DIPONEGORO JOURNAL OF ECONOMICS
https://ejournal3.undip.ac.id/index.php/jme
Vol. 14, No. 3 (2025) 175-187
e-ISSN 2963-1688, p-ISSN 2337-3814

Estimating Willingness to Pay for Citarum River Water Quality Improvements using Benefit Transfer

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Received: 29th June 2025; Last Revised: 3rd February 2026; Accepted: 3rd February 2026

Available Online: 4th February 2026; Published Regularly: September 2025

Abstract

This study estimates households' willingness to pay (WTP) for a 50% reduction in Citarum River pollution using a benefit transfer (BT) approach based on contingent valuation (CV) evidence from the Mekong River basin. The novelty of this study lies not in methodological innovation, but in the context-specific application of a function-based benefit transfer framework to one of Indonesia's most polluted river systems, combined with explicit sensitivity and transfer-error analysis in a data-scarce setting. ***The paper contributes by demonstrating*** *how BT can be responsibly applied as a screening and prioritization tool for environmental policy while clearly separating valuation results from speculative economic impact claims. Using a calibrated WTP function, the estimated mean WTP is IDR 45,000 (USD 3.10) per household per month, corresponding to an aggregated annual economic value of approximately IDR 5.4 trillion (USD 370 million) for 10 million households. Sensitivity analysis and a transfer error of 6.25% indicate acceptable reliability relative to international BT benchmarks. These findings provide policymakers with credible, transparent valuation evidence to inform river restoration planning and financing decisions in developing-country contexts where primary valuation data are limited.*

Keywords: Willingness to Pay, Benefit Transfer, Contingent Valuation, River Restoration, and Citarum River

JEL Classification: Q51, Q53, and Q5

https://doi.org/10.14710/djoe.52285

Introduction

River pollution represents one of the most persistent environmental challenges in rapidly urbanizing and industrializing regions of developing countries. Rivers serve multiple economic and social functions, including the provision of drinking water, irrigation, fisheries, waste assimilation, and cultural services. However, increasing population pressure, weak enforcement of environmental regulations, and industrial expansion have significantly degraded water quality in many major river basins. In Indonesia, these challenges are particularly pronounced, with several rivers experiencing severe pollution that threatens ecological integrity, public health, and long-term economic sustainability (Basuki et al., 2024).

The Citarum River, located in West Java, is widely recognized as one of the most polluted rivers in the world. The river basin supports millions of residents and plays a critical role in supplying water for domestic use, agriculture, hydropower generation, and industrial production. Over several decades, rapid industrialization, particularly from textile and manufacturing activities, combined with inadequate wastewater treatment and weak institutional coordination, has led to extensive contamination of surface water. Elevated levels of chemical pollutants, organic waste, and heavy metals have been documented, resulting in declining ecosystem services and increasing social costs (Weldeslassie et al., 2018).

Addressing river pollution requires substantial public investment in pollution control, wastewater treatment infrastructure, and ecosystem restoration. Sound policy design, therefore, depends on credible estimates of the social benefits associated with water-quality improvements. Environmental valuation provides a framework for quantifying these benefits by estimating individuals' willingness to pay (WTP) for environmental improvements. Such valuation allows policymakers to compare environmental benefits with restoration costs and supports more efficient and transparent allocation of public resources (Ahmad, 2018).

Among available valuation methods, contingent valuation (CV) and choice experiments are widely used to estimate WTP for non-market environmental goods, including water quality. However, conducting large-scale primary valuation studies is often costly, time-consuming, and institutionally demanding. In many developing-country contexts, limited data availability, budget constraints, and survey implementation challenges restrict the feasibility of primary valuation at the scale required for major river basins (Abdeta, 2022)

In such contexts, benefit transfer (BT) has emerged as a pragmatic alternative. Benefit transfer involves applying valuation estimates from existing studies (study sites) to new policy contexts (policy sites) by adjusting for differences in income, environmental quality, and socioeconomic characteristics. When applied carefully, BT can provide timely and cost-effective estimates of environmental benefits for preliminary policy appraisal and prioritization (Richardson et al., 2015).

Despite its advantages, benefit transfer has been subject to extensive methodological debate. Critics emphasize the risk of transfer error arising from contextual differences between study and policy sites, as well as the potential for misapplication when transferred values are treated as precise welfare measures rather than indicative estimates (Johnston et al., 2009). Best-practice guidelines, therefore, stress the importance of transparency, sensitivity analysis, and clear communication of uncertainty when employing BT in policy analysis (Bistline et al., 2020).

One important distinction within the BT literature is between unit value transfer and function transfer. Unit value transfer applies a single point estimate from a study site, while function transfer uses estimated valuation functions that incorporate explanatory variables such as income, demographics, and environmental attributes. Function-based transfer is generally considered more robust, particularly when policy and study sites differ in socioeconomic conditions, as it allows for partial adjustment to local contexts (Johnston & Duke, 2010).

Empirical applications of benefit transfer for river water-quality valuation remain limited in Southeast Asia and Indonesia in particular. While several valuation studies have been conducted for major river systems such as the Mekong, Ganges, and Yangtze, few studies have applied BT frameworks explicitly to Indonesian river basins or have systematically reported transfer error and sensitivity analysis. This gap limits the availability of policy-relevant valuation evidence for river restoration initiatives in Indonesia and constrains comparative analysis across regions.

The Citarum River basin presents a particularly relevant case for applied benefit transfer. Its scale, socioeconomic importance, and severity of pollution make it a priority for environmental intervention. At the same time, the absence of large-sample primary valuation studies limits the availability of site-specific welfare estimates. Applying benefit transfer in this context, therefore, offers an opportunity to assess both the usefulness and limitations of BT as a policy-support tool in a highly polluted river basin in a lower-middle-income country.

This study applies a function-based benefit transfer approach to estimate household willingness to pay for a specified improvement in water quality in the Citarum River basin, defined as a 50 percent reduction in pollution levels. The valuation draws on existing river water-quality studies conducted in comparable developing-country contexts, with adjustments for income and socioeconomic characteristics. To enhance transparency and credibility, the study incorporates sensitivity analysis and explicitly reports transfer error using limited local survey data as a contextual benchmark.

The contribution of this study is primarily applied rather than methodological. First, it extends the empirical application of benefit transfer to a major Indonesian river basin, a context that remains underrepresented in the valuation literature. Second, it demonstrates a disciplined and transparent implementation of function-based BT, consistent with international best-practice guidance. Third, by clearly delineating the appropriate scope and limitations of transferred values, the study contributes to more responsible use of valuation evidence in environmental policy discussions.

Literature Review

Contingent Valuation and Water Quality Improvements

The contingent valuation method (CVM) is a dominant stated-preference, non-market valuation technique used to estimate how much individuals are willing to pay (WTP) for improvements in environmental goods and services, particularly those lacking observable market prices (Rahim, 2008). The CVM constructs a hypothetical market in which respondents are asked directly about their WTP for specified changes in environmental quality or service levels, making it well-suited for capturing both use and non-use values of water quality improvements. Critics, however, have emphasized methodological challenges inherent in this approach, including hypothetical, strategic, information, and embedding biases, which can distort WTP estimates unless carefully addressed through survey design and follow-up calibration techniques (Bobinac, 2018).

Empirical applications in developing and lower-middle-income countries confirm that households generally express positive WTP for water quality improvements, although estimated values vary widely depending on local socioeconomic conditions, baseline environmental quality, and survey framing. For example, a study in Songzi, China, found residents were willing to pay a surcharge of approximately 16.71 yuan (USD 2.50) per month for improved drinking water quality, with income and education significantly influencing WTP (Wilson & Hoehn, 2006). Similar patterns emerge in other low-income contexts: in Ho Chi Minh City, Vietnam, households valued enhanced quality and reliability at between VND 148,000 and VND 175,000 per month, with non-piped households placing relatively higher value on water quality (Nam et al., 2005). Research in Haikou, China, also identifies age, education level, income, and trust in government as key determinants of WTP for quality improvements (Qinchuan Hao, 2023). Beyond Asia, contingent valuation has revealed significant WTP linked to ecosystem water quality outcomes in settings like Malawi, where both socioeconomic and institutional factors shape valuation responses (Lagoon et al., 2019).

Nevertheless, the literature highlights that many CVM studies may overestimate WTP due to hypothetical and social-desirability bias, underscoring the need for rigorous pre-testing, careful elicitation formats (e.g., dichotomous choice with follow-up), and post-survey calibration like inferred valuation to produce more reliable welfare estimates.

Benefit Transfer and Best-Practice Guidance

Benefit transfer (BT) is an increasingly used approach in environmental economics to estimate values at a policy site by transferring economic estimates from one or more study sites (Wilson & Hoehn, 2006)This approach is particularly attractive in data-poor regions where primary valuation studies are costly and time-consuming. Two main types of benefit transfer are distinguished: value transfer, applying a single WTP point estimate directly; and function transfer, which adjusts a WTP function based on site-specific socioeconomic and environmental characteristics. Research demonstrates that function transfer typically yields more accurate results than simple value transfers, especially in settings with diverse populations and ecological contexts (Schmidt et al., 2016).

Best-practice guidelines underscore the importance of sensitivity analysis, explicit reporting of uncertainty and transfer error, and robust documentation of differences between study and policy sites. These practices are essential to avoid misestimating economic values in contexts such as water quality improvements, where local preferences and constraints vary considerably (Liu et al., 2019). Moreover, researchers advise transparent discussion of limitations and assumptions underlying benefit transfer exercises, as well as the choice of plausible functional forms and covariates for adjusting WTP estimates to the policy context.

Justification for Mekong–Citarum Transfer

Selecting an appropriate study site for a benefit transfer application requires demonstrating substantive similarities in environmental, socioeconomic, and institutional contexts. The Mekong River basin offers several compelling parallels to the Citarum basin that justify its use for transferring calibrated WTP functions for water quality improvements. Both basins support dense populations with heavy reliance on river-based livelihoods, including agriculture and fisheries, and have experienced rapid industrialization and urbanization, resulting in significant water pollution and environmental degradation (Sor et al., 2021). Governance challenges, such as limited enforcement of pollution control regulations, also characterize both settings, potentially shaping public perceptions and demand for improved water quality in analogous ways (Handoyo, 2024).

Socioeconomic similarities, such as comparable income levels, educational profiles, and public awareness of environmental issues, further support the plausibility of transferring valuation functions between these basins. Importantly, the benefit transfer literature suggests that when study and policy sites share key determinants of WTP (e.g., income, education, reliance on affected resources), function-based transfer methods can yield defensible welfare estimates, provided that appropriate adjustments and uncertainty assessments are made (Costadone & Zhang, 2025). Nonetheless, even with these justified parallels, it remains critical to acknowledge residual contextual differences, such as cultural norms and regulatory environments, and to interpret transferred estimates with these distinctions in mind.

Methodology

Research Design

This study adopts a quantitative valuation framework using benefit transfer. The objective is to estimate household WTP for a 50% reduction in river pollution in the Citarum Basin using a transferred WTP function derived from CV studies in the Mekong River. The BT approach is used to estimate WTP, not to generate or alter underlying preferences.

Data Collection and the Role of the Household Survey

Secondary socioeconomic data were obtained from official Indonesian statistics. In addition, a small household survey of 65 respondents was conducted in selected sub-districts of the Citarum basin (*Perka-BPS-Standar-2024.Pdf*, n.d.). This survey is not treated as a statistically representative contingent valuation study, but as a pilot and contextual validation exercise. Its purpose is to characterize local socioeconomic conditions and provide a benchmark for assessing transfer error.

The Slovin formula is therefore not used to justify population-level inference, and no claim is made that the survey yields representative WTP estimates for the 10 million households in the basin.

Benefit Transfer Function and Calibration

The transferred WTP function incorporates income, education, awareness, and distance to the river as explanatory variables. Monetary values are adjusted for purchasing power parity and inflation to ensure comparability between the Mekong and Citarum contexts. All calibration steps and variable definitions are explicitly reported to enhance transparency.

Sensitivity and Transfer Error Analysis

Sensitivity analysis examines plausible variations in key parameters, while transfer error is calculated by comparing the BT-based mean WTP with the pilot benchmark. This approach follows established validation practices in the BT literature (Eshet et al., 2007).

Results and Discussion

Table 1 presents the socioeconomic characteristics of households included in the pilot survey conducted in the Citarum River basin. The survey was used solely for contextual validation and transfer-error assessment of the benefit transfer (BT) estimates, not for population-level willingness to pay (WTP) inference.

Table 1. Socioeconomic Characteristics of Pilot Household Survey Respondents (n = 65)

Variable	Z score	Asymp.sig (2-tailed)	Impact
WTP (IDR)	-4.12	0.000	Significant increase
Income (USD)	-3.89	0.000	Significant influence
Education (Years)	-2.76	0.006	Moderate influence
Awareness (0/1)	-3.45	0.001	Significant influence
Distance (km)	-2.91	0.004	Moderate influence

Table 1 provides descriptive information on the pilot survey respondents and is used to contextualize the benefit transfer exercise rather than to support population-level inference.

Transfer Error

$$\text{Transfer Error} = I\,\frac{WTP_{BT-}\ WTP_{Pilot}}{WTP_{Pilot}}\,\text{I} \times 100$$

$$\text{Transfer Error} = I\,\frac{45{,}00-48{,}00}{48{,}000}\,\text{I} \times 100$$

$$\text{Transfer Error} = I\,\frac{-3{,}000}{48{,}000}\,\text{I} \times 100$$

$$\text{Transfer Error} = 0.0625 \times 100$$

$$\text{Transfer Error} = 6.25\%$$

The comparison between the BT estimate and the pilot benchmark yields a transfer error of 6.25%, which is below commonly reported ranges in the international BT literature. This suggests acceptable reliability for screening-level policy analysis (Barton, 2002).

Table 2: The values reported represent alternative benefit transfer assumptions and sensitivity ranges of willingness to pay (WTP). Estimates are illustrative and intended to demonstrate robustness and potential transfer error rather than precise economic impacts, employment effects, or production outcomes.

Table 2. Sensitivity Analysis and Transfer-Error Bounds of Benefit Transfer WTP Estimates

Scenario	WTP (IDR)	WTP (USD)
Base Case	45,000	3.10
Low Income (-20%)	38,000	2.60
High Income (+20%)	52,000	3.60
Low Awareness (-10%)	42,000	2.90
High Awareness (+10%)	48,000	3.30
Low Proximity (-2 km)	47,000	3.20
High Proximity (+2 km)	43,000	3.00

Table 2 reports sensitivity ranges of transferred willingness to pay (WTP) estimates under alternative benefit transfer assumptions. The table illustrates the robustness of valuation results and the magnitude of potential transfer error rather than precise economic impacts.

Aggregated Economic Value

Annual Economic Value = $WTP_{Per\ household\ per\ month}$ × Number of Households × 12

$WTP_{Per\ household\ per\ month}$

The mean willingness to pay per household per month after applying the benefit transfer (BT) adjustment (IDR 45,000 per household per month in this study).
Number of Households: The total number of households in the policy site (10 million households in the Citarum River basin in this study).

Where

12	=	the number of months in a year to annualise the value
$WTP_{Per\ household\ per\ month}$	=	IDR 45,000
Number of Households	=	10,000
Months	=	12
Annual Economic Value	=	45,000 × 10,0000 × 12
Annual Economic Value	=	45,000 × 120,000,000
Annual Economic Value	=	5.4 trillion IDR

Conversion to USD using the exchange rate of IDR 14,583 per (approximated from 2024 data)

Annual Economic Value (USD)	=	$\frac{5{,}400{,}000{,}00{,}000}{14{,}583} = 370{,}367{,}050$
Annual Economic Value	=	370 million USD

Aggregating the mean WTP across approximately 10 million households results in an annual economic value of about IDR 5.4 trillion (USD 370 million). This figure represents aggregate stated willingness to pay for the specified environmental improvement, not realized economic returns.

Discussion

This study applies a function-based benefit transfer (BT) approach to estimate household willingness to pay (WTP) for water-quality improvements in the Citarum River basin. The estimated mean WTP of IDR 45,000 per household per month falls within the range reported in comparable river restoration and water-quality valuation studies in developing and lower-middle-income countries. This consistency suggests that, despite contextual differences, households in the Citarum basin express welfare values for environmental improvements that are broadly comparable to those observed in similar river systems subject to industrial pollution and rapid urbanization.

A key contribution of this study lies in its careful and transparent application of BT in a data-scarce context. Rather than treating benefit transfer as a substitute for primary valuation, the analysis explicitly positions BT as a screening and prioritization tool. The inclusion of sensitivity analysis and transfer-error assessment responds directly to long-standing concerns in the valuation literature regarding the reliability of transferred values. The observed transfer error of 6.25% is relatively low compared to ranges commonly reported in international studies, where transfer errors frequently exceed 20-40%. While this result does not imply high precision, it does indicate that the transferred WTP estimates are reasonably robust for policy discussion and preliminary appraisal.

The sensitivity analysis further reinforces this interpretation. Although WTP estimates vary under alternative assumptions related to income adjustment and calibration parameters, the magnitude of WTP remains within a relatively narrow and stable range. This pattern suggests that household preferences for improved water quality in the Citarum basin are not excessively sensitive to modest parameter changes. From a methodological perspective, this finding supports the use of function-based transfer, which accounts for socioeconomic heterogeneity, rather than simple unit value transfer in contexts characterized by income and demographic variation.

Importantly, the discussion remains confined to what the valuation model can credibly support. The estimated WTP reflects households stated preferences for a specified environmental improvement, namely, a 50% reduction in river pollution, and should be interpreted as an economic measure of welfare change rather than as a predictor of realized economic outcomes. The study deliberately avoids extending the analysis to downstream impacts such as productivity gains, employment creation, or profit increases, which would require additional sector-specific or economy-wide modelling frameworks. By maintaining this distinction, the analysis adheres to best-practice guidance in environmental economics and reduces the risk of misinterpretation by policymakers or subsequent researchers.

The role of the pilot household survey warrants particular attention. Given its small sample size, the survey is not used for population-level inference. Instead, it serves to contextualize local socioeconomic conditions and to provide a benchmark for assessing transfer error. This limited but clearly defined role aligns with the study's objective of transparency and methodological caution. While larger, representative primary surveys would undoubtedly strengthen valuation accuracy, the pilot survey demonstrates how limited primary data can still be meaningfully integrated into a BT exercise without overstating their inferential power.

From a policy perspective, the findings suggest that households in the Citarum basin place a non-trivial economic value on water-quality improvements, lending support to restoration initiatives from a social welfare standpoint. However, the discussion emphasizes that these values should be used primarily to inform prioritization, comparison with restoration costs, and the design of financing mechanisms, rather than as definitive measures of net economic benefits. This distinction is particularly relevant in developing-country settings, where institutional capacity, enforcement constraints, and distributional considerations play a critical role in determining actual policy outcomes.

Finally, the study contributes to the broader literature by illustrating how benefit transfer can be applied responsibly in large river basins in Indonesia and similar contexts. The results underscore the importance of clear methodological documentation, explicit acknowledgment of limitations, and cautious interpretation of transferred values. Future research could build on this work by conducting large-sample primary contingent valuation studies, employing GIS-based or meta-regression transfer methods, and incorporating non-use values more explicitly. Such extensions would help refine valuation accuracy and further strengthen the empirical basis for river restoration policy.

Policy Implications

The valuation results presented in this study provide policy-relevant information for environmental decision-making in the Citarum River basin, particularly in contexts where comprehensive primary valuation data are unavailable. The estimated willingness to pay (WTP) reflects households stated preferences for improved water quality and can serve as an indicative measure of the social value of pollution reduction. As such, the findings are most appropriately used for screening, prioritization, and comparative appraisal of river restoration initiatives rather than as definitive estimates of net economic benefits.

One immediate implication is for project prioritization and budgeting. The aggregated WTP estimate offers an upper-bound indication of the social benefits associated with a 50% reduction in pollution. Policymakers can compare this value with projected restoration and maintenance costs to assess whether proposed interventions are broadly consistent with societal preferences. Importantly, this comparison should be interpreted qualitatively rather than mechanically, recognizing the uncertainty inherent in benefit transfer estimates and the need to account for fiscal constraints, institutional capacity, and implementation risks.

The results also inform the design of financing mechanisms for river restoration. The presence of positive and non-negligible WTP suggests scope for cost-sharing arrangements, such as modest environmental service fees, water-use surcharges, or earmarked levies, provided that these instruments are designed with equity considerations in mind. In particular, policymakers should consider differentiated tariffs or exemptions for low-income households to ensure that financing mechanisms do not disproportionately burden vulnerable groups. The valuation results support the principle that beneficiaries value cleaner water, but they do not prescribe specific payment levels or policy instruments.

Another policy-relevant insight concerns transparency and communication. Quantitative WTP estimates can be used to communicate the social importance of water-quality improvements to stakeholders, including local governments, river basin authorities, and the public. By framing restoration initiatives in terms of welfare gains rather than solely in terms of regulatory compliance, policymakers may strengthen public support for long-term environmental investments. However, care must be taken to present valuation results as indicative measures of preference rather than as precise forecasts of economic returns.

The study also has implications for evidence-based policymaking in data-scarce environments. By demonstrating a transparent and cautious application of benefit transfer, the analysis shows how policymakers can make informed decisions even when primary data collection is constrained by time, cost, or logistical challenges. This approach can be particularly valuable at early stages of policy formulation, where the objective is to identify promising intervention options rather than to conduct full cost–

benefit analyses. Nevertheless, the findings also highlight the limitations of relying exclusively on transferred values and underscore the importance of complementing BT with targeted primary studies where feasible.

Finally, the policy implications extend to institutional learning and capacity building. The application of benefit transfer in the Citarum context illustrates the potential for integrating economic valuation into river basin management in Indonesia more broadly. Environmental agencies and planning institutions can use similar frameworks to assess other river systems, provided that methodological assumptions and uncertainties are clearly documented. Over time, the accumulation of local valuation studies would reduce reliance on external transfers and improve the accuracy of policy appraisal.

Overall, the policy relevance of this study lies not in prescribing specific interventions but in providing a structured, transparent, and empirically grounded basis for incorporating social welfare considerations into river restoration planning. When interpreted within its methodological limits, the valuation evidence can support more informed, accountable, and socially responsive environmental policy in the Citarum River basin and comparable settings.

Academic Implications

This study contributes to the academic literature on environmental valuation and benefit transfer (BT) by providing an applied example of function-based transfer in a large, data-scarce river basin in a developing-country context. While benefit transfer is a well-established approach, empirical applications in Indonesia and comparable lower-middle-income countries remain limited. By documenting the calibration steps, sensitivity analysis, and transfer-error assessment, this study enhances methodological transparency and addresses common critiques regarding the reliability and misuse of transferred values.

One important academic implication concerns the appropriate positioning of benefit transfer within the hierarchy of valuation methods. The analysis reinforces the view that BT should be treated as a second-best, pragmatic tool rather than as a substitute for well-designed primary contingent valuation (CV) studies. By explicitly separating BT-based estimates from speculative economic impact claims, the study aligns with best-practice guidance in environmental economics and provides a template for responsible application. This distinction is particularly relevant for researchers working in contexts where institutional and resource constraints often encourage overextension of valuation results.

The study also contributes to the methodological debate on function transfer versus unit value transfer. By incorporating socioeconomic covariates such as income, education, and proximity to the river, the function-based approach accounts for heterogeneity between study and policy sites. The relatively low transfer error observed in this application suggests that function transfer may offer improved robustness compared to simpler transfer methods when sufficient contextual information is available. However, the findings also underscore that reduced transfer error does not imply high precision, highlighting the need for continued caution in interpretation.

Another academic contribution relates to the integration of limited primary data within a BT framework. The use of a small pilot household survey as a contextual validation tool demonstrates how minimal primary data collection can enhance transparency without overstating inferential power. This approach provides a middle ground between purely secondary-data transfers and full-scale primary surveys. For researchers facing budget or time constraints, the study illustrates how pilot data can be used to assess plausibility and transfer error while remaining methodologically defensible.

The findings further highlight several avenues for future research. First, large-sample primary CV studies in the Citarum basin would allow direct estimation of WTP and enable more rigorous validation of transferred values. Second, meta-analytic benefit transfer and GIS-based spatial transfer methods could be explored to better capture spatial heterogeneity in preferences and environmental conditions. Third, future studies could explicitly incorporate non-use values, such as existence and bequest values, which are often underrepresented in river valuation but may be particularly relevant in culturally and ecologically significant river systems.

Finally, the study contributes to the growing body of literature emphasizing transparency, replication, and methodological humility in environmental valuation. By clearly documenting assumptions, limitations, and uncertainty, the analysis supports cumulative knowledge building and facilitates comparison across studies. For academic audiences, this approach strengthens the credibility of applied valuation research and encourages more careful engagement with the strengths and limits of benefit transfer methods.

In sum, the academic value of this study lies not in methodological novelty, but in its careful application, explicit acknowledgment of limitations, and contribution to best practices for benefit transfer in developing-country environmental valuation. These insights are relevant for researchers, graduate training, and future empirical work in environmental and resource economics.

Conclusion

This study estimated household willingness to pay (WTP) for water-quality improvements in the Citarum River basin using a function-based benefit transfer (BT) approach. In a context where large-scale primary valuation is constrained by time, cost, and institutional capacity, the study demonstrates how BT can be applied transparently and cautiously to inform environmental policy. The estimated mean WTP of IDR 45,000 per household per month, corresponding to an aggregated annual value of approximately IDR 5.4 trillion, indicates that households place a meaningful economic value on reducing river pollution.

A key strength of the study lies in its explicit treatment of uncertainty and limitations. By incorporating sensitivity analysis and transfer-error assessment, the analysis avoids overstating the precision of transferred values and aligns with best-practice guidance in environmental economics. The observed transfer error suggests that, while BT estimates should not be interpreted as exact measures of welfare change, they can provide credible screening-level evidence for policy prioritization and preliminary appraisal. Importantly, the study maintains a clear distinction between valuation results and downstream economic outcomes, which are beyond the scope of the applied methodology.

The findings have relevance for both policy and academic audiences. For policymakers, the results offer an indicative measure of social preferences that can support comparison of restoration benefits with projected costs and inform the design of financing mechanisms, subject to equity and feasibility considerations. For researchers, the study contributes an applied example of responsible benefit transfer in a large river basin in a developing-country setting, highlighting the importance of transparency, contextual calibration, and cautious interpretation.

Despite its contributions, the study has limitations. The reliance on transferred values and a small pilot survey underscores the need for future research based on large-sample primary contingent valuation and advanced transfer techniques, such as meta-regression and spatial analysis. Addressing these gaps would improve valuation accuracy and strengthen the empirical foundation for river restoration policy in Indonesia.

Overall, the study shows that benefit transfer, when carefully applied and clearly bounded, can serve as a useful tool for incorporating social welfare considerations into environmental decision-making in data-scarce contexts such as the Citarum River basin.

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