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Bridging the divide: reconciling stakeholder values for payment for ecosystem services

A framework for sustainable management in Batticaloa Lagoon, Sri Lanka

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Abstract

Coastal lagoons are vital and productive ecosystems globally. However, recent anthropogenic pressures have substantially degraded these environments. The sustainability of lagoon resources critically depends on stakeholder engagement. Employing a choice experiment, this study quantifies the divergent preferences of key stakeholder groups–fishermen, tourists, and flood-affected residents–for preservation versus degradation scenarios in Sri Lanka's Batticaloa Lagoon. The survey targeted stakeholders using stratified sampling and reached 405 participants in the Batticaloa Lagoon Watershed. The analysis further assessed local perceptions of degradation and stakeholders' compensation expectations (WTA). The Choice Experiment and multinomial logit model identified significant conflicts between conservation valuations and compensation expectations. This novel empirical application directly compares within-subject Willingness-to-Pay and WTA measures, revealing significant valuation asymmetries that complicate Payment for Ecosystem Services (PES) design. These results provide empirical evidence of pronounced preference diversity among lagoon users in the study area. This study argues that management decisions must account for heterogeneous stakeholder valuations, rather than universal conservation ideals. The findings demonstrate the inevitability of one-size-fits-all PES policy failure and propose a differentiated PES framework with tailored incentives for fishermen, tourists, and flood-affected residents.

Keywords

Lagoon; Ecosystem; Resources; Land use; Willingness to accept; Willingness to pay

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1. Introduction

Ecosystem services constitute the fundamental contributions of natural systems to human well-being and economic activities. Since 1980, the Payment for Environmental Services (PES) framework has been applied globally, but empirical evidence remains limited in several regions. Successful PES implementation requires robust governance frameworks, which are deficient in numerous nations and necessitate improved water management policies (Bergkamp, 2006; Shaad et al., 2022)

Coastal lagoons are among the most productive aquatic ecosystems in the world. They span approximately 13% of the continental coastlines and estuaries and provide critical environmental and economic benefits (Sousa et al., 2020). The capacity of lagoons to provide ecosystem services depends on their ecological health. However, pervasive mismanagement has diminished this capacity. When maintained optimally, lagoons support water purification, carbon sequestration, flood prevention, and recreational opportunities (e.g. birdwatching) while harbouring biodiverse habitats, such as mangroves, salt marshes, and seagrass beds (Chacón Abarca et al., 2021). Consequently, these ecosystems are invaluable economic assets essential for human well-being (Clara et al., 2017). However, environmental degradation and anthropogenic pressures pose an escalating threat to these resources (Newton et al., 2018). Recent evidence confirms accelerating degradation rates in Asian lagoons, with tourism infrastructure increasing sediment load by 40-60% (Veettil et al., 2023).

Despite evidence that human exploitation compromises the long-term viability of lagoons (Murray et al., 2022), scholarly enquiry has disproportionately focused on cataloguing uses rather than investigating pathways for collaborative management. The critical deficit in stakeholder interaction data hinders the development of integrated sustainability frameworks. Understanding diverse stakeholder valuations is essential for reconciling ecological and economic imperatives (Pham et al., 2018). By quantifying stakeholder-specific values, this study moves beyond the counterproductive dichotomy that pits conservation against resource utilisation.

Fish biodiversity is a key asset in the lagoons. The escalating demand for fish has driven overexploitation, depleting fish populations, and compromising local nutrition (Maitland, 1995). Similarly, mangroves, which are critical for water filtration, coastal stabilisation, and juvenile fish nurseries, face unprecedented losses, with a 35% global decline over 20 years (Vo Trung et al., 2020). In Asia, mangrove deforestation occurs at an annual rate of 1.52% and is driven by aquaculture, infrastructure, development, and tourism (Mumby et al., 2006; Valiela et al., 2001)mby et al., 2006; Valiela et al., 2001). The Batticaloa Lagoon epitomises these challenges, hosting unique biodiversity and cultural traditions (Blanco et al., 2012). However, tourism poses a risk of resource depletion (Wolf et al., 2019). Hydrodynamic processes (e.g. water circulation) underpin lagoon resilience (Dolbeth et al., 2016). Finally, increased flooding negatively impacts the quality of life of those living near lagoons. However, the challenges associated with wetland protection and related costs have received little attention to date. This study proposes that human desires and exploitation must be factored into lagoon valuation. Environmental valuation is a tool for estimating the market value of natural ecosystem services without a market (Qiao et al., 2023). Beyond their ecological benefits, lagoons have significant cultural and recreational value, particularly for tourism, which introduces both opportunities and risks. Lagoons contain valuable resources that are often undervalued by society. Given the diversity, intricate socioeconomic backdrop, and structure of lagoons, it is difficult to assign value to them because they are not tradable goods (Pissarra et al., 2021). Four degradation fronts threaten Batticaloa lagoon: (1) declining water purity; (2) unsustainable mangrove loss; (3) reduced fish diversity; and (4) increased flooding. However, the costs of wetland protection remain understudied.

While discrete choice experiments are widely used in environmental valuation, few studies have concurrently elicited WTP and WTA from the same respondents to expose preference asymmetries and potential conflicts between stakeholder groups in a coastal lagoon context. This research fills this gap by evaluating stakeholder valuations of resources in the Batticaloa Lagoon, specifically examining the tension between conservation priorities and compensation demands. By integrating Willingness to Pay (WTP) and Willingness to Accept (WTA) measures, this study provides policymakers with actionable insights for balancing ecological and socio-economic objectives. This investigation addresses four key objectives: (1) to quantify WTP for specific lagoon attributes, such as fish diversity and mangrove coverage; (2) to assess WTA compensation for projected ecosystem degradation; (3) to evaluate the applicability of Payments for Ecosystem Services (PES) schemes for the lagoon's management; and (4) to elucidate the differential livelihood impacts on upstream and downstream communities.

2. The study area

2.1 Batticaloa Lagoon Ecosystem

Batticaloa lagoon, situated in Sri Lanka's Batticaloa District, is one of the nation's largest estuarine lagoons. It spans approximately 11,500 ha and extends 56 km from Chenkalady to Kalmunai (Partheepan et al., 2023). The watershed supports prawn farming, aquaculture, and crop cultivation, with seagrass meadows and mangroves dominating its borders. Notably, the lagoon harbours a significant diversity of aquatic fauna. As a shallow coastal feature, it is separated from the ocean by a barrier and intermittently connected via two restricted inlets (Fig.1). The formation and maintenance of lagoons are governed by sediment transport systems that create barriers requiring continuous sedimentation to counteract erosional forces (Harris & Wiberg, 2002; Stein et al., 2021).

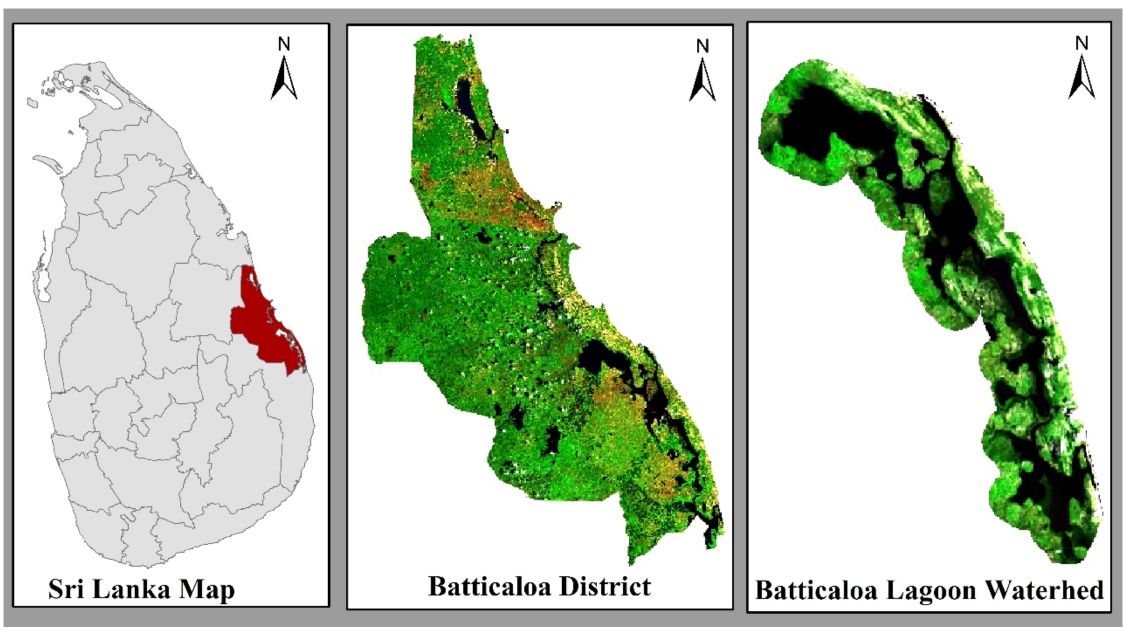

Fig.1 Batticaloa District and Batticaloa Lagoon, Sri Lanka

Designated as a nationally significant wetland, Batticaloa Lagoon hosts exceptional biodiversity but is facing anthropogenic stressors (e.g. wetland conversion to other land uses, agricultural runoff, and tourism). Poverty, population growth, and sociocultural conflicts further complicate the management of these problems. In addition, human activities, such as converting wetlands into intensive farming, commercial, and residential areas, drainage from unsustainable agricultural irrigation, and damage from nitrogen runoff from intensive farming, aquaculture runoff, and industry, are putting more stress on the lagoons. Factors such as poverty, economic deprivation, demographic growth, globalisation, mass tourism, and social and cultural conflicts significantly affect the management of lagoons (Suresh et al., 2021). Other possible lagoon management service beneficiaries and people's preferences in the western part of the lagoon for reimbursement of environmental services are not included in the PES system, necessitating further research on this topic.

3. Methodology

This section delineates the methodological approach, prioritising the questionnaire design, survey methodology, and econometric frameworks. The study then explains the methods used to estimate the average WTP and its underlying factors. This study focused on the Batticaloa Lagoon and its surrounding watershed, encompassing its key ecological and socioeconomic dimensions. A stratified sampling technique ensured data collection efficiency and guaranteed that the information sufficed to meet the study's objectives.

3.1 Questionnaire design and survey methodology

Questionnaire design

Theoretically, the fundamental economic value of an ecosystem service comprises two primary components: use and non-use values (Albani & Romano, 1998). Humans can directly benefit from the consumption of these lagoon resources. Additionally, non-consumptive use occurs when humans interact with natural resources. These non-consumptive uses include recreational activities such as birding or sightseeing that do not involve resource consumption. The knowledge that these resources exist for ecosystem function or are available for future generations generates non-use value (Barbier, 2011). These non-use values cannot be exchanged in the market. Environmental economics devises methods for measuring the value of ecosystem services for project implementation and policy development (Birol et al., 2006).

Focus groups with the village heads of the relevant communities under study and the lagoon management authority were convened to ensure the questionnaire's applicability. The questionnaire elicited respondents' Willingness to Pay (WTP) for the preservation of Batticaloa Lagoon, focusing primarily on non-use values.

A total of 409 questionnaires were completed through comprehensive interviews. Of the 409 responses, 405 were considered appropriate for analysis. This study aimed to assess local perceptions of potential lagoon degradation from tourism and development and, consequently, their Willingness to Accept (WTA) compensation for these negative impacts.

The survey questionnaire was divided into three sections. The demographic and socioeconomic characteristics of the survey site were gathered in the first section for statistical purposes and used as explanatory variables in the regression analysis in the third section. Enumerators questioned the respondents regarding their age, marital status, employment position, degree of education, and other factors.

The second segment aimed to comprehend the respondents' perspectives on lagoon ecosystem services. This section describes lagoon conservation and the risks to lagoon biodiversity. Respondents were provided sufficient information to determine the value of lagoon resources based on direct and other non-use advantages. Therefore, our enumerators presented the following scenarios to the locals: Our enumerators elucidated the vulnerability of the Batticaloa Lagoon based on scientific research. Respondents were given a visual representation of how vulnerable the Batticaloa Lagoon would be in the coming decades, using images depicting lagoon degradation and declining biodiversity. Respondents were asked to rate the importance of the reasons for conserving the lagoon on a scale of 1 (not at all important) to 5 (very important).

The scenario presupposed that between now and 2030, a local project would be undertaken and that all residents would be compelled to contribute money to conserve the lagoon resources. The next question was how much of a lump sum respondents would be willing to contribute to the project.

The final segment contained elicitation questions regarding WTP and WTA. Two methods are commonly used to elicit preferences: acceptance and refusal. Prior to the main survey, an open-ended pretest was conducted with 50 households in the buffer zone to evaluate and refine the survey's design.

In the pre-test survey, the lagoon management committee invited household members to participate in interviews with enumerators. This pre-test helped to determine the appropriate attribute levels and compensation rates for the choice experiment. The questionnaire was designed to encourage genuine and accurate responses regarding WTP. Enumerators recorded positive WTP declarations and enquired about the reasons for refusal when the respondents were unwilling to pay.

Survey method

The survey targeted the lagoon's 1-km buffer zone (9 DS divisions and 145 Grama Niladhari divisions within an area of 82.74 km^2; population ~116,000). Using stratified sampling, interviews were conducted with 405 respondents (fishermen, 16.05%; tourists, 62.47%; and flood-affected residents, 21.48%). Face-to-face interviews ensured the reliability of the data.

A stratified sampling strategy was designed to capture the geographic and socioeconomic variability within the lagoon watershed. The primary strata were the nine Divisional Secretariat (DS) divisions bordering the lagoon with a 1 km buffer zone, with further consideration given to the distinct environmental and socio-economic contexts of the eastern and western regions of the Batticaloa district. This approach ensured that the sample adequately represented population heterogeneity related to land use, dependency on ecosystem services, and socioeconomic characteristics, thereby enhancing the robustness and validity of the data collected.

3.2 Econometric framework

Lancaster's model of consumer choice provides the theoretical foundation for the Choice Experiment (CE) approach, while a multinomial logit (MNL) model provides econometric underpinnings based on Random Utility Theory (RUT) (Lancaster, 1966). According to Lancaster's theory, consumers derive pleasure from products or services and their features and benefits (Birol et al., 2006). Carefully planned experiments or tasks constitute the backbone of CE methodology, which is a highly structured approach to data production (Hanley et al., 1998). The CE approach integrates behaviour with economic valuation based on random utility theory, which characterizes decisions in a utility-maximising framework (Wang, 2007).

Respondents' decision-making is always guided by a random utility-maximising strategy in the choice experiment (Louviere et al., 2010). According to random utility theory, the choice of individual i is based on that person's utility from option j, denoted by Uij. Thus,

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

Systematic elements (V) and random elements (ε) are combined to form the utility (U). The independent and identically distributed (IID) error term is represented by (V_{ij}), which represents the systematic utility elements that person i places on alternatives (j), and (ij), which represents the random elements.

As a result, the multinomial logit (MNL) model can be used to begin the DCM. Eq. (2), where m is a scale parameter that is inversely proportional to the standard deviation of the error distribution and is typically assumed to be one, can be estimated using MNL regression, which assumes that scale factors persist persistently throughout the alternatives and permit various ranges of utility with repetition.

$$E(ij) = \frac{exp^{mV_{ij}}}{\sum_{n \in C} exp^{mV_{in}}} \quad (2)$$

The estimated linearity in the parameter utility framework for the jth option is.

$$V_{ij} = ASC_j + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots \dots \dots + \beta_k X_k + \gamma_p (S_p * ASC_j). \quad (3)$$

In the utility function, j stands for an option, k represents quality, and p reflects socio-demographic variables. The constant word ASC refers to all alternatives in a choice set. Interaction terms (e.g. Fish Diversity × Fishermen) were incorporated into the utility function to statistically test the differences between stakeholder groups. The Wald test confirmed significant differences ($p < 0.05$) in the coefficients of fish diversity ($\chi^2 = 12.34$, $p = 0.002$) and flora/fauna ($\chi^2 = 9.87$, $p = 0.007$) among the groups.

To compare the degree of conservation, this study evaluated respondents' WTP and WTA. As a result, the WTP and WTA display the marginal substitution rate between the value of the conserved traits and those sacrificed and the cost of conservation and compensation. The WTP for a slight modification of the kth attribute (k) is as follows:

$$WTP_k = -\frac{\beta_k}{\beta_\mu} \quad (4)$$

Therefore, the WTA clarifies that there is little exchange between conservation traits and the willingness to accept remuneration. The WTA for a slight change in the kth attribute (k) is described as follows:

$$WTA_k = \frac{\beta_k}{\beta_\mu} \quad (5)$$

(Hensher et al., 2015) claimed that this study used an MNL model to understand stakeholders’ desires for lagoon conservation.

The within-subject design was deliberately chosen to enable a direct comparison of the same individual's trade-offs when framed as a gain (WTP) versus a loss (WTA), which is a key focus of this research. While this approach can introduce potential bias, such as cognitive dissonance or sequencing effects, the study mitigated this by randomising the choice tasks and enforcing a time gap between the WTP and WTA sections of the questionnaire (Carson et al., 2001).

3.3 Choice task Design

The initial phase of the Choice Experiment (CE) involved selecting attributes that represent the key ecological services of the Batticaloa Lagoon. Informed by a comprehensive literature review and focus group discussions with stakeholders and the lagoon management authority, four core attributes were identified: Fish Diversity, Mangrove Coverage, Waterbirds and other Flora & Fauna, and Flood Control. A Cost/Payment attribute was included as the payment vehicle. The selected attributes satisfied three criteria: (1) they pertain directly to ecosystem services (ES); (2) they are directly influenced by management practices; and (3) they lack established market values (Bateman et al., 2002).

Choice Task Model – Choice Set I -WTP

Attributes	Definition	Levels
Fish Diversity	Number of fish species/ types	Current Status (96)
		Level I (91)
		Level II (86)
		Level III (80)
Mangrove Coverage	Mangrove coverage in hectares (-20% and -40%)	Current Status (321 ha)
		Level I (257 ha)
		Level II (203 ha)
		Level III (175 ha)
Waterbirds and other flora and fauna	Species diversity	Level I Current
		Level II (10% Decrease)
		Level III (25% devastating)
Flood control	Flood control level by the meter (m)	Current Status (2. 75m)
		Level I (2.30m)
		Level II (2.00m)
		Level III (1.75m)
Cost/ Payment (LKR)	Willingness to Accept for recreational program/ monthly Compensation via a reduction in your monthly/ annual LA Taxes (LKR/Per month)	Level I (LKR 150)
		Level II (LKR 260)
		Level III (LKR 440)

Tab.1 Attributes and levels used in WTP choice modelling set 1 task

Choice Task Model – Choice Set II -WTA

Attributes	Definition	Levels
Fish Diversity	Number of fish species/ types	Current Status (96)
		Level I (100)
		Level II (105)
		Level III (110)
Mangrove Coverage	Mangrove coverage in hectares (-20% and -40%)	Current Status (321 ha)
		Level I (340 ha)
		Level II (385 ha)
		Level III (420 ha)
Waterbirds and other flora and fauna	Species diversity	Level I Current
		Level II 5% Increase
		Level III 8% Increase
Flood control	Flood control level by the meter (m)	Current Status (2. 75m)
		Level I (3.20m)
		Level II (3.75m)
		Level III (4.20m)
Cost/ Payment (LKR)	The monthly payment for Lagoon management via increasing in your monthly LA Taxes (LKR/Per month)	Level I (LKR 230)
		Level II (LKR 320)
		Level III (LKR 550)

Tab.2 Attributes and levels used in the WTA choice modelling set 2 task

The levels for each attribute, representing scenarios of enhanced or degraded environmental quality, were grounded in scientific research and expert consultation to ensure realism and policy relevance for the Batticaloa Lagoon Watershed. Tab.1 outlines the attributes, their definitions, and the specific levels used in the Willingness-to-Pay (WTP) choice sets, which framed scenarios as potential gains or improvements from the status quo. Conversely, Tab.2 presents the attribute levels for the Willingness-to-Accept (WTA) choice sets, which framed scenarios as potential losses or degradations requiring compensation. To construct the choice scenarios, a statistical design with orthogonality constraints was used, which allowed each attribute to be evaluated independently (Louviere et al., 2010). Using SAS software and following the D-efficiency rules, an orthogonal factorial design was generated, resulting in 18 unique choice scenarios. In line with established practices (Rolfe & Bennett, 2009), these 18 scenarios were structured into six blocks. Each block was presented to a subset of respondents and contained choice sets with three management alternatives and a status-quo option.

3.4 Choice Experiment (CE) approach

The final step was to present the designed scenarios to the respondents in a clear and intuitive format. Table 3 provides a concrete example of a choice set from the WTP survey, in which respondents selected their preferred option for conserving the lagoon at a specified cost. Table 4 shows a parallel example from the WTA survey, where respondents chose their preferred option for accepting a certain level of degradation in exchange for a monthly compensation. Prior to the main survey, the attributes and their levels were refined through in-depth interviews with representatives from key stakeholder groups (fishermen, flood-affected residents, and tourists) and consultations with lagoon specialists from relevant government entities. This process ensured that the scenarios were credible and meaningful to the respondents. To mitigate the potential influence of dominant opinions, this study relied on individual interviews rather than solely on group discussions. In the final survey, each respondent was presented with six choice sets. A respondent's consistent selection of the status quo option across all sets was interpreted as a preference for the current situation, a point verified through follow-up questions asking for their rationale for this choice. This design ensured that the data captured the nuanced trade-offs between lagoon attributes and monetary amounts.

Choice Modelling – Choice Set I-WTP

Attributes	Choice 1	Choice 2	Choice 3	Current Status
Fish Diversity (Number of fish species/ types)	91 Species	86 Species	80 Species	96 Species
Mangrove Coverage (Mangrove coverage in hectare (-20% and -40%))	257 ha	203 ha	175 ha	321 ha
Waterbirds and other flora and fauna (Species diversity)	Maintain the current biodiversity	Species diversity decreases by 10%	Species diversity decreases by 20%	No increase
Flood control (Flood control level by the meter -m)	2.30 m	2.00 m	1.75 m	2.75 m
Cost/ Payment via addition in your monthly (The monthly payment for Lagoon management via increasing in your monthly LA Taxes -LKR/Per month	LKR 150	LKR 260	LKR 440	LKR 0

Tab. 3 Examples of choice tasks used in the choice experiment approach for the WTP survey.

Choice Modelling – Choice Set II (via Local Authority tax)-WTA

Attributes	Choice 1	Choice 2	Choice 3	*Current Status*
Fish Diversity (Number of fish species/ types)	100 Species	105 Species	110 Species	*96 Species*
Mangrove Coverage (Mangrove coverage in hectare (-20% and -40%))	340 ha	385 ha	420 ha	*321 ha*
Waterbirds and other flora and fauna (Species diversity)	Maintain the current biodiversity	Species diversity increases by 5%	Species diversity increases by 8%	*No increase*
Flood control (Flood control level by the meter -m)	3.20 m	3.75 m	4.20 m	*2.75 m*
Cost/ Payment via addition in your monthly (The monthly payment for Lagoon management via increasing in your monthly LA Taxes -LKR/Per month	LKR 230	LKR 320	LKR 550	*LKR 0*

Tab.4 Examples of choice tasks used in the choice experiment approach for the WTP survey

4. Results

4.1 Individual characteristics

The respondents' demographics are summarised in Tab.5. Most respondents were male (59.51%), with a median age of 45 years and a median income of LKR 29,430 per month. Only 29.87% of respondents had tertiary education.

Demographic characteristics of the respondents (N =405)

Gender and Family		Type of respondents (%)	
Male (%)	59.51	Fishermen (%)	16.05
Female (%)	40.49	Recreational visitors (%)	62.47
The average age in years	45.14	Subject to flood damage (%)	21.48
Average family size	2.41	**Monthly income (%)**	
Average monthly income (LKR)	29,429.62	Below LKR 20,000a	11.36
Educational level (%)		LKR 20,000 – 40,000	45.19
Primary Education	26.92	LKR 40,000 – 60,000	36.05
Secondary Education	43.21	LKR 60,000 - 80,000	5.43
Tertiary Education	29.87	LKR 80,000 - 100,000	1.23
Willingness of lagoon conservation (%)	93.58	More than LKR 100,000	0.74

Tab.5 Demographic characteristics of the respondents

4.2 Local awareness of Batticaloa lagoon conservation

As shown in Tab.6, 37.28% of respondents attributed degradation to aquaculture/fishery, and 30.86% cited agricultural waste as the cause. Tab.7 shows that "benefits for future uses" (63.21%) and "provisioning services" (30.37%) were the primary conservation motivators. Notably, 93.58% of the respondents supported conservation, and 78.3% expressed their WTP (Fig.2).

Reasons	Percentage
Agriculture, Chemical Waste	30.86
Aquaculture, fishery, *etc*.	37.28
Land Degradation	4.44
Sedimentation	6.91
Urbanisation	20.49

Tab.6 Perceived causes of lagoon degradation.

Reasons	Very important	Important	Neutral Important	Not so important	Not at all important
Benefits for future uses	63.21	15.06	12.10	5.19	4.44
Preventing floods, erosion, and salinisation	2.96	9.88	22.96	32.10	32.10
Providing recreation	0.99	36.54	14.81	21.73	25.93
Conserving biodiversity	2.47	22.47	31.36	21.98	21.73
Providing wood, fish, and raw materials	30.37	16.05	18.77	19.01	15.80

Tab.7 Perceived motives for lagoon conservation

These results suggest two important reasons: benefits for future use, such as providing wood, fish, and raw materials, and providing recreation. The less important reason for lagoon conservation is the prevention of floods, erosion, and salinisation. In addition, 93.58% of respondents were willing to conserve lagoons. Of those surveyed, 78.3% expressed a willingness to pay, while 21.7% expressed no willingness to pay to protect the Batticaloa Lagoon (Fig.2).

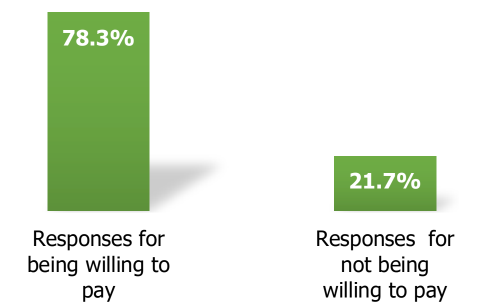

Fig.2 Responses for Willing to Pay

Tab.8 reveals that 78.2% of the respondents supported conservation for communal benefits, while 52.3% cited financial constraints as a barrier to WTP. The most important reason was that it was a good project for society (78.2%). Approximately 10% of respondents believed that their contributions were beneficial for their own sake, while 6.2% thought they would benefit future generations. However, household income restrictions, which accounted for 52.3% of the negative replies, were followed by the claim that payment for Batticaloa Lagoon services was the exclusive duty of LA (26.1%) as the primary justification for not being willing to pay for them.

Reasons	Percent
Respondent's reasons for being willing to pay	
This initiative program benefits the entire community.	78.2
This initiative program is beneficial to me.	10.0
This initiative is beneficial for future generations.	6.2
This initiative program is required to preserve culture and beliefs.	5.6
Respondent's reasons for not being willing to pay	
My family has no funds to donate.	52.3
Local government is solely responsible for lagoon conservation.	26.1
I am concerned that my family's donation will not be utilized correctly	11.4
I do not believe in the programme's success.	5.7
It is the beneficiary who should fund	4.5

Tab.8 Reasons for being willing and not being willing to pay

Tab.9 presents the MNL model's results. The MNL model revealed substantial variation in how stakeholders value lagoon resources. Stakeholders place a high value on the lagoon's flora and fauna, as reflected in the significant WTP and WTA for these attributes. All model fit statistics confirmed the final model's superiority. Lagoon users are prepared to incur significant costs to safeguard fish populations in the lagoon. However, research shows that lagoon users value fish diversity more highly and desire more significant compensation if it diminishes in the future. This could significantly impact the WTA, suggesting that many survey participants were fishermen who would benefit from increased lagoon fish diversity. Mangrove coverage significantly influences lagoon conservation value.

This finding aligns with (De Rezende et al., 2015), who reported strong public support for mangrove expansion in Brazil. Many of the respondents in the survey appeared to be tourists who would rather see an ecological service provided, such as protecting the lagoon's flora, fauna, and mangroves. The results indicate that stakeholders care about ensuring the longevity of the lagoon's flora and wildlife and that their WTP for conservation increases as the lagoon's flora and fauna improve. (Suresh et al., 2021) claimed that a decline in biodiversity affects the public's willingness to pay for the preservation of lagoon spaces. Thus, the aesthetic attractiveness of the areas surrounding lagoon ecosystems is enhanced by a wide variety of plants and animals, which increases the number of visitors to these areas. Flood control was a statistically significant negative variable, indicating that respondents valued flood damage more than flood control. The marginal values in Tab.10 indicate that stakeholders, on average, would require LKR 32 in compensation for the loss of one fish species, while their mean WTP to gain one fish species was LKR 8. The study suggests that fish diversity in lagoons is essential for their users. The WTA is approximately LKR 1 for every percentage point of decline, whereas lagoon users are prepared to pay LKR 5 for every percentage point of increased mangrove coverage. Although the loss of mangroves would severely affect the long-term viability of lagoon resources, stakeholders in lagoons have a low priority.

Choice Set	Attribute	Levels	WTP (LKR ± SE)	WTA (LKR ± SE)
Choice Set 1	**Fish Diversity**	Level I (91 species)	8.12** (±1.25)	32.02*** (±3.01)
	Mangrove Coverage	Level I (257 ha)	5.05* (±0.83)	1.25 (±0.22)
	Flora & Fauna	10% Decrease	-59.86*** (±18.90)	-120.18*** (±21.05)
	Flood Control	Level I (2.30 m)	3.25 (±20.72)	5.92 (±29.33)
	Payment/Compensation	LKR 230	-2.04*** (±0.00)	-1.72** (±0.00)
Choice Set 2	**Fish Diversity**	Level II (86 species)	6.78* (±1.98)	28.45*** (±3.45)
	Mangrove Coverage	Level II (203 ha)	-3.25 (±0.72)	-2.02 (±0.80)
	Flora & Fauna	25% Devastation	-127.81*** (±30.10)	-245.60** (±35.20)
	Flood Control	Level II (2.00 m)	-4.56 (±53.20)	-8.93 (±72.47)
	Payment/Compensation	LKR 320	-1.88*** (±0.00)	-1.53** (±0.00)
Choice Set 3	**Fish Diversity**	Level III (80 species)	4.52 (±10.21)	21.35 (±24.50)
	Mangrove Coverage	Level III (175 ha)	-6.72 (±7.55)	-4.10 (±8.42)
	Flora & Fauna	Current (No change)	Base	Base
	Flood Control	Current Status (2.75 m)	Base	Base
	Payment/Compensation	LKR 550	-1.23*** (±0.00)	-1.10** (±0.00)
Model Fit	**Log-Likelihood**	-	379.93	444.98
	Pseudo R²	-	0.204	0.165
	Constant	-	4.42*** (±0.00)	3.57*** (±0.00)
Respondents	**N**	405	-	-

***, **, * = significance at 1%, 5%, 10%, respectively; n.s. = not significant.

Tab.9 Results of multinomial logit models for WTP and WTA

A key finding was the significant disparity between the WTP and WTA values across all attributes. For instance, fishermen's WTA for the loss of a single fish species (LKR 32.02) was approximately four times higher than their WTP for gaining one (LKR 8.12), highlighting a strong endowment effect. The results (Tab.10) demonstrate that stakeholder perceptions of lagoon preservation and degradation are highly diverse. The positive and statistically significant coefficient for fish variety suggests that anglers place a higher valuation on this attribute than on others. The analysis revealed a consistent pattern in which WTA values substantially exceeded WTP values for equivalent changes in ecosystem attributes, a key finding explored in the subsequent discussion.

This supports the findings of (Suresh et al., 2021), who discovered that fishermen place high importance on maintaining fish populations because of their considerable economic benefits. In addition, WTA analysis indicated that fishermen regard flora and wildlife as crucial elements of lagoon ecosystems. Therefore, they are more inclined to seek significant compensation for the destruction of these resources and contribute financially to conservation initiatives.

Attribute	MNL model	
	Monetary value of WTP (Rs)	Monetary value of WTA (Rs)
Fish diversity	8.12**	32.02***
	-4.3612	-3.2985
Mangrove coverage	5.05***	1.25
	-0.8325	-0.2201
Flora and fauna	59.86***	120.18***
	-18.9004	-21.0485
Flood control	3.25	5.92
	-20.7235	-29.3274

***, **, * Significance at 1, 5, 10% levels, respectively.

Tab.10 Monetary value of the base model for WTP and WTA

Multinomial logit (MNL) model analysis revealed critical insights into stakeholder preferences for Batticaloa Lagoon's conservation attributes, highlighting synergies and conflicts in valuation. Key findings demonstrated statistically significant disparities in WTP and WTA across stakeholder groups, shaped by their dependency on specific ecosystem services (Tab.10). WTP and WTA responses were analysed independently using distinct MNL models to avoid conflating valuation contexts.

Tab.11 shows the implicit pricing of WTP for the three lagoon consumers to find improvements in the lagoon's features and WTA compensation for their loss. Increasing the variety of fish available would cost the fishing community an additional LKR 90, and increasing the diversity of flora and wildlife would cost an additional LKR 9. Meanwhile, fishermen asked for payouts three times more than the WTP (LKR 29) for every unit of biodiversity added to the fish population. In contrast, compensation for biodiversity loss tended to increase (LKR: 60). This could be because fishermen in developing nations are more concerned with making a living than having fun.

The statistically significant disparities in WTP/WTA across stakeholder groups (Tab.11) underscore the need for differentiated policy instruments. For instance, fishermen's high WTA for losing fish diversity (LKR 29.33) suggests compensatory payments for fishery-related restrictions. Simultaneously, tourists' elevated WTP for flora/fauna (LKR 65.34) justifies ecotourism levies (de Rezende et al., 2015), and the indifference of flood-affected residents to flood control ($p > 0.05$) highlights the urgency of awareness campaigns linking lagoon health and flood resilience. As fishermen place a significantly higher value on mangroves than other lagoon resource users, they are willing to accept only half of their WTP compensation. Corroborating previous WTA studies, our results show that vulnerable lagoon users assign high value to flood prevention. Globally, these findings resonate with coastal ecosystems facing analogous anthropogenic pressures, from Chilika Lake in India to the Celestún Lagoon in Mexico (Newton et al., 2018; Prosser et al., 2017). The WTA-WTP asymmetry observed here, a four-fold gap for fishermen, reflects broader behavioural economics principles, where stakeholders demand higher compensation for losses than they will pay for gains (Coursey et al., 1987; Plott & Zeiler, 2005). This underscores the urgency of reframing conservation incentives using equity-centred PES frameworks (Ureta et al., 2022). Also, the payment for ecosystem services performance based on fine-tuning measures which involve building and population densities and vegetation cover (Lai et al., 2023). The results reveal a key behavioural pattern: stakeholders are more inclined to demand compensation (WTA) for resource degradation than to contribute to conservation efforts (WTP). This asymmetry mirrors global studies showing that individuals often assign a higher value to losses than to gains, a phenomenon rooted in behavioral economics. Similar valuation asymmetries were observed in Brazil's Pantanal wetlands, where stakeholder-specific PES improved conservation outcomes by 45% (Guerra et al., 2025).

Attribute	WTP (LKR)	WTA (LKR)
Fish Diversity		
Fishermen	9.93** (±1.25)	29.33*** (±3.01)
Flood-Affected	3.25 (±2.10)	16.03* (±4.15)
Tourists	8.95* (±1.98)	33.21*** (±2.75)
Mangrove Coverage		
Fishermen	1.01*** (±0.15)	0.07 (±0.21)
Flood-Affected	0.46 (±0.30)	0.24 (±0.18)
Tourists	0.53 (±0.25)	0.17 (±0.22)
Flora & Fauna		
Fishermen	89.89** (±16.21)	60.01** (±31.26)
Flood-Affected	99.12** (±18.32)	82.23* (±47.70)
Tourists	65.34** (±9.26)	101.72*** (±23.26)

***, **, * denote significance at 1%, 5%, and 10% levels, respectively. Standard errors (±) are explicitly labelled for clarity.

Tab.11 Stakeholder-Specific WTP/WTA Values

5. Discussion

5.1 The behavioral economics of valuation

The core of the study findings reveals a landscape of stakeholder valuation fundamentally shaped by behavioural economic principles, challenging the standard economic assumption of a symmetric value for gains and losses. The pronounced disparity between WTA and WTP across all groups, most strikingly the four-fold gap for fish diversity among fishermen, is a classic manifestation of loss aversion (Johnston et al., 2006), where the disutility of losing an asset is psychologically far more impactful than the utility of acquiring it. For fishermen, fish stocks are not only a potential source of income but also a vital endowment central to their identity, food security, and economic survival. This endowment effect (Feng et al., 2024) explains why they demand significantly higher compensation (LKR 32.02/species) to relinquish this asset than they are willing to pay (LKR 8.12/species) to enhance it. Their valuation is not merely that of a commodity but of a foundational component of their livelihood, which they feel they already 'own' and stand to lose. This behavioural reality creates a critical policy challenge: conservation measures that restrict access are not perceived as a forgone future gain, but as an immediate and deeply felt loss, requiring commensurate compensation to be politically and socially viable. This loss aversion was most acute for fishermen regarding the fish diversity. The highest WTA was demonstrated for fish diversity loss (LKR 32.02/species), reflecting their direct and heavy dependence on lagoon fisheries for their livelihood and food security (Suresh et al., 2021). This aligns with the context of Batticaloa, where over 16% of the respondents identified declining fish stocks as a threat to food security. This situation highlights a critical vulnerability: the economic pressures on fishermen, combined with other anthropogenic stresses on the lagoon, can lead to overexploitation, creating a feedback loop that undermines the long-term viability of fisheries and, consequently, regional food security. Therefore, fishermen are not a threat per se, but rather a key group whose economic stability must be addressed to break the cycle of resource degradation. This aligns with global studies in which small-scale fishing communities disproportionately value biodiversity because of their direct reliance on their livelihood (Dupras et al., 2017; Valiela et al., 2001). An elevated WTA reflects a defensive stance against potential income loss, consistent with observations in tropical fisheries where overexploitation threatens food security (Suresh et al., 2021). Notably, this mirrors the findings in Vietnam's Cat Ba Biosphere Reserve, where fishermen demanded higher compensation for mangrove restrictions than tourists (Pham et al., 2018).

Conversely, tourists exhibited a distinct preference for the flora and fauna of the lagoon. Contrary to what might be assumed, the results indicate that lagoon resource users highly value the preservation of flora and fauna. The WTA for a loss of species (LKR 120.18) was double the WTP for a gain (LKR 59.86), reinforcing the loss aversion phenomenon among Batticaloa residents. This suggests that the non-use and aesthetic values of biodiversity are strongly held, and its degradation would be perceived as a significant loss by the community. The status of Batticaloa as a nationally significant wetland with high biodiversity underscores the need to leverage ecotourism for conservation funding, as in Costa Rica (Locatelli et al., 2013). This behaviour echoes the principles of behavioural economics, where individuals assign greater weight to potential losses than to gains, and aligns with ecotourism studies that emphasise aesthetic values (Wolf et al., 2019). For instance, in Brazil's mangrove restoration projects, tourists prioritised scenic integrity over utilitarian benefits (De Rezende et al., 2015; Gatt et al., 2022). A critical and paradoxical finding was the statistical insignificance of flood control in both the WTP ($\beta = 3.25$, $p > 0.05$) and WTA ($\beta = 5.92$, $p > 0.05$) models, despite the lagoon's known role in flood mitigation. This finding mirrors the trends in Bangladesh, where immediate livelihood concerns overshadow long-term flood risks (Hoq et al., 2021; Islam et al., 2021). This undervaluation is critical in Batticaloa, where 21.48% of the respondents face flood risk. This paradox suggests that immediate socioeconomic pressures, such as income generation, overshadow long-term flood risks, a trend that has been observed globally in flood-prone communities (Newton et al., 2018). For example, in Bangladesh's coastal zones, residents prioritise fishing access over flood infrastructure investments until catastrophic events occur (Islam et al., 2021). Similarly, the regulatory services provided by mangroves are substantially undervalued. Despite their role in coastal protection, mangrove coverage had a negligible WTA (LKR 1.25/ha loss), likely because of limited awareness of these regulatory services. A similar undervaluation was observed in Southeast Asia until cyclones highlighted this importance. This aligns with Southeast Asian studies, where communities recognised the provisioning benefits of mangroves (e.g. firewood) but undervalued disaster resilience until cyclones caused irreversible damage (Vo et al., 2020).

5.2 An institutional blueprint: from monocentric pes to polycentric governance

These behavioural insights challenge the feasibility of universal, monocentric PES designs, which often fail because they cannot account for profound value heterogeneity (Ostrom, 2009; Bocca et al., 2024). Our results empirically demonstrate that a single payment mechanism would either grossly under-compensate fishermen (leading to non-compliance and conflict) or over-compensate other groups, wasting scarce conservation resources. Instead, we advocate for a polycentric governance system, a framework of multiple, overlapping decision centres operating at different scales with a degree of autonomy but under a shared set of rules (Lubell & Morrison, 2021; Van Der Plank et al., 2022). This approach is uniquely suited to managing the divergent preferences we have identified, moving from a one-size-fits-all payment to a suite of tailored and mutually reinforcing instruments. For fishermen, the high WTA for fish diversity loss suggests that direct restrictions without compensation are untenable. A viable mechanism involves "Payment for Seasonal Closure Compliance" or "Gear-Restriction Stewardship Payments." Rather than a simple cash transfer, payments can be structured as conditional contracts. Local fishery cooperatives can be contracted to adhere to scientifically determined seasonal bans or use selective fishing gear that reduces bycatch. Compliance would be verified by the lagoon management authority or the community monitors. The payment level should be calibrated to the fishermen's WTA (approximately LKR 29/species lost) to ensure it is perceived as a fair exchange for a loss, not as a welfare handout. This model, akin to Ghana's community-led marine reserves, transforms fishermen from targets of regulation into active, paid stewards of the resource. For tourists, the elevated WTP for flora and fauna (LKR 65.34) underscores the economic potential of leveraging non-use value. A practical mechanism is a "Transparent Ecotourism Surcharge." This levy could be a small, mandatory fee (e.g., LKR 100-200) bundled with existing entry fees to lagoon-side parks, boat tours, or registered hotels within the watershed. To overcome the trust issues revealed in our survey (Table 8), the revenue must be ring-fenced in a dedicated "Batticaloa Lagoon Conservation Fund", managed by a board comprising local government, community representatives, and tourism operators. Disbursements from this fund would be publicly documented and finance specific visible projects, such as mangrove sapling nurseries, anti-erosion fencing, or biodiversity corridors, creating a tangible feedback loop for tourists who contributed. For flood-affected residents, the paradoxical undervaluation of flood control points to a critical awareness gap that must be addressed. A program for this group must combine "Structural Mitigation with Environmental Literacy." This could involve co-investment in small-scale infrastructure (e.g. community flood barriers, mangrove replanting along vulnerable shores) coupled with mandatory educational campaigns. These campaigns should visually and convincingly demonstrate the direct causal link between mangrove root systems and wave attenuation, making the abstract 'regulating service' more concrete. By linking lagoon health directly to personal safety and property protection, such programs aim to shift long-term valuations and build a constituency for conservation beyond direct use.

5.3 Synthesizing the framework: addressing the "diversity of values"

Together, these proposed mechanisms exemplify a polycentric approach to PES that directly addresses the "diversity of values" theory (Barbier, 2011). They acknowledge that stakeholders hold conflicting priorities not out of irrationality but due to divergent dependencies, knowledge, and behavioural biases. The fishermen's compensatory system operates at a local, resource-user scale; the tourist levy functions at a regional, sectoral scale; and the resident program integrates municipal disaster risk reduction with community engagement. This multi-tiered, participatory governance model is more complex to establish than a top-down payment scheme; however, this complexity allows it to balance local autonomy with regional coordination, enhancing its legitimacy, equity, and long-term resilience (Chaffin & Gunderson, 2015).

6. Conclusion

This study demonstrates that sustainable lagoon management in Batticaloa requires strategically managing stakeholder divergence rather than seeking an unattainable consensus. By employing a novel within-subject choice experiment, this study uncovered fundamental valuation asymmetries that critically inform Payment for Ecosystem Services (PES) design. The four-fold disparity between willingness-to-accept (WTA) and willingness-to-pay (WTP) for fish diversity among fishermen provides empirical evidence of loss aversion rooted in direct livelihood dependency. Conversely, tourists' high valuation of flora and fauna underscores the economic potential of leveraging ecotourism for conservation funding in the region. A critical and paradoxical finding is the significant undervaluation of flood-control services, even among flood-affected residents. This reveals a pervasive disconnect between immediate socioeconomic pressures and long-term climate risks, highlighting a priority area for targeted environmental education alongside financial incentives. Consequently, these findings are a clear warning against one-size-fits-all conservation policies. The empirically demonstrated heterogeneity in stakeholder preferences necessitates a polycentric PES framework composed of parallel tailored instruments: compensatory payments for fishermen, ecotourism levies for tourists, and risk-mitigation programs coupled with awareness campaigns for residents. For policymakers in Sri Lanka and analogous Global South contexts, this study provides a replicable blueprint for designing equitable and effective conservation strategies that reconcile ecological integrity with socioeconomic well-being by explicitly accounting for the values and behaviours of those who depend on the resource.

7. Recommendation and future research

Building on the findings and limitations of this study, several promising avenues for future research have emerged. Integrating Underrepresented Stakeholders:

- Quantifying Long-term PES Equity: Research is needed to quantify the long-term equity and livelihood outcomes of PES schemes implemented in such socio-ecological systems, tracking how benefits and costs are distributed over time;
- Leveraging Predictive Analytics: The integration of machine learning with discrete choice data could help predict stakeholder-specific valuation thresholds and behavioural responses under different policy scenarios, thereby enhancing the adaptive management of PES frameworks;
- Fostering Comparative and Collaborative Learning: Expanding comparative analyses to other lagoon systems in the Global South can help identify transferable governance innovation. Furthermore, facilitating South-South knowledge exchange would be valuable for adapting the differentiated PES model developed for Batticaloa to analogous socio-ecological contexts.

Conserving Sri Lanka’s Batticaloa Lagoon and analogous ecosystems requires a multifaceted approach that balances ecological preservation and socioeconomic equity. Policymakers can ensure the long-term viability of vital ecosystems through stakeholder-specific incentives, enhanced environmental literacy, and community engagement. Investment in environmental education and local conservation initiatives will safeguard lagoon resources and fortify the synergy between ecological health and human well-being.

Data availability

The data are available upon request.

Declarations

Ethics approval and consent to participate: Ethical approval and consent to participate were obtained for this study. In the manuscript, it should be noted that, due to the absence of an institutional ethical board for approving social science research, there was no opportunity to apply for the approval of the Research Ethics Board (REB). This academic limitation resulted in an exemption from the requirement for ethical approval for this study.

Consent to participate: All participants provided informed consent for the use of their data in scientific publications. Minors were excluded from the study.

Competing interests: The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this study.

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Image sources

All images are by the Authors.

Fig.1: Batticaloa District and Batticaloa Lagoon, Sri Lanka.

Fig.2: Responses for Willing to Pay

Author's profile

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