP and its determinants. In relation to the quantitative approach, there are two broad objectives by estimating a parametric model for a dichotomous CV study. The first objective is to estimate WTP for the prescriber environment good in our case the water quality and the second objective is to investigate the exploratory variables attributed to the respondent.

All 36 respondents approached participated in the survey. However, 2 of the respondents chose not to answer some of the qualitative questions. The study is helpful in evaluating the survey questionnaire, diagnosing biases or framing issues, testing acceptability of the contingent scenario and estimate a preliminary range for WTP.

The findings of the pilot study were consistent with previous CV studies both internationally and in Sri Lanka. The previous international CV studies in relation to water quality have found individuals are generally WTP for better water quality with socio economic factors such as income, education, and size of households having significant influence. International CV studies have shown a substantial variance in WTP. In Sri Lanka, looking at broader range of CV studies, given the limited research on water quality; the study findings are also consistent with individuals being WTP for non-market environmental goods. In the Sri Lankan context socio-economic factors such as income, education and age were significant for WTP. However, budget constraints have been highlighted as one of the key reasons for no WTP responses. The pilot study finds that conservation of public goods maybe possible through an appropriate pricing mechanism is well consistent with previous CV studies.

3.2 General Attitudes and Perceptions

In relation to the proximity to the river, 50% of the survey respondents live less than 1km from the Kelani River and 64% of the respondents live less than 2km from the river so the respondents would have a good appreciation of the key issues in relation to the KRB. All respondents, 100%, said they were up to date with current environmental issues while 1 respondent or 3% said they were a member of an environmental organization and only 1 respondent or 3% have donated money to an environmental organization. These responses suggest that the respondents maybe overstating their knowledge on environmental matters.

As illustrated in table 2, 44% of the respondents felt that floods were the main environmental issue, followed by water pollution and deforestation at 22% each, respectively. It is also important to note that of the 8 respondents who selected water pollution, 6 were from the Kelaniya Pradeshiya Sabha and living less than 1Km from the river. The sample suggests that proximity to the river may be a major determinant of selecting water pollution as the main environmental issue.

Table 3 – Main environmental issues as per the sample

Main Environmental issues	Number	Percentage
Floods	16	44%
Water pollution	8	22%
Deforestation	8	22%
Air pollution	3	8%
Solid waste disposal	1	3%
Others, please specify:	0	0%

The NEP framework Likert score for the respondent's ecological consciousness scored a total of 47.7 (scale of 1 – 75), which indicates a positive pro-environmental worldview. However, respondents demonstrated a more limited awareness of the finite nature of ecological resources and a lack of confidence in humans' ability to manage the environment. These elements underscore the importance of a sustained campaign on environmental awareness.

Table 4 – New Ecological Paradigm scale score

Statement	Mean
We are approaching the limit of the number of people the earth can support.	3.280
Humans have the right to modify the natural environment to suit their needs.	4.107
When humans interfere with nature it often produces disastrous consequences.	3.804
Human ingenuity will ensure that we do not make the earth unlivable.	2.429
Humans are severely abusing the environment.	4.016
The earth has plenty of natural resources if we just learn how to develop them.	1.987
Plants and animals have as much right as humans to exist.	4.189
The balance of nature is strong enough to cope with modern industrial impacts	2.826
Despite our special abilities, humans are still subject to the laws of nature.	3.041
The so-called 'ecological crisis' facing humankind has been greatly exaggerated.	2.919
The Earth is like a spaceship with very limited room and resources.	3.166
Humans were meant to rule over the rest of nature.	2.624
The balance of nature is very delicate and easily upset.	3.097

Humans will eventually learn enough about how nature works to control it.	2.213
If things continue as it is, we will soon experience a major ecological catastrophe.	4.044
Mean NEP Score	47.742

Perception is a key parameter in understanding behavior. Policymakers exploring solutions that require a change in behavior, need an in-depth understanding of how individuals perceive and behave. This study looks at respondents' knowledge of water quality based on sensorial, contextual, scientific, heuristics, culture, and belief. None of the respondents felt that the water quality was good from a sensorial, contextual, scientific, or heuristic perspective. 77% of the respondents, or 32 respondents, felt that water quality was terrible or bad from a taste, color or smell perspective. While 69% of the respondents or 31 respondents felt that in the level of waste and sewage entering the river was at Terrible or Bad state. The number of respondents indicating that they were unsure of the questions is also the highest number of respondents, or 36% being unclear about the question with regard to cultural belief in relation to the water quality of the Kelani River

Table 5 – Perceptions of the Kelani River water quality

Items	**Scale**				
	Terrible	Bad	Unsure	Good	Very Good
Sensorial - Rate the water quality of the Kelani River (based on taste, color, and smell)	11%	61%	17%	0%	0%
Contextual - Rate the water quality of the Kelani River (relating to the presence of waste-dumps, sewer line and drain outlets entering the river and the presence of aquatic life)	11%	58%	17%	0%	0%
Scientific - Rate the water quality of the Kelani River (relating to knowledge of the presence of harmful chemicals based on evidence)	8%	44%	28%	0%	0%
Heuristics - Rate the water quality of the Kelani River (opinion based on experience, intuitive judgement, educated guess, etc.)	6%	39%	36%	0%	0%
Cultural and belief - Rate the water quality of the Kelani River (opinion based on cultural belief	0%	33%	36%	11%	0%

A vast majority of respondents (92%) indicated the negative consequences of water pollution on the environment, society and economy were severe while the remaining 8% indicated that the impact was moderate. Respondents also attributed the major source of river pollution to urban wastewater, industrial affluents and solid waste dumping.

3.3 Socio- Economic Characteristics

The socio-economic characteristics of the respondents influence the total responses to the survey, so it is essential that it is carefully examined. Some of the key pilot survey findings are summarized below

In relation to education level, the survey indicates that 52% of the surveyed sample have an education level beyond Ordinary level, while only 8% have received an education up to Graduate level. Given the limited seats available in the University space in the context of Sri Lanka, it may be appropriate to consider professional qualifications in addition to graduate education.

Table 6 – Education level of respondents in the sample

Education Level	Number	Percentage
No schooling	0	0%
Primary education (1 – 5 years)	0	0%
Secondary education (6 – 9 years)	4	11%
Ordinary Level Exam (10 years)	13	36%
Advances Level Exam (12 years)	16	44%
Graduate	3	8%
Postgraduate	0	0%

In relation to employment, the highest proportion of the respondents, 31%, were homemakers, this may be a result of the primary income earner being away from the household at the time of the survey. The second largest group was self-employed.

Table 7 – Employment types of the sample

Employment	Number	Percentage
Housewife	11	31%
Self Employed	10	28%
Retired	5	14%
Private Sector	3	8%
Government Sector	2	6%
Student	1	3%
Laborer	1	3%
Agriculture	1	3%
Looking for a Job	1	3%
Not Responsive	1	3%
Fisherman	0	0%

The income level of 50% of respondents was below LKR 29,999, while the household income of more than 50% is higher than LKR 60,000, noting that the primary income earner was not interviewed as part of the survey. The implication of this must be carefully considered as part of the analysis. The average monthly household income of at least 58% is below the monthly household income of LKR 76,414 computed by the Department of Census and Statistics in 2019.

Table 8 – Income levels of the respondents in the sample

	Your Income		Household Income	
Income Level (LKR)	**Number**	**Percentage**	**Number**	**Percentage**
< 20,0000	16	44%	1	3%
20,000-29,999	2	6%	2	6%
30,000-39,999	6	17%	2	6%
40,000-49,999	2	6%	4	11%
50,000-59,999	1	3%	4	11%
60,000-69,999	2	6%	7	19%
LKR > 70,0000	6	17%	16	44%
Non-Responsive	1	3%	1	3%

3.4 Statistical Model Findings

The model reliability and measures of goodness of fit were evaluated using likelihood-based measures appropriate for a dichotomous choice probit model. The model reported a -2 Log Likelihood value of 18.798, Cox and Snell R^2 of 0.1616, and Nagelkerke R^2 of 0.320 indicating that the model fit appears to be statistically acceptable and economically reasonable.

The -2 Log Likelihood score indicates that the maximum likelihood estimation converged successfully, suggesting stable parameter estimation. The Cox and Snell Pseudo R2 measure suggests that 16.1% of the variance of the dependent variable (WTP) is explained by the predictors in the model. The Nagelkerke R2 from rescaling the Cox and Snell score of 0.320 suggests that the bid and covariates meaningfully explain response variation, indicating moderate explanatory power.

The estimated bid coefficient was negative, confirming the consistency of the estimated function, that the probability of accepting the bid decreases as the bid amount increases. This supports the validity of the estimated utility difference function and the derived estimates.

It should be noted that the small sample size, given the pilot nature of the study, limits the precision and interpretation of the estimates. However, the fit statistics and the theoretically consistent sign of the bid co-efficient suggest a meaningful representation of the respondents' WTP behaviour. The Probit model findings should be more favorable with the larger complete data set.

Table 9 – Model Reliability Measures

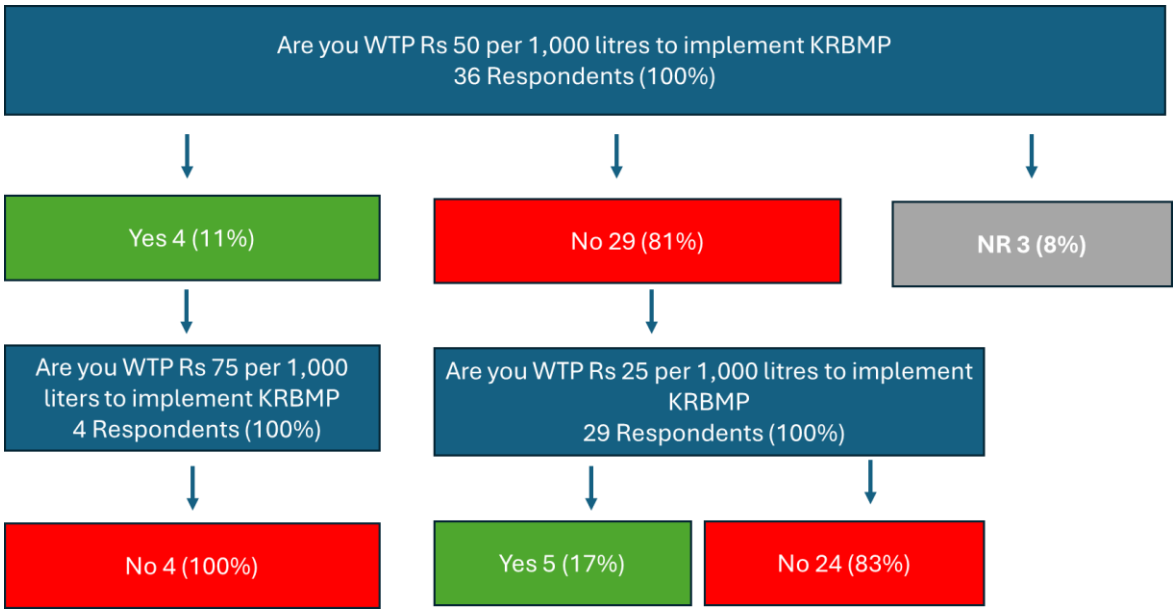
-2 Log Likelihood	**Cox & Snell R Square**	**Nagelkerke**
18.798	0.161	0.320

In relation to the first CV question of WTP of LKR 50 per 1,000 Liter for the implementation of the KRBMP, only 3 respondents or 11% indicated their WTP, while 29 respondents or 82% were not WTP. 3% of respondents were non-responsive. In establishing the upper bound the respondents who were WTP were asked to respond to a

follow-on question if they would be WTP for LKR 75 and they were all not WTP at LKR 75. The respondents who were WTP to implement the KRBMP 50% indicated that they would like the government to manage the KRBCF. However, the small number of WTP responses make the accuracy of the response questionable.

The low WTP may be a result of economic, social, psychological, and contextual factors Further study must be undertaken to understand these reasons for interpretation of results, avoiding survey bias and improving the survey design for the full study. The low-income levels and lack of perceived benefits may also be significant reasons for the low WTP from the respondents.

Figure 5 – WTP Decomposition of Respondents



50% of the respondents who were WTP indicated their reason for responding 'Yes' as wanting future generations to have reliable environmental products and services. The majority of residents, or 59% of the respondents who answered 'No' to the WTP question, gave the reason as affordability. The second largest group, or 14% of the residents, felt that the government should pay for maintaining water quality.

Table 10 – Reasons given for not WTP of the sample

	Number	**Percentage**
I cannot afford	17	59%
The Government should pay for this	4	14%
I am not interested	3	10%
Lack of Trust in Government	2	7%
I do not think the Government will improve the water quality	2	7%
It is too expensive	1	3%
Only rich households should pay	0	0%
We pay thru Taxation	0	0%

In evaluating the Probit model findings, the validity, reliability, and interpretability of the results were considered.

The study found that the model reliability requirements were successfully met. The coefficients have positive correlation.

The statistical model uses found the bid amount highly significant with p value less than 0.01 where when the bid amount increases the WTP falls this is consistent with previous contingent value studies (Carson, 2000). The distance from the river and environmental awareness was found to be statistically significant with p value less than 0.05. The other key factors of gender, age, education, occupation, income, and marital status were not found to be statistically significant at the 5% level. A summary of the Data findings is presented below

Table 11 – Summary of Data Findings

Variable	**Coefficient**	**p-value**	**Interpretation**
Constant	-4.564	0.005	Statistically significant ($p < 0.05$). This represents the baseline WTP when all other variables are zero.
Personal Income	6.424	0.011	Statistically significant ($p < 0.05$). Higher income is associated with a greater WTP, consistent with economic theory that ability to pay effects valuation
Family Income	3.268	0.071	Not statistically significant ($p < 0.05$). Reflects a weak relationship and may indicate personal disposable income is more relevant than household income
Gender	6.022	0.014	Statistically significant ($p < 0.05$). Indicates systemic difference between males and females in accepting the bid.
Age	0.031	0.860	Not statistically significant ($p < 0.05$). Age does not have a meaningful impact on respondents WTP
Education Level	0.148	0.700	Not statistically significant ($p < 0.05$). Formal education does not have a meaningful impact on respondents WTP
Profession	0.586	0.444	Not statistically significant ($p < 0.05$). Employment type or job category does not have a meaningful impact on respondents WTP
Marital Status	0.423	0.515	Not statistically significant ($p < 0.05$). Being married or unmarried does not significantly influence valuation
Family Size	0.758	0.384	Not statistically significant ($p < 0.05$). The household dependency structure does not strongly determine WTP
Membership	0.133	0.716	Not statistically significant ($p < 0.05$). Being a member of an environmental organization or community group does not significantly change the likelihood of WTP

3.5 Measuring Household Willingness to Pay

The Probit model in the pilot survey is designed primarily to ascertain the suitability of the questionnaire. The WTP estimate derived from the survey at this stage is exploratory and not meaningful for inference. The small

size of the pilot sample leads to unstable coefficients, and while the exploratory bid design leads to weak bid sensitivity and less reliable WTP measures. Whilst the primary purpose of the Pilot study is not to ascertain the WTP and TEV values of the KRB, the model specification was tested with the collected data for hypothetical illustrative purposes.

For a Probit model in a double-bounded CVM, the general specification is:

$WTPi*=\beta 0+\beta 1X1i+\beta 2X2i+\cdots+\beta kXki+\varepsilon i$

Where respondents answer Yes/No to a given bid amount. The probability of a "Yes" is:

$P(\text{Yes})=\Phi(\beta 0+\beta 1X1i+\cdots+\beta kXki-\beta \text{bid}$

The mean WTP for a linear utility function is computed as per Hanemann (Michael W Hanemann, 1984):

Mean $WTP=-\beta 0+\sum \bar{X}i\beta i \,/\, \beta \text{bid}$

If you assume average values of the explanatory variables the expression simplifies to:

Mean $WTP=-\beta 0 \,/\, \beta \text{bid}$

Applying our computed figures of Constant coefficient of 44.315 and bid amount -0.924 we arrive at our mean WTP for water quality improvement

Mean WTP = − (44.315 / -0.924) = 47.93

Mean WTP =*Rs.* 47.93 per household per 1,000 Liter of water or 1 cubic meter

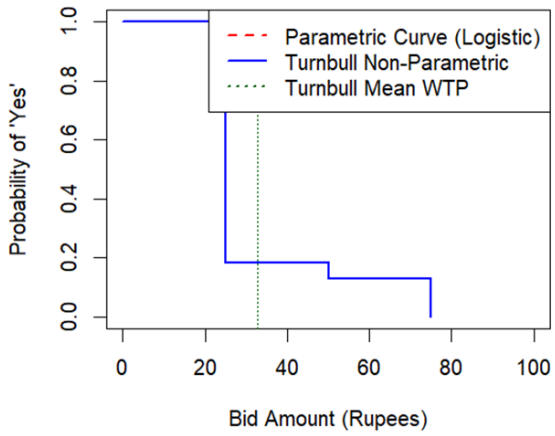
However, the statistical results indicate that the estimated mean is not robust and the model is not statistically reliable. The standard error of the bid co-efficient and the constant are extremely large (SE of 718.996 and P value of 0.999), indicating that the coefficients are not statistically significant and parameters are imprecisely estimated. It is important to note here that given the results estimated mean may not be reliable for policy analysis.

Given the weak identification of the WTP estimates, non-parametric Turnbull bounds have also been applied. Turnbull bounds rely on the observed acceptance rates (distribution free) and are particularly relevant given the exploratory study, small sample size and the bid design being tested and the weak statistical significance.

The study had 81.5% of the respondents falling in the LKR0–25 WTP interval. However, the smaller group of respondents WTP LKR 50 -75 pull the average upwards. Turnbull lower bound estimate of mean WTP was calculated at LKR 32.86. This is consistent with previous CVM studies. The Turnbull lower bound mean WTP estimate is used to compute the TEV by multiplying by the number of households. The figure calculated in is a conservative lower-bound estimate of the TEV

We can compare the Turnbull WTP estimate with the average monthly household consumption of 16.81m^3 and average household monthly bill value of LKR 1,030.88 in the Western Province (*NWSDB Annual Report 2022*, 2022). The mean WTP of LKR 32.86 per m^3 for water quality improvement is significant in comparison with the LKR 61.32 per m^3 cost currently incurred by households for their water consumption. Each household would add an additional LKR 552.38 (16.81 x 32.86) resulting in an increase of 53.58% to their current water or bill

Figure 6 – Turnbull bounds demand curve



Total Economic Value (TEV) is equal to the mean WTP per household multiplied by the relevant households. The study indicates a TEV of LKR 10.4 million per month per KRB area

Turnbull lower bound mean WTP estimate for $1m^3$ of water – LKR 32,86

Turnbull lower bound mean WTP estimate for household – LKR 552.38 (32.86 x average water consumption by household)

Total Economic Value = Turnbull lower bound estimate for household x number of households

TEV = 552.38 x 1,351,909

TEV = LKR 746,762.897

It is important to note that the TEV calculation is to illustrate the methodology and for the purposes of method refinement prior to the application of the full field survey. The TEV results obtained here may not reflect the final valuation that will be computed from the comprehensive survey. The intended purpose of the pilot study is on refining survey design, ensure clarity of the payment vehicle, enhance respondents understanding of the valuation scenario and identify potential protest responses.

4. Discussion

4.1 Importance of Research Results

The pilot study is set as a precursor to avoid technical issues with the full survey and to help pilot a final questionnaire prior to commencing on the comprehensive field survey. The sample size of the Pilot scheme of 36 households will be expanded to 395 households in the full survey. The learnings from the Pilot study will be assessed to achieve a more effective field survey and more applicable results including improved questionnaire design, refined payment vehicle and improved explanation around the contingent scenario description.

The findings of the study are helpful in identifying the various stakeholders' interests in the KRB. The stakeholder considerations and research findings will provide an economic framework to reduce water pollution in the Kelani River which has been identified as a major concern by the survey respondents. The study can also provide ideas for enhancing drinking water quality for Colombo and the Western province and for developing ideas for mitigating flood risks.

The pilot probit model was used primarily to verify expected coefficient signs, assess monotonicity of responses with respect to the bid level, and explore potential determinants of willingness to pay in a qualitative manner, rather than for formal welfare estimation. The pilot study and the improved full survey will be applied with a consistent methodology to global best practice. This provides a basis to relate the KRB study to other studies for consistency, credibility and international relevance. Post the completion of the pilot study, a statistically significant and economically meaningful model can be generated by conducting the final survey, which would help refine bid design, improve response consistency, and enhance data quality.

4.2 Identifying New Insights

Several key insights need consideration in the development of the effective contingent scenario. Simply asking the question, how much the respondent would be WTP for improved water supply does not provide quality data for the development of a credible contingent scenario. This includes improvements to data gathering strategy, adjustment to contingent scenario, adjustments for hypothetical bias and assessment of impact of available water sources.

Data gathering strategy can be improved by partnerships with local area people for survey and this also has multiple benefits as they would have a greater appreciation of the water challenges for the residents of the study site as well as being in a better position to explain the benefits of the contingent scenario to the respondents. The possibility of engaging with undergraduates from Kelaniya university will be explored. The study shows that most respondents appreciate the severity of the impacts of water quality degradation but are not WTP to maintain the water quality. This could be a result of the low-income level of many of the respondents. The contingent scenario may need to be adjusted to address low-income household responses. Previous studies have shown that households with good alternative water sources have low WTP and high rejection rates for improved services (Asian Development Bank, 2013). Survey questions may need to explore the relationship between alternate sources and WTP. The use of dichotomous choice method minimizes the occurrence of biases in the study. Methods to mitigate "Cheap talk" can be incorporated into the CVM survey to mitigate the problem of hypothetical bias. Other payment vehicle options should consider improving data gathering options

4.3 Research limitations

A traditional reservation about the CV method is that responses may not reflect actual behavior of respondents. However past studies have shown that predictions from CV studies have compared well with actual behavior (Asian Development Bank, 2013). However, despite lingering concerns from some researchers, the CV studies remain a satisfactory approach given the limited alternatives. This argument has been enhanced by significant improvements in CV methodology over the last several years.

Past researchers have identified three significant problem aspects in the application of CV studies including poorly crafted CV scenarios, poor survey implementation, and lack of sufficient test to determine validity of responses. In addition, ensuring all value segments are captured as part of the survey, i.e., individuals, agricultural, industrial, commercial and any residents outside the KRB who will benefit but are not captured by the survey.

One of the key challenges with CV applications is the explanation in relation to the abstract nature of the CV market. Respondents may struggle to conceptualize the CV scenario. This can also lead to hypothetical bias with the stated preference not affecting the actual behavior. The CV responses are also highly dependent on how the environmental goods are described, how much background information is provided and if visual aids are included. Furthermore, the WTP data could be left censored or censored at ZERO as most respondents WTP = 0, where the true valuation is unknown but positive or small. Despite the people having a positive idea for the KRB conservation but saying zero due to affordability issues, mistrust, or lack of understating of the hypothetical situation. This may have several implications including income constraints, leading to true WTP being higher than expressed.

4.4 Research Contributions

The research findings clearly indicate that there is public desire to preserve the Kelani River. The findings of the CV study can be integrated into the Sri Lanka national water resources policy[17] by revealing public preferences for water service attributes and valuation of such services and quantifying benefits of conservation presently not captured in markets. The studies can also be used for justifying investments, cost benefit analysis of different policy options and for informing of pricing policy of water supply and drainage and pollution control. Furthermore, CV findings can be used in guiding tradeoffs when allocating water among competing users based on social welfare. In addition, the study can also support the implementation of several of the objectives of the Sustainable Development Goal Six (SDG6)[18], 'clean water and sanitation for all' given the central role of the Kelani River.

The study can also help to build on previous provincial and catchment level activity by providing new insights to explain the activities and effectiveness. These include programs such as Kelani River Basin Multi-Stakeholder Partnership Program (KRMP) of the CEA, the Kelani River Water quality restoration program by the

[17] Water Resources Policy and Implementation Management Mechanism was introduced in 2023

[18] SDG6 is one of 17 sustainable development goals established by the United Nations General Assembly to ensure availability and sustainable management of water and sanitation for all

Environmental Foundation Limited, The Kelani Valley Protectors Initiative (KVPI) of the Kelani Valley Plantations Plc, etc.

The findings of the CV study can help policymakers and local government authorities make informed decisions in environment protection, resource allocation decisions and designing effective regulations. The WTP values of the KRB can provide justification for prioritizing environmental programs when allocating public funding. The WTP estimates from the KRB CV studies can be used to compare the benefits of pollution control and river restoration against cost of intervention in the form of investment in wastewater treatment plants. If the WTP for water quality improvement (from implementing the KRMB) is higher than the cost of spending on wastewater treatment plants, then implementing the water quality programs is more economical. The WTP estimates can also provide guidance in setting pollution charges or compensation for communities affected by water pollution. Furthermore, WTP estimates can also be integrated into Environmental Impact (EIA) assessments of the CEA to incorporate potential social costs of pollution and provide evidence to support conservation efforts in policy discussions.

From an academic perspective, this study makes an important contribution to the existing body of work on CV survey design by adding additional field experiences to the existing body of literature. This is important in the case of applications in developing markets where the existing body of knowledge is limited. This is also particularly relevant in adjusting CV design to accommodate for limited awareness of environmental services and impact of low-income households

The CV study presents further research can improve valuation validity and reliability by applying alternative stated preference formats including choice experiments, payment cards, open-ended questions and compare method sensitivity. Furthermore, further study can include improvements in methodology in the estimation of WTP values, and particularly WTP components of non-use value. The proper capture of non-use values depends on survey design, respondents' knowledge, and methodological robustness. CV studies can be expanded to better capture non-use values by improving the survey design, refining the valuation methods, better addressing survey bias, and applying CV with a non-use focus. In improving survey design, framing effects can be further explored to check how alternate ways of presenting environmental goods can affect the stated WTP, this can include visual aids such as short videos and 3D models, Valuing methods can also be refined by including CV method with alternate methods such as Choice Experiment (CE) methods to isolate and decompose values for specific attributes or non-use values. The survey can also better incorporate cheap talk scripts and certainty scales to offset the misstatement of WTP values by respondents. Furthermore, a longitudinal valuation can be undertaken with repeat CV studies to how ecological changes and public awareness campaigns affect WTP. There are also opportunities to disaggregate WTP into various components and value such services such as flood control.

4.5 Policy Implications

The study has significant implications from a policy perspective as it helps quantify non-market values of better water quality. This quantification will help policymakers provide stronger rationalization for additional investment and policy measures such as investment in treatment plants and pollution related regulations and penalties. The proper assessment of environmental and social benefits arising from these studies lead to better decisions making in water resources management. The study also has significant benefits in better stakeholder engagement and greater legitimacy in any subsequent policy actions taken. The CV study is also helpful in a more effective Cost-Benefit Analysis (CBA) of any individual project by incorporating the monetary value of a non-market component water quality. This will reduce the risks of underinvestment in pollution control and conservation.

The study can help develop a policy package for the conservation of the Kelani River by fully considering the preferences of the public as well as the economic value attributed to water quality. The study findings help incorporate actionable strategics as well as affordable financing mechanisms from a policy perspective. This study can address historically limited prioritization given to the Kelani River water quality by assigning monetary value to the improvement of water quality.

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