Original Research Article

Evaluating Stakeholder Preferences and Willingness to Pay for Ecosystem Services in Kole Wetlands: Insights for Effective Conservation Planning

Abstract

Kole wetlands in Kerala are a multifunctional sub-sea level wetland rice agroecosystem with high ecological significance and are one of the most productive as well as threatened wetland in the State. This study attempts to identify the various ecosystem services provided by the Kole wetlands and examine the stakeholder priority for ecosystem services through preference ranking analysis using Garrett's ranking method. Payment card method was used to estimate the stakeholder willingness to contribute for the conservation in terms of willingness to pay (WTP) and analysed the factors that affect their WTP using an ordinary least square regression model. The data were collected from 50 stakeholders equally representing the major stakeholder groups from three block panchayaths having highest Kole wetland area. The study identified 20 ecosystem services supplied by Kole wetlands illustrating its multifunctional vital role in sustaining ecological and human systems. Stakeholders prioritised the water-related ecosystem services such as groundwater recharge and flood water regulation as the most important service reflecting its critical importance in daily life and agriculture. Estimated mean annual WTP was Rs.211,indicating a general willingness among stakeholders to contribute financially to conservation efforts. Stakeholder group, Kole tourists were willing to contribute highest amount with mean annual WTP of Rs.248, expecting an improvement of recreational amenities in tourist spots. Stakeholders with higher incomes, larger land holdings, and greater

awareness are more willing to pay for the conservation of the Kole wetlands. The insights from the study are valuable for guiding conservation strategies and resource allocation, along with ensuring the supply of essential services and exploring the opportunities for economic diversification, that are crucial to secure necessary financial and non-financial support for the management of Kole wetland ecosystem in a sustainable way.

Keywords: Ecosystem services, Kole wetlands, Preference ranking analysis, Garret's ranking method, Willingness to pay (WTP)

1. Introduction

Wetlands are unique and vital ecosystems characterized by the dominance of water in shaping their environmental conditions and supporting their plant and animal life [1]. Wetlands are indeed regarded as one of the most vital ecosystems globally due to their numerous ecological, economic, and cultural benefits. According to the Millennium Ecosystem Assessment [2], about 50% of the world's wetlands have been lost since the early 1900s. This dramatic reduction highlights the severity of wetland depletion over the past century. Recent estimates also suggest that wetlands are continuing to be lost at an alarming rate. The Ramsar Convention reports that, on average, wetlands are being lost at a rate of 1.5% per year [3]. Wetland depletion is a pressing global issue with significant environmental, economic, and cultural impacts.

Kole wetlands in Kerala are basically a rice crop-based agroecosystem, that are situated below mean sea level. These systems integrate the principles of both wetland ecology and agriculture, aiming to utilize the benefits of wetlands while also engaging in agricultural activities. Kole lands are multifunctional wetland agroecosystems with high ecological significance and were declared as Ramsar site in 2002 [4]. They are one of the most productive as well as threatened wetland in Kerala State [5]. One of the defining features of wetlands is their waterlogged conditions. Effective water management is crucial in wetland agro-ecosystems to control flooding, drainage, and irrigation. This often involves techniques such as constructing canals, levees and bunds to regulate water flow and ensure optimal conditions for crops.

Despite their potential benefits, Kole wetland agro-ecosystems also face challenges such as land conversion, ecosystem degradation, habitat loss, climate change and conflicts over land use. Researchers [6] while studying about the land use and cropping pattern changes in Kerala had observed that among the various price and non-price factors influence farmers in allocating area for different crops, prioritizing the area allocation for food crops is crucial to arrest the decline in food crop cultivation which would significantly impact the food security and ecological sustainability of the state. Researchers [7] highlighted crucial insights into the

impact of climate change on agro-ecosystems, particularly in Kerala. Their findings emphasize the challenges and need for integrated approaches to manage agricultural production and wetland conservation. Balancing these factors requires a holistic approach that incorporates sustainable agricultural practices, effective water management, adaptive strategies, and supportive policies. By addressing these challenges through integrated planning and stakeholder engagement, state can work towards achieving long-term sustainability and resilience in both its agro-ecosystems and wetland environments. Therefore, balancing agricultural production with the conservation of wetland ecosystems requires careful planning and management to ensure long-term sustainability.

Wetland depletion presents a multifaceted challenge with significant environmental, economic, and cultural consequences [8]. Protecting and restoring wetlands is essential for maintaining their ecological functions, supporting local economies, and preserving cultural values. Hence, understanding unique features of Kole wetlands and addressing the challenges it face are crucial for its conservation and management. Implementing protective and adaptive measures will help to ensure the sustainability of this ecosystem for future generations. Addressing wetland depletion requires coordinated efforts at local, national, and international levels, including implementing conservation measures, promoting sustainable land use practices, and enhancing public awareness about the importance of wetlands. Taking comprehensive action may result in mitigating the impacts of wetland loss and ensuring the long-term health and resilience of these vital ecosystems. In this context, current study attempts to identify the various ecosystem services provided by the Kole wetland agroecosystem through stakeholder discussions and literature reviews. Understanding stakeholder perceptions is indeed crucial for effective conservation strategy development and policy implementation [9]. Examining stakeholder preferences for ecosystem services and estimating their willingness to contribute for the conservation, will be useful to bridge the gap between policy design and stakeholder needs. Analysing the factors affecting willingness to pay (WTP), helps to modify interventions, ensuring they are both effective and supported by the community. This approach of effective conservation planning, not only enhances the effectiveness of conservation efforts but also fosters greater stakeholder engagement and commitment to sustaining ecosystem services.

2. Materials and methods

2.1 Study area

The Thrissur-Ponnani Kole wetlands in Kerala are below-sea level exceptional rice production wetland agroecosystem spread over Thrissur and Malappuram districts. This wetland lies in

latitude 9.67-10.71°N and longitude 765.58-76.11°E covering an area of 13,632 hectares. The Kole wetlands are a part of Vembanad-Kole RAMSAR site and was classified as coastal wetland complex [4]. Kole wetlands were identified to provide various provisional, regulatory, supporting and cultural categories of ecosystem services [10,11]. The study area is spread over 10 block panchayaths and the sampling of stakeholders was restricted to three block panchayaths namely Anthikkad, Puzhakkal and Mullassery. These blocks are having the highest area of Kole wetlands and stakeholder population. The rice cultivation is the major activity in the wetland area and is limited to one season (Late rabi season). The rice cultivation is followed by duck rearing or fish rearing or other crop cultivation like vegetable or pulse or lotus cultivation depending on the elevation of area and water level.

2.2 Study design and data collection

The study was based on both primary and secondary data. A systematic literature review was conducted in May 2024 in Google Scholar as well as Scopus research database. As a first step search was carried out in Google scholar for relevant articles up to May 15, 2024 by searching the topic realm using combined keywords such as 'Kole wetlands' OR 'Kol wetland' OR 'Vembanad-kol wetland' AND 'ecosystem services' OR 'agroecosystem'. A total of 95 peer-reviewed articles were obtained. The articles were individually gone through to eliminate the irrelevant studies and to gather the information about stakeholders and ecosystem services provided by the Kole wetlands. Out of 95 articles, 30 were found to be irrelevant and omitted. As a second step, we also searched scopus database following the same procedure and 6 more unique peer reviewed articles were collected. Therefore, the information on stakeholders and ecosystem services were collected from 71 articles without any duplication. All types of ecosystem services provided by Kole wetlands as identified by the studies were considered in the next part of the study. The major stakeholders identified as rice farmers, local residents, Kole tourists and general public. Minor stakeholder groups include inland fisherman, lotus cultivators, duck rearers, bird watchers etc. The ecosystem services from Kole wetlands were finalised after discussions with stakeholder groups, government department officials and experts.

In the next stage of study, primary data was collected from randomly selected 50 different types of stakeholders. The stakeholders were selected from three major block panchayaths having highest Kole land area. The major stakeholder groups were equally represented in this sample to avoid various types of biases in the survey. The primary data on socio-economic information, land holding size, awareness level about the status of Kole wetlands (Depleting-0, No change-

1 and Improving-2), ranking of first ten preferred ecosystem services provided by Kole wetlands and Willingness to Pay (WTP) for conservation were collected from selected stakeholders. A pre-tested structured interview schedule was used for the personal interview. The WTP was assessed using a payment card approach where respondents were presented with a card presenting a hypothetical situation and range of monetary values from zero to one thousand rupees. Respondents were informed about the details of the new eco-project, including its purpose and benefits, as well as the payment vehicle i.e., the mechanism through which they would make their contributions. They were asked to indicate the amount they would be willing to contribute towards the implementation of a new eco-project aiming at conservation of Kole wetlands. The data were collected during May and June months of the year 2024.

2.3 Analytical tools

Henry Garrett's ranking method is the technique used for analysing preferences of stakeholders for ecosystem services based on ranked data from respondents. Each respondent was asked to rank first ten most preferred ecosystem services received from Kole wetlands, from the list of identified ecosystem services, depending upon the individual utility. Each respondent provides a ranked list where the most useful ecosystem service from individual viewpoint receives the highest rank. Summarising respondent ranks was done by determining the number of respondents who assigned each rank to each ecosystem service. This step provides a summary of how many respondents rated each ecosystem service at each rank level. Using the Garrett formula (eqn 1), compute the percent position (PP) for each rank.

$PP = [(R_{ij} - 0.5) / N_j] * 100$ ……(Eqn 1)

R_{ij} - Rank given to i^{th} ecosystem service by j^{th} respondent

N_j - Number of variables ranked by ^{jth} respondent

This formula converts the rank into a percentage position within the set of ranked services. The equivalent value was found out by referring to the Garrett table to convert the percent position into a corresponding value [12]. The Garrett table provides values that help in understanding the severity or importance of constraints based on the percent position. The scores for each ecosystem service were calculated by multiplying the Garrett value by the number of stakeholders who assigned that rank to the ecosystem services. Adding up all the scores calculated for each rank of a given ecosystem service will provide the total score. The ecosystem services which were considered more important by the stakeholders were obtained

based on the average score values. Order the average scores in descending order and higher values typically indicate greater importance.

The mean and median WTP values were estimated from the payment card figures for the whole sample as well as for the major stakeholder groups. The determinants of WTP were analysed using Ordinary Least Squares (OLS) regression model given as equation 2.

$Y_j = \beta_0 + \beta_i X_i + \epsilon$ ……(Eqn 2)

Y_j – WTP of j^{th} stakeholder (Dependent variable)

β_0 - Intercept

β_i – Regression coefficients

X_i – Independent variables

ϵ - Error term

The independent variables considered in this model are Age (years), Education (years), Gender (Male = 0, Female = 1), Average monthly income (Rs.), Family size (number of members), Land holding size (Acre) and Wetland status awareness level (Score). The model explains WTP as a function of socio-economic variables and awareness level. Apart from above, other descriptive statistical methods were also used to summarise the data.

3. Results and discussion

3.1 Ecosystem services from Kole wetlands

The different types of ecosystem services provided by Kole wetlands is summarised in table 1 under four categories. The Millennium Ecosystem Assessment (MEA) classifies ecosystem services into four distinct categories such as provisioning, regulating, supporting and cultural [2]. Provisioning services refer to the products obtained from ecosystems that are necessary for human survival and economic activities. Regulating services are the benefits derived from the regulation of ecosystem processes and functions, which help to stabilize and balance the environment. Supporting services are essential for the production of other ecosystem services. They underpin the functioning of ecosystems and are vital for maintaining the health of ecosystems. Cultural services encompass the non-material benefits that people obtain from ecosystems, which contribute to cultural, spiritual, and recreational values. The findings about the Kole Wetland ecosystem services indicate that it provides all four categories of ecosystem services, illustrating the multifunctional nature of this important ecosystem.

Table 1: Different types of ecosystem services provided by Kole wetlands

Major category of ecosystem services	Kole wetland ecosystem services
Provisioning	1. Food, Fodder and Fuel
	2. Raw Materials
	3. Medicinal Plants
	4. Quality Local Products
Regulating	5. Flood Regulation/Mitigation
	6. Groundwater Recharge
	7. Microclimate Regulation
	8. Biodiversity Conservation
	9. Water Purification
	10. Soil Fertility Maintenance
	11. Migratory Bird Habitat
	12. Carbon Sequestration
	13. Pollination
Supporting	14. Soil Sediment Retention
	15. Food Chain Support
	16. Nutrient Cycling
	17. Migratory Bird Habitat
Cultural	18. Aesthetic Landscape
	19. Recreational Services
	20. Religious and cultural facilities

3.2 Socio-economic status of sample

The socio-economic characteristics of the sample are given in table 2. All sample respondents were literate with an average education of 13 years, in tune with the high literacy status in the state. Small households were dominant in the sample with a land holding size of 0.31 acres. The males (66%) dominated the sample and 64 percent of the respondents opined that Kole wetlands are depleting by quantity as well as quality.

Table 2: Socio-economic characteristics of sample

Particulars	Sample average
Age (Years)	46
Education (Years)	13
Average monthly income of household (Rs.)	32160
Farmily size (Number of family members)	4

Land holding size (Acres)	0.31

3.3 Stakeholder preferences for Kole wetland ecosystem services

The results from Garret ranking analysis are given in table 3. The mean value of ranking scores shows that stakeholders prioritise the conservation of water-related ecosystem services, particularly water consumption and flood water management. Stakeholders place high importance on services related to the provision of freshwater, essential for both household use and agricultural activities. Researchers [9] also observed similar results while studying about stakeholder preferences of wetland ecosystem services in South carolina. Effective management of floodwaters is prioritized due to its critical role in mitigating damage during the monsoon season and maintaining agricultural productivity. Researchers [13] also opined that the poor water management was the major reason for crop loss in Kole wetlands. High priority given to water-related services reflects their fundamental role in supporting both daily life and economic activities. In regions, where water availability is crucial for survival and agriculture, stakeholders naturally focus on these services to ensure stability and resilience. On the other hand, the least priority was given to recreational services like tourism. The lower priority assigned to recreational services like tourism indicates that this sector is still in the early stages of development. Economic benefits from tourism are not yet fully realized or prioritized compared to more immediate needs like water management and food provision. The emerging status of recreational activities suggests that while they may have future potential, they are currently less critical to stakeholders who are primarily concerned with essential services that directly impact their livelihoods.

Table 3: Stakeholder's preference to priority ecosystem services from Kole wetlands

Ecosystem services	Rank scores										Garret rank score (Total)	Average Garret score	Rank
	1	2	3	4	5	6	7	8	9	10			
Flood regulation	1968	350	252	464	156	144	126	0	0	0	3460	69.2	2
Groundwater recharge	820	2240	378	58	52	0	0	0	0	0	3548	70.96	1
Biodiversity conservation	0	140	693	406	260	240	294	222	116	54	2425	48.5	5
Microclimate regulation	0	140	819	812	260	240	294	111	29	0	2705	54.1	4
Provisional (Food, fodder, fuel)	984	210	0	116	104	0	210	296	174	216	2310	46.2	6

Water purification	0	0	63	0	156	240	126	185	638	198	1606	32.12	10
Soil fertility maintenance	0	70	63	348	468	528	168	370	87	90	2192	43.84	7
Migratory bird habitat	82	140	126	174	312	288	546	333	87	90	2178	43.56	8
Quality local products	328	210	630	406	468	480	168	74	0	18	2782	55.64	3
Recreational services	0	0	126	116	364	240	168	222	319	234	1789	35.78	9

Participants also view the production of quality local food products as crucial for local livelihoods. These products are seen as integral to the economic stability and health of the community. Moreover, there is an emphasis on eco-friendly production methods, which align with sustainable practices and contribute to environmental health. Quality local food products not only support traditional diets but also contribute to better health outcomes and improved quality of life. This reflects a holistic approach to well-being that incorporates both physical health and cultural values.

Soil fertility maintenance and biodiversity conservation was supposed as a prime sustenance for the provision of multiple ecosystem services, was given medium ranks. The Kole wetlands were recognized for their role in maintaining soil fertility [10]. The wetlands contribute to nutrient retention and soil productivity, which are essential for successful agricultural practices. Maintaining soil fertility is critical for the yields of both food crops and fodder. Healthy soils ensure that plants receive the necessary nutrients, which in turn supports food security and agricultural productivity.

Biodiversity conservation was also ranked medium which was considered as fundamental to sustaining provisioning ecosystem services as well as ecosystem resilience. Diverse ecosystems support a range of functions and services that are essential for maintaining soil health and productivity.

3.4 Willingness to pay (WTP) for Kole land conservation

The values for the mean and median WTP are presented in Table 4. The mean WTP provides an average estimate of the value that respondents place on the conservation of the Kole wetlands. A higher mean WTP suggests that, on average, respondents perceive a significant value in the conservation project and are willing to contribute a substantial amount. the median WTP represents the value that splits the population into two equal groups, it indicates the price point that has the support of at least half of the respondents. It reflects a value that has broad community backing and is representative of the typical respondent’s willingness to contribute.

Table 4: Willingness to pay (WTP) value

Particulars	Mean WTP (Rs./Year)	Median WTP (Rs./Year)	Maximum WTP (Rs./Year)	Minimum WTP (Rs./Year)
Rice farmers	168	125	400	5
Local residents	212	188	500	40
Kole tourists	248	150	600	10
General public	246	238	500	30
Sample total	**211**	**187**	**600**	**5**

The WTP analysis for the Kole wetlands reveals varying levels of financial support for conservation efforts based on different stakeholder groups and their perspectives. Tourists show the highest WTP for the Kole wetlands, driven by their desire for improved recreational amenities at tourist spots. This indicates that tourists value enhanced recreational facilities and are willing to pay more to ensure that these amenities are developed and maintained. This can be leveraged to secure additional funding for tourism-related improvements and conservation efforts.

Rice farmers have the lowest WTP, as they perceive that they are already contributing to the conservation of the Kole wetlands through their agricultural practices. They believe that further conservation efforts should be the responsibility of the government. This perspective highlights a reliance on governmental support for additional conservation measures. To increase their WTP, it may be necessary to address their concerns and demonstrate how further conservation efforts can benefit their agricultural productivity and community resilience.

Local residents exhibit a higher WTP due to their concern about potential damage to their property and homes due to flood water. They recognize the importance of effective water management in preventing damage from floods and other water-related issues. This group's willingness to pay reflects their direct stake in water management and property protection. Engaging local residents with targeted conservation strategies and emphasizing the direct benefits to their property can secure their support and contributions.

Generally, the awareness about the need for conservation is at high level among general public. This high level of awareness about the importance of Kole wetlands may be due to the bitter experiences during the devastating floods that happened in Kerala during 2018. The flood might have heightened the public's understanding of the importance of wetland conservation.

The fact that no respondents indicated a zero contribution signifies a widespread recognition of the value of Kole wetland ecosystem services and a willingness to support the conservation efforts, financially to some extent.

3.5 Determinants of Willingness to pay (WTP)

Among all the independent variables in the results shown in table 5, income, land holding size and awareness level showed a statistically significant positive effect on WTP values. Researcher [14] also reported similar results while conducting economic evaluation of Kole wetlands in Kerala. This indicates that the stakeholders with high monthly income are more likely to contribute more without a change in their existing utility. Higher-income stakeholders are more financially capable of supporting conservation projects without significantly impacting their standard of living. Their ability to contribute more reflects a willingness to invest in ecosystem preservation, driven by a long-term perspective on the benefits for future generations. Stakeholders with larger land holdings are more inclined to contribute financially to conservation efforts. Individuals who own more land may have a greater vested interest in the health of the ecosystem, as it directly impacts their agricultural productivity and property value. Larger landholders might perceive a higher value in maintaining ecosystem services that support their land use and reduce risks associated with environmental degradation. Stakeholders who are more informed about the condition and importance of the Kole wetlands are more willing to contribute. Increased awareness leads to a greater understanding of the ecological value of the wetlands and the benefits of conservation. Educated stakeholders recognize the importance of preserving the ecosystem and are thus more likely to contribute financially to support conservation initiatives.

Table 5: Regression estimates

Independent variables	**Coefficient(β)**	**Std. Error**	***P* value**
Age	-0.8540	2.1993	0.69
Education	0.0262	9.6395	0.79
Gender	-3.7152	-5.8142	0.53
Monthly income	0.0067**	0.0015	0.03
Family size	-0.0023	0.0014	0.13
Land holding size	0.6319*	0.3662	0.09
Ecosystem status awareness level	0.4655**	0.2393	0.05
Constant	30.7442	18.9833	0.11
R^2	0.3807		
Number of observations	50		

Notes: **denotes *P* value < 0.05, *denotes *P* value < 0.10

4. Conclusion

The study findings regarding the various types of Kole wetland ecosystem services illustrate its multifunctional role. The Kole wetlands provide all four categories of ecosystem services such as provisioning, regulating, supporting, and cultural, demonstrating its vital role in sustaining ecological and human systems. The Garrett ranking analysis reveals that stakeholders in the Kole wetlands prioritize the conservation and management of water-related ecosystem services due to their critical importance in daily life and agriculture. The lower emphasis on recreational services indicates a current focus on essential needs, with potential for future development in tourism and other recreational activities.

The WTP analysis reveals differing levels of financial support for the Kole wetlands conservation project based on stakeholder interests and perspectives. Tourists were willing to invest in recreational amenities, local residents were concerned with property protection and water management, and rice farmers viewed conservation as a government responsibility. The high general awareness following recent floods and the absence of zero contributions indicate a broad recognition of the wetland value. The analysis of factors that influence WTP value, indicates that stakeholders with higher incomes, larger land holdings, and greater awareness are more willing to pay for the conservation of the Kole wetlands. These factors highlight the importance of targeting specific groups with tailored messages and appeals. High-income individuals are better positioned to contribute significantly, while landholders benefit directly from the ecosystem services that conservation provides. Increased awareness enhances stakeholders' willingness to pay by fostering a deeper understanding of the conservation needs and benefits.

The multifunctional nature of this ecosystem highlights the importance of comprehensive conservation and management strategies that recognize and support the diverse services provided by wetlands. The insights from the study are valuable for guiding conservation strategies and resource allocation, ensuring that the essential services are maintained while exploring opportunities for economic diversification**.** Adapting stakeholder engagement and funding strategies to these insights can enhance the effectiveness of conservation efforts and ensure comprehensive support from all stakeholder groups.

Overall, the study provides a comprehensive view of the ecosystem services provided by Kole wetlands, stakeholder preferences, and willingness to pay for conservation. Integrating

stakeholder perspectives into conservation planning and policy, the effectiveness of conservation programs and ensure that they are aligned with the needs and values of the local communities and other stakeholders. This approach fosters greater support for conservation initiatives and helps achieve sustainable management of the valuable wetland resources.

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