

Stakeholder responses on biodiversity and ecosystem uses of Chettuva - a small tropical Indian estuary

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Abstract

In this study, a diverse stakeholder assemblage representing different demographic ranges were interrogated on the functions and values of an aquatic ecosystem, Chettuva-a small tropical estuary in India. Almost all respondents—95%—agree that they depend on the Chettuva estuary and they use the estuary for fishing, tourism, silt collection, and aesthetic pleasure. About 90% of the stakeholders' livelihood is influenced by the quality and state of water in the estuary, and 40% of respondents think that water quality is not suitable for various bids. The proposal for mangrove afforestation in a participatory mode was in line with their responses- (65% respondents) the mangrove ecosystems should be conserved for future generations. Stakeholders recognize mangroves as an important breeding ground and a means of coastal defence. The principal economic activities in the estuary are fishing and tourism. However, 60% of respondents favoured a framework for managing sustainable tourism in the estuary. About 90% of the stakeholders consume fish at least once in a week, and they prefer the fish from the Chettuva estuary rather than from adjacent freshwater or marine realm. About 90% of the stakeholders opined that the estuary's aquaculture activities have not been explored yet, though there were some isolated trials. Over the last two decades, fish availability has decreased by 40 to 60 % for most of the resource groups in the estuary. They also note that the fish in the estuary can safely be eaten (80%) and calls for management measures to protect them..

Key words: *Estuary; Chettuva; mangroves; fisheries; livelihood; tourism and recreation*

Introduction

Estuaries are highly productive transitional aquascape, which serve important life-support services to the human-kind (Elliott et al. 2007). The major ecosystem functions that supported by estuaries are water quality control, nutrient cycling, flood protection, biodiversity support and habitats, and supply of natural resources and raw materials etc. (Sreekanth et al. 2023). The estuarine bays are important economic areas as they attract settlement, shipping, fishing, harbour and tourism activities. However, they are classified among the most impacted ecosystems on earth's surface driven mainly by the anthropogenic activities (Lotze et al. 2006, Halpern et al. 2008, Barbier et al. 2011, Sreekanth et al. 2023). The degradation of the habitats results from these impacts will ultimately alter the ecosystem functions and obstruct the smooth delivery of ecosystem services. Globally, the estuarine habitats are disappearing and authorities should give top priority in conserving these ecosystems.

However, there are wide data gaps in the estuaries with respect to ecosystem functioning, natural resources, ecosystem services and estuarine environment (Granek et al. 2010). The estuarine ecosystem services/uses are not properly identified/documented/evaluated barring a few isolated attempts (Barbier et al. 2011).

Moreover, the knowledge and awareness of the stakeholders about the ecosystem is always ignored and many times, not recognised. This is more evident in the case of small estuaries (Sreekanth et al. 2023). The stakeholders of an estuary have rich knowledge and diverse views on the importance of the ecosystem towards their livelihood. The major support of the estuary towards mankind are fishing and fisheries, mangroves, opportunities for recreation and water provisioning services (Sreekanth et al. 2023). To receive proper responses from the stakeholders, a designed field record and survey procedure need to be followed. Moreover, a diverse stakeholder network that connects the estuary

and human uses needs to be identified for increasing the efficiency of the perception analysis. In this study, a heterogeneous group of stakeholders (350) in a small tropical estuary: Chettuva, located in Kerala, southwest coast of India was interviewed on different uses/values of the estuarine ecosystem. The objectives of the study were 1) to capture and assess the responses of various stakeholders on the uses of the estuary and 2) to outline the perceptions of stakeholders on the status of fisheries, water quality, mangroves and tourism and recreation in the estuary.

Material and methods

Chettuva Estuary (CE) is a small estuary (<10 km²) located in Kerala along India's western coast. The estuary is an important coastal ecosystem and a fundamental part of the Thrissur-Kole Wetlands. In classification and definition, the estuary is considered as a small-shallow estuary with an area of 7.4 km², which receives freshwater from Kechery, Puzhakkal and Karuvannur river systems and connects to the Arabian Sea via Engadiyoor Pulimutt (Fig. 1). The estuary is famous for its fishery resources, especially the state fish of Kerala- Pearlsport (*Etroplus suratensis*), Mud crab (*Scylla serrata*), Striped grey mullet (*Mugil cephalus*), Indian white shrimp (*Fenneropenaeus indicus*), Tiger shrimp (*Penaeus monodon*), Croakers (*Otolithes ruber*, *Johnius borneensis*, and *Daysciaena albida*), Silver sillago (*Sillago sihama*), Whipfin silver-biddy (*Gerres filamentosus*), Red snapper (*Lutjanus argentimaculatus*), Clams (*Villorita cyprinoides*, *Meretrix meretrix*, *M. casta*, *Anodonta anatine*, and *Paphia malabarica*), Green mussel (*Perna viridis*) and Indian backwater oyster (*Crassostrea madrasensis*). The thick mangrove vegetation within the estuary is a wonderful attraction for the tourists and performs the carbon sequestration function efficiently (Varghese et al. 2021). However, the estuary faces habitat degradation from different factors such as eutrophication (Shibini Mol et al. 2019), heavy siltation and sedimentation (Varghese et al. 2021), heavy metal pollution (Udayakumar 2012) and reduction in the freshwater discharge from the upper reaches. Thus, the physico-chemical, biological and ecological system could have been changed (Shibini Mol et al. 2019). People's perceptions on these ecosystem

features and alterations are of great significance when designing the management plans for aquatic ecosystems.

Here, we recorded the responses of the stakeholders on their general understanding of an ecosystem, benefits, and issues from Chettuva estuary during October 2022 to January 2023. For this step, we selected a diverse stakeholder network including scientific and non-scientific personnel (n = 350). To receive these perceptions, a questionnaire schedule was prepared. This was adapted and modified from Sinclair et al (2021) described for Ashtamudi estuary. The schedule was divided into 1) general details (Section A), 2) socio-demographic and general preferences (Section B) and 3) Question-based preferences (1. Estuary use (three questions), 2. Fisheries related (four questions), 3. Water quality related (four questions), 4. Mangrove based (five questions), and tourism/recreational related (five questions). The estuary use was assessed using questions such as number of times to visit the estuary, purpose of visit, and improvement options for estuary use. The fishery perceptions of the stakeholders included information on how frequently the estuarine fish is used for consumption, safety of fish for consumption, the fish availability declined/increased since last decade, and the fish should be conserved for future generations. The water quality questions included 1) water quality of Chettuva estuary is important to me, 2) I am satisfied with the quality of water in Chettuva, 3) the quality of the water of Chettuva affects the livelihood of my household, 4) which of the following might improve your satisfaction with the water quality of the estuary? The mangrove based perceptions inquired information on the conservation of mangroves, visit to mangroves, benefits of mangroves, and aquaculture in Chettuva and its impact on mangroves. Tourism and recreation based inquiries were 1) personal opinion on the importance of tourism and recreation in the estuary, 2) number of times visits for the recreation, 3) type of recreation and the most popular types, 4) Tourism/recreation in Chettuva is an important source of income for the economy and 5) How satisfied are you about the sustainable tourism in Chettuva.

Results and discussion

The need for participatory programmes with some level of stakeholder involvement is acknowledged in

order to guarantee widespread support for management strategies (Keneley et al. 2013). The stakeholders included 52% were dependent on fish, 24% were general public and other users, 15% were government policy makers and department officials, and 9% were researchers & students (Fig. 2). The stakeholder types and the percentage contribution to the total count of units surveyed is given in Table 1 and Fig. 2. Approximately 50% of the stakeholders in and around Chettuva in one way or the other way depend on the CE for their livelihood needs and 61% of them visit Chettuva on a daily or weekly basis (Fig. 3). Maintaining a good water quality status in estuarine and coastal habitats is essential for the ongoing growth of fishes in mariculture (Brown et al. 2020). As a response to the water quality status of the estuary,

40% of the stakeholders opined that the water quality of Chettuva is not adequate. Moreover, 80% of the responses consider water quality as an important parameter and the state of water quality affects their livelihood in some way or the other. Regarding the involvement of development agencies of the Govt. in conservation of the estuary, 40% opined that the projects are not implemented in the right direction so as to conserve and manage the CE. Similarly, about 70% people strongly agree that revival of Chettuva estuary is very vital for them and they consider the environmental issues with a greater significance (90%) (Fig. 3). Studies found that discharge of untreated sewage and industrial effluents affect the water quality of the estuary, as perceived from the sampling experiments and the local residents (Ayyappan et al. 2013; Sreekanth et al. 2023).

Table 1: The type, count and percentage of stakeholder profile for the field survey in Chettuva

SN	Type of stakeholder	Count	Percentage
S1	Researchers and students	26	7.4
S2	Fishermen (only fishing)	92	26.3
S3	fishermen cum traders (fishing and marketing)	25	7.1
S4	Fish farmers	10	2.9
S5	Fish traders (only involved in trade and marketing)	26	7.4
S6	Officials from state departments (Fisheries, Forests, Geology and Mining, Irrigation, Harbour engineering, Panchayat)	33	9.4
S7	People involved in fishing, trade and tourism	24	6.9
S8	Coastal police	6	1.7
S9	Local inhabitants	8	2.3
S10	Women (Household activities, clam picking, and NRGEGA	43	12.3
S11	Livestock farmers	4	1.1
S12	Local leaders	5	1.4
S13	Members of co-operative societies	5	1.4
S14	Tourists and tourism operators	10	2.9
S15	Hotel and resorts	10	2.9
S16	Devotees of temples/church/mosque	6	1.7
S17	Banks and financial institutions	8	2.3
S18	Ferryboat owners	2	0.6
S19	Local print and media	4	1.1
S20	Boat-race co-ordinators	3	0.9

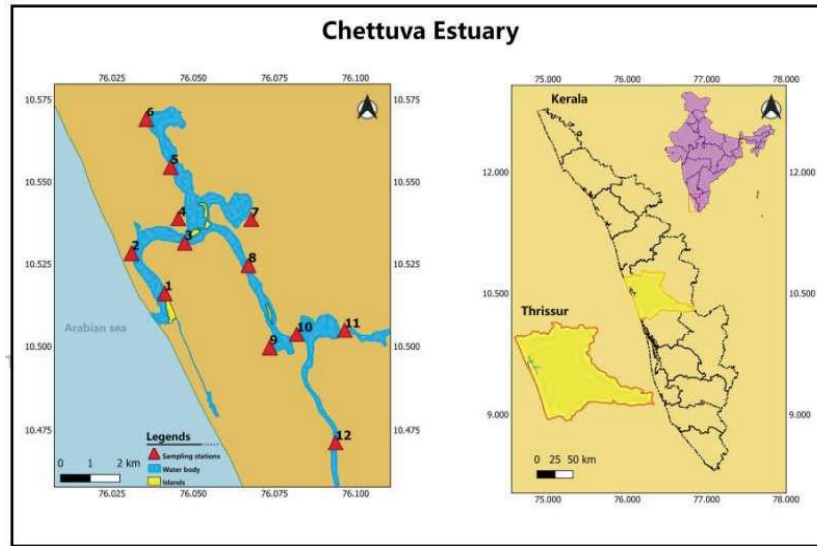


Fig. 1. The map showing Chettuva estuary and the field survey points

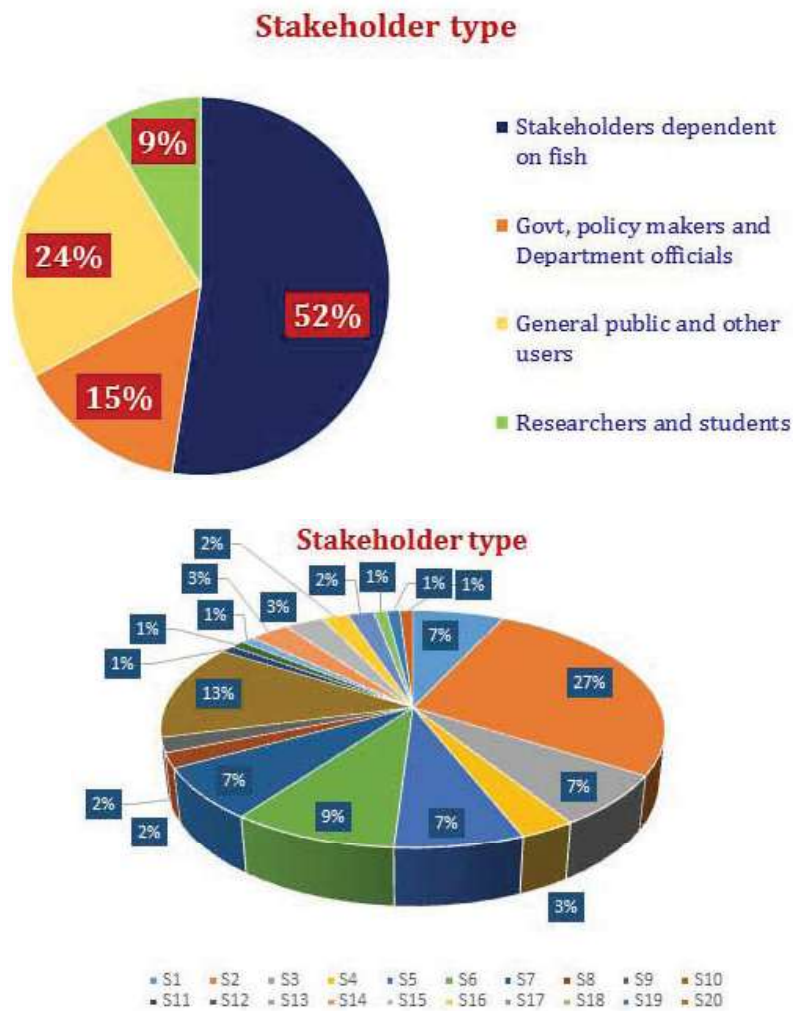
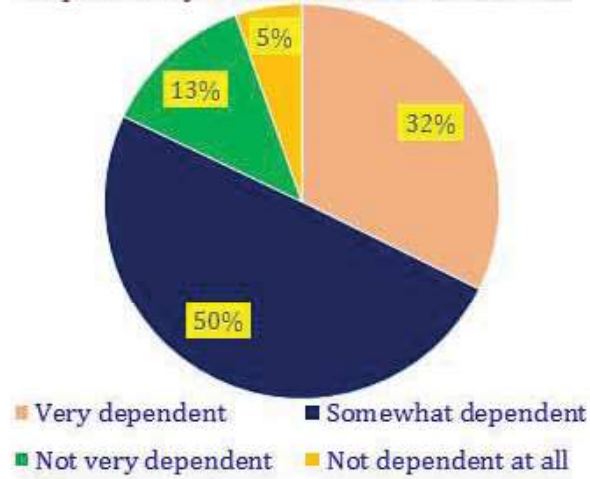


Fig. 2. The stakeholder profile and percentage contribution for the field surveys in Chettuva (the codes of stakeholders (S1 to S20) are given in Table 1)

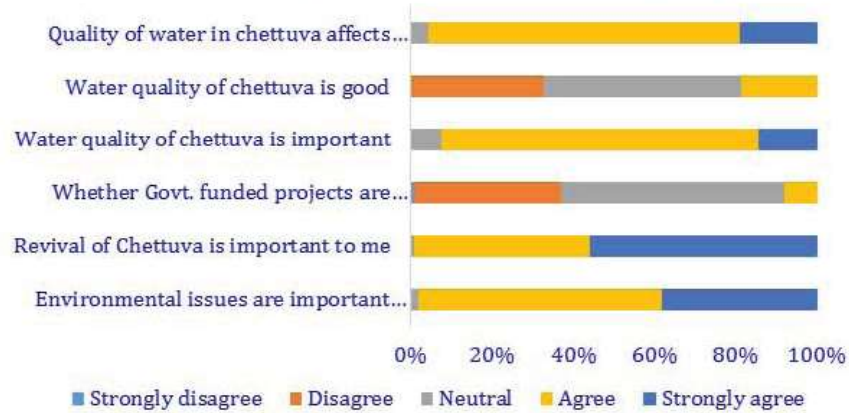
Dependency on Chettuva for livelihood



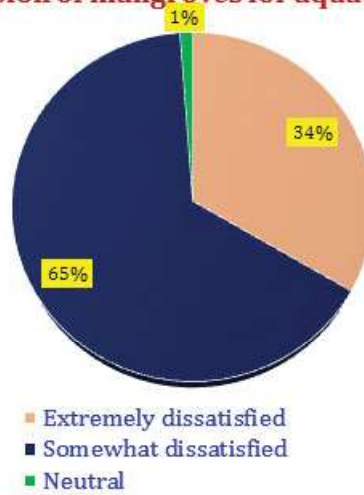
How often you visit Chettuva



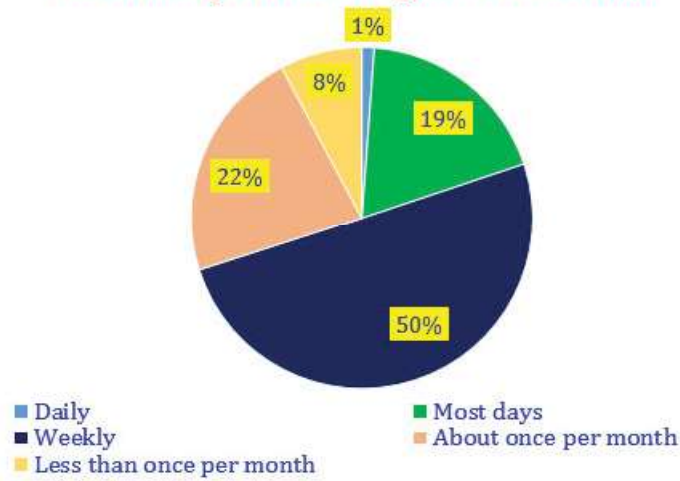
General Perceptions on Chettuva and water quality



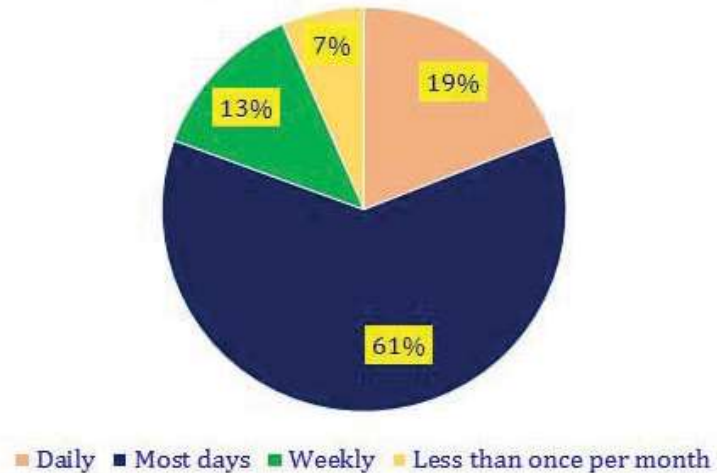
Conversion of mangroves for aquaculture



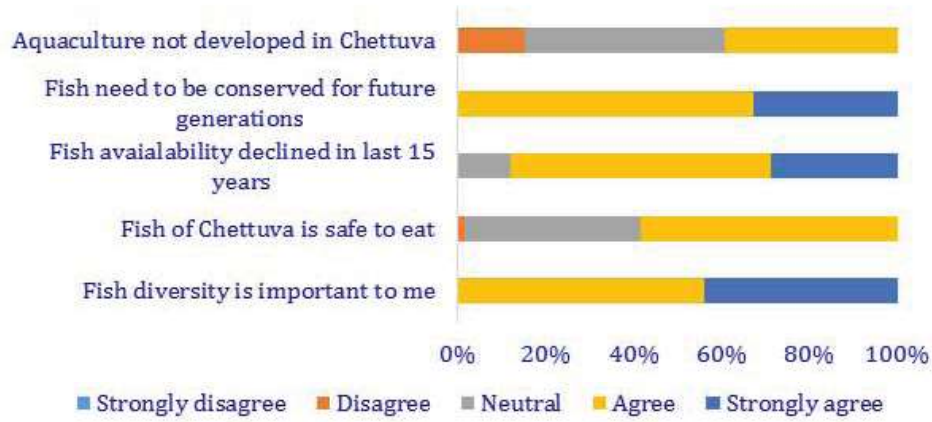
How often you visit mangroves of Chettuva



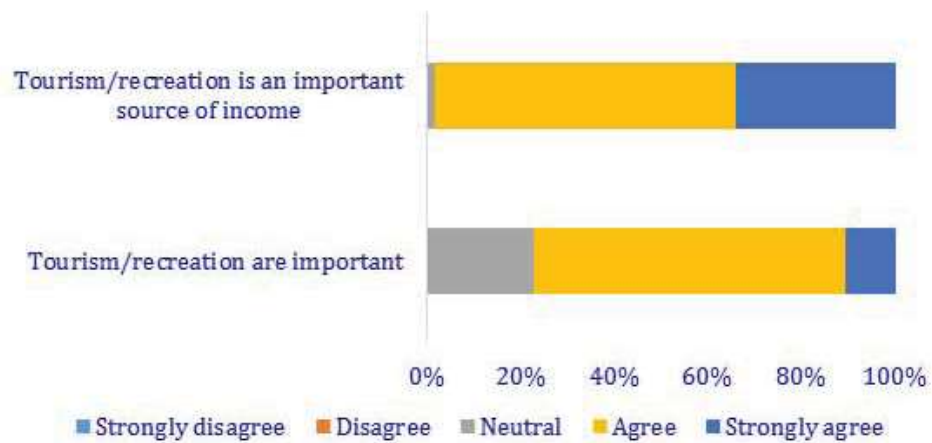
Consumption pattern of fish from Chettuva



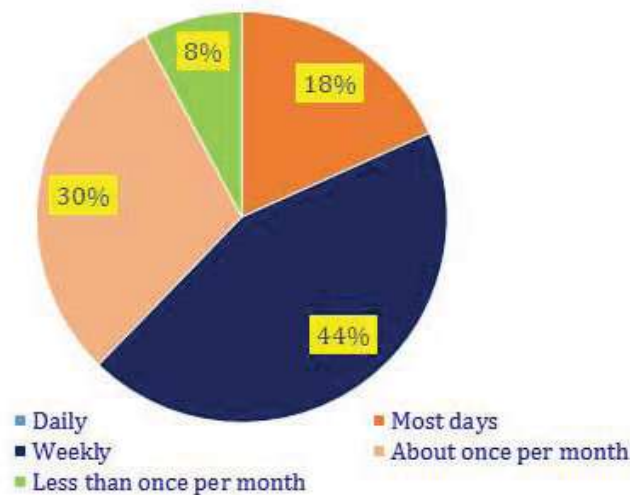
Fisheries and Aquaculture



Tourism and recreation



How many times visit for recreation



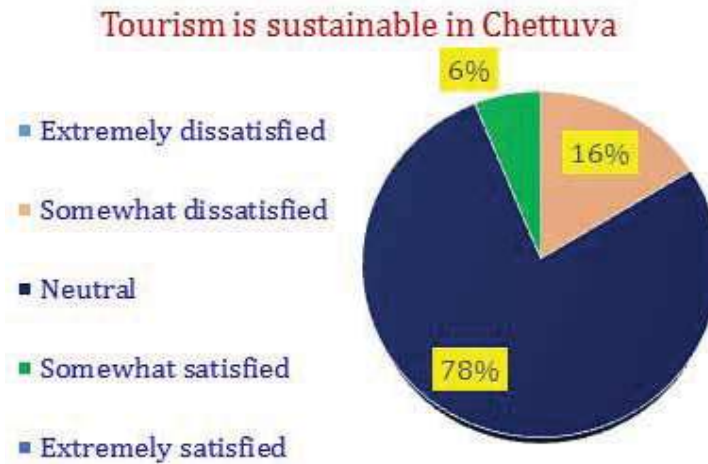


Fig. 3. The responses of the stakeholders towards different ecosystem uses based questions

Local residents and fishermen consider the mangrove ecosystem as a source of recreation, aesthetic pleasure, and enjoyment of the landscape and biodiversity (Rönnbäck et al. 2007, Iftekhar and Takama 2008, López et al. 2011). Hence, gathering their views on the mangrove status and clues for conservation are of paramount importance. As a response to the mangrove based interrogations, almost 50% of people often visit mangroves of the estuary weekly and 19% visit the mangroves on most days. The Chettuva estuary is known for its thickest mangrove cover though the area of the mangrove cover is limited considering the total area of the CE (Varghese et al. 2021). Hence, the stakeholders consider the mangroves as an important resource that needs to be conserved. Almost all (99%) the stakeholders were dissatisfied with the conversion of mangroves for the aquaculture activities, since they consider this resource as resource for fish breeding and also as coastal buffer systems. It is already established that the mangrove ecosystem should receive proper attention when the coastal ecosystem conservation is taken into consideration (Abdullah et al. 2014).

The Chettuva estuary supports a rich fish community covering a total of 120 fish species (Amritha Priya et al. 2023 unpublished). Earlier reports too recorded a comparatively good diversity of fishes from the CE (Johny et al. 2016, a count of 68 species). Regarding the consumption of fish caught from CE, about 60% of people consume fish from the CE frequently. The locally produced/

caught fresh fish undoubtedly contributes significantly to the health condition/nutritional security of man-kind by reducing the chances of coronary heart disease and also acts as regenerative medicine (He et al. 2004). The safety of fish harvested from CE is inquired and the stakeholders still consider the fish is safe for consumption (80% of the responses were positive). Though Chettuva holds a great potential for aquaculture activities such as cage culture, pond culture, majority of the stakeholders (80%) opined that aquaculture is not developed in the CE. Everybody opined that they would love to see the fish diversity in Chettuva and strongly backed the measures required to conserve fish for future generations. The stakeholders also opined that the fish availability from the CE declined drastically in the last 10-15 years (90% responses). Thus, they indirectly suggested actions to conserve fisheries resources and improve the aquaculture development in the estuary.

Tourism /recreation is considered as an important livelihood option for the people of Chettuva with activities such as Boat rowing, mangrove trips, boat ride, house-boat cruise, kayaking, bird watching, and recreational fishing. About 60-70% stakeholders believe that the CE is an important estuary for tourism and recreational purposes and these activities form an important source of livelihood for the local residents. About 40% people visit Chettuva on a weekly basis whereas 30% of them visit once during a month. Many of the respondents were mostly neutral

about the sustainability of the tourism activities in the CE. Sreekanth et al (2023) also described the recreational uses of estuaries along with quantification of values. Thus, the stakeholders indirectly demanded sustainable operations of tourism and recreational activities in the CE.

This study is a very simple and straightforward attempt to identify the various ecosystem uses of CE based on the stakeholder's perceptions. They identified the CE as a major source for fisheries, and tourism and recreational activities. The mangrove ecosystem of the estuary is vital in conserving the aquatic communities and serving as a coastal buffer system. In their opinion, the aquaculture activities are not much explored/developed in the estuary, which needs critical attention from the government. departments. They truly accept and love biodiversity and the fish community of the estuary and state that the fish communities should be conserved for future generations. The water quality status of the estuary is not satisfactory at its current state and since the water quality affects their livelihood, proper actions are required to reinstate the water quality of the CE. They also agree that tourism and recreational activities are one of the most important economic sources for the people and however, it needs to be managed in a sustainable way.

The management measures for the Chettuva estuary should include the following major recommendations.

- 1) The removal of silt from the high sedimentation segments of the estuary.
- 2) The depth profile of the estuary should be restored and the sub-tidal habitats should be deepened.
- 3) The freshwater discharge to the estuary should be increased and environmental flows should be maintained.
- 4) A proper fisheries management plan should be prepared and implemented including legal restrictions, ranching, reserving protected zones and developing participatory management programmes.
- 5) The mangrove habitats of the estuary should be properly measured, demarcated and designated and also published in mass-media to conserve these precious ecosystems.
- 6) Awareness campaigns and programmes may be organised to encourage the stakeholders for conservation actions

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