Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5493

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 196-205 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Ecosystem Services, Drivers of Ecosystem Deterioration and Institutional Arrangements for their Management: The case of Kuttanad Coastal Wetland Ecosystem of Kerala

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Received: 21.08.2017 | Revised: 30.09.2017 | Accepted: 3.10.2017

ABSTRACT

Ecosystems provide a range of services, many of which are of fundamental importance to human well-being, for health, livelihoods, and survival. Wetlands are diverse and productive ecosystems with ecological and economic values. Kuttanad wetland ecosystem is such of a kind situated in the fertile lands of Vembanad Lake in Alleppey district of Kerala. Kuttanad ecosystem is a complex interaction between the various endemic floras, fauna, birds, fishes, livestock, ducks, crops with the human beings. But due to enormous anthropogenic activities, this region is deteriorating. Hence, in spite of being a source of livelihood their multiple-use potential is seriously undermined due to a narrow management regime focusing only on direct agricultural benefits. Therefore, in this paper the wetland ecosystem services, drivers of change in ecosystem services and the institutional arrangements for managing the Kuttanad wetlands. Both qualitative and quantitative data were collected from different stakeholders. Discussions with wetland specialists revealed a total of 22 ecosystem services, and a high level of dependency on these services by the residents. The major drivers of ecosystem deterioration are household sewage discharge and tourism encroachments. This suggests that there is an urgent need to have deeper insights into the multiple—often unrecognized—direct and indirect benefits of wetland ecosystems and also actions are required to manage the wetland ecosystem and its services in order to sustain these benefits to the current and future generations.

Key words: *Kuttanad wetland; Ecosystem services; Drivers of deterioration; Institutional arrangements*

INTRODUCTION

Wetlands are valuable and ecologically sensitive systems that occupy about 6% of the world's land surface[27]. They comprise both land ecosystems that are strongly influenced by water, and aquatic ecosystems with special characteristics due to shallowness and proximity to land[21]. Although various different classifications of wetlands exist, a useful approach is one provided by the Ramsar Convention on Wetlands.

Cite this article: Rao, S. and Balasubramanian, R., Ecosystem Services, Drivers of Ecosystem Deterioration and Institutional Arrangements for their Management: The case of Kuttanad Coastal Wetland Ecosystem of Kerala, *Int. J. Pure App. Biosci.* **6(1):** 196-205 (2018). doi: http://dx.doi.org/10.18782/2320-

It divides wetlands into three main categories of wetland habitats: (1) marine/coastal wetlands; (2) inland wetlands; (3) man-made wetlands[2]. Globally, the areal extent of wetland ecosystems 12.8 million km^2 with an estimated economic value of about US$15 trillion a year (MEA, 2005) and US$70 billion per year[23]. Wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant species, and soil and sediment characteristics[3]. They also play a significant role in delivering ecosystem services globally. The highest benefits were found in Asia with an economic value of $1.8 billion per year[5]. Despite the economic value and the benefits associated, wetlands across the world are persistently (over) utilized and reclaimed at great cost[10]. Global land use changes between 1997 and 2011 have resulted in a loss of ecosystem services of between $4.3 and $20.2 trillion/year[7]. The root cause of much wetland degradation is information breakdown[27]. The various stake holders as well as the policy makers often have insufficient understanding of the economic values of wetlands. Ignorance or misunderstanding of the value of goods and services provided by wetlands, these are considered as wastelands and has resulted in its conversion to intensive agricultural, industrial or residential purposes[13]. The wetlands have hence been over exploited and also converted to other uses which are beneficial to the society. However, such mindless exploitation has also cost the society. This is the result of what Turner and Jones[27] refer to as interrelated market and intervention failures, which derive from a fundamental failure of information, or lack of understanding of the multitude of values that may be associated with wetlands. Hence, there is a real need to better and more widely understand these economic benefits and to further highlight the economic and other values of wetlands to the beneficiaries as well as the policy makers. The state of Kerala is known for its rich coastal wetlands and backwaters. Kuttanad wetland ecosystem is such of a kind situated in the fertile lands of Vembanad Lake in Alappuzha district of Kerala. Kuttanad, which in local language means 'low lying lands', is one of the most fertile wetland ecosystems of the world where rice is cultivated below sea level and this will be of great importance in view of the projected sea level rise caused by global warming. The Kuttanad floodplains comprise marshy low lying areas lying below mean sea level, coastal alluvial belt, uplands of higher elevation, river networks and backwaters, contributes to a unique ecology[19]. The unique ecological character of Kuttanad makes it even more important. The ecological character is tightly linked to the local socio-culture and local livelihood. The unique ecology of Kuttanad wetland ecosystem has supported a multiplicity of enterprises based on inland fisheries, paddy, coconut, and several other allied enterprises. However, these wetlands have been continually under serious threat caused by enormous human interventions, pollution of water bodies due to eutrophication, soil degradation and productivity loss, household sewage discharge, tourism encroachments and lack of ecosystem perspectives in their management[22]. The deterioration is evident from the rapid shrinkage of flood carrying capacity of the lake by 78% due to reduction in its area and depth. Kuttanad ecosystem is a complex interaction between the various endemic floras, fauna, birds, fishes, livestock, ducks, crops with the human beings. But due to enormous anthropogenic activities, this region is deteriorating. Embracing a typical developmental agenda over the past few decades with a network of roads, reclamation of wetlands and construction activities, ignoring the sensitivity of the Kuttanad Wetland Ecosystem and the vulnerability of the area to regular flooding, a serious man-made crisis has been created on ecology, livelihoods, agricultural activities and alternate options, which collaterally and cumulatively contribute to a spiralling agrarian distress in the region[17].Ecosystems provide a range of services, many of which are of fundamental importance to human well-being, for health,

livelihoods, and survival[7,9,24] ecosystems offer joint products some of which are hidden, public goods in nature leading to neglect of these natural capital assets from national income accounts[8]. Information on individual wetlands and their exploitation at the local level is very limited. Precise information about the values and drivers of changes is required for the conservation and sustainable use of wetlands. Market failure and poorly defined property rights are amongst the most important reasons that have contributed to the loss of natural resources like wetlands worldwide[13]. Knowledge on wetland ecosystem services, drivers of change and subsequent impacts specific to regions or areas of concern is essential for ensuring wise use, conservation and sustainable development[4].With this background the necessity for studying the different aspects of wetland ecosystems, its services and drivers of deterioration is recognized and its need to be thoroughly undertaken is understood. Hence, this study aims to provide deeper insights into the multiple (direct and indirect) benefits of Kuttanad wetland ecosystem, drivers of its deterioration and also analyze the institutional arrangements for managing the wetland ecosystems.

Design of the study

Study Area

Kuttanad wetland system was selected because of its ecological significance, societal value and the anthropogenic threats it is presently facing. Kuttanad region is spread across the districts of Alappuzha, Kottayam and Pathanamthitta. The area consists of fragmented landscapes and diverse ecosystems such as coastal backwaters, rivers, waterways, marshes, ponds, paddy fields and garden lands. More than two-thirds of the total land area in this region is wetlands. Enriched by the silt deposited through the river systems of Meenachil, Pamba, Manimala and Achencoil, the loamy soil in this region is very fertile and suitable for paddy cultivation[25]. Nearly 57 per cent of the KWS is shared by Alappuzha district, 30 per cent by the Kottayam district and remaining 13 per cent by the Pathanamthitta district. Administratively, Alappuzha district is divided into six taluks, namely, Ambalapuzha, Chengannur, Chertala, Karthikapally, Kuttanad and Mavelikkara, comprising a total of 82 villages. Out of these, 42 villages fall within Kuttanad. Three taluks of Kottayam district, namely, Changanassery, Kottayam and Vaikom comprising 27 panchayats and 16 villages are part of Kuttanad. In Pathanamthitta district, five panchayats under Thiruvalla taluk fall within Kuttanad. Thus, the KWS has a total of 64 panchayats. The boundary of Kuttanad is differently marked in different studies. The demarcation used in this study is in accordance with the definition of area made by an official committee appointed by the Government of Kerala and also in compliance with the map provided by the Kerala State Land Use Board. Alappuzha district was purposively selected for sampling as it comprises the largest share of whole Kuttanad wetland system ecologically as well as socio-economically.

MATERIAL AND METHODS

In order to fulfill the objectives of the study, primary data were collected from the sample respondents by personal interview, using a pre-tested and structured questionnaire. The method of personal interview was adopted to ensure that the data obtained from the respondents were relevant, comprehensive and reasonably correct and precise. Different schedules were used for the different stakeholders. The data were collected from the major stakeholders of the Kuttanad wetland ecosystem which include the paddy farmers, fishermen, duck and vegetable farmers as well as the local residents.A total of 120 sample households were interviewed from the six randomly selected villages (during July-November 2016) namely, Alleppey, Muhamma, Thannermukkom, Champakkulam, Ramankary, and Neelamperoor. Most of the respondents (heads) were male aged between 25 and 67 years. Questions were focused on the ecosystem services used, people's dependency on them, drivers of change, their impacts on ecosystem services and

institutional arrangements for sustainable management of Kuttanad wetlands. Agricultural officers of various agricultural offices of Kuttanad area of Kerala, wetland specialists, NGOs, research institutes, and Paadasekhara committee members, and other organizations were also consulted for listing of ecosystem services of the wetland during the period of study. The key questions asked during interviews focused on wetland services, livelihood strategies and drivers of change in the wetland. Details regarding the institutional arrangements in the Kuttanad area for its sustainable management were also collected using a semi-structured interview schedule. A total of 12 representatives from various organizations were consulted as key informants to help understand the wetland services and the drivers of deterioration. Criteria for selection of the key informants were their knowledge about the wetland ecosystem, institutional arrangements, and people's dependency and involvement in the management of the wetland. Qualitative data obtained from interviews were first coded and categorized into themes according to the research questions (i.e., ecosystem services; drivers of change, institutional arrangements etc.) and similar coded themes were grouped together. Ecosystem services ranking was performed using participatory tools. Respondents were asked to identify key ecosystems available from the wetlands. Once key ecosystem services were listed, participants were asked to rank the listed ecosystem services on a scale of 1 to 10 (1 with least preference and 10 with the highest). The overall ranking was based on the total scores for each ecosystem service divided by number of respondents.

RESULTS AND DISCUSSION

The present study aims to provide deeper insights into the multiple (direct and indirect) benefits of Kuttanad wetland ecosystem, drivers of its deterioration and also analyze the institutional arrangements for managing coastal wetland ecosystems.

Ecosystem services of Kuttanad Wetland Ecosystem

Kuttanad wetland system provides an array of services which could be categorised into provisioning, supporting, regulating and cultural services. This study has identified a total of 22 ecosystem services in the study area. Among them nine were provisioning, two were supporting, four were regulating and seven were cultural or aesthetic services. The list of services is given in Table 1.

Table 1: List of ecosystem services identified in the study area

Category of service	Nature of service	Biophysical / socio-economic Indicators
Provisioning	Food and raw materials: Paddy, fish, vegetables, ducks, lotus, edible plants, medicinal plants,	Value of output
	Water for agricultural production	Area irrigated, duration of water supply, quantity and value of water used in agriculture, value of output
Regulating	Nutrient cycling, flood control, siltation control, water regulation and recharge (used for irrigation)	Removal of nutrients by wetlands (in tonnes or per cent) Water quality in aquatic ecosystems (sediment, turbidity, phosphorous, nutrients etc.)
Supporting	Biodiversity conservation	Number of flora and fauna supported by the ecosystem.
Cultural and aesthetic	Tourism, water sports,	No. of visitors to sites/year Amount of tourism earnings

Source: Key informant interview and Household Survey, 2016

A total of 22 ecosystem services were identified. The stakeholders were requested to rank the various ecosystem services on the basis of the use and dependency. The most depended service was ranked one and so on. Group discussions and survey results with the different stakeholders revealed that paddy farming was the major occupation of the Kuttanad wetlands. Kuttanad is hence appropriately known as the rice bowl of Kerala. Almost 70 per cent of the population depends on paddy farming as a source of livelihood. The average income earned by the paddy farmers is ₹60059 per hectare. Fishing was ranked as the second most dependent activity or service. Almost 60000 active fishermen of the Kuttanad area are employed in inland fishing with an average income of ₹1600 per day, during the peak season of fishing. The most ranked services with details on their use by local people are given in Table 2.

Table 2: Ecosystem services, their use and ranking by local communities

Sl No	Ecosystem services and category	Uses	Rank	Remarks
1	Paddy farming (provisioning)	Food and market value	1	70 per cent of the population depend on paddy farming as a source of income
2	Fishing (provisioning)	Food and market value	2	More than 60000 active fishermen in the area. Average income of ₹1600 per day during peak seasons
3	Recreational (Cultural)	Employment and global recognition	3	Important tourist destination. Average inflow of tourist is more than two lakhs per annum
4	Water (provisioning)	Irrigation and household purposes	4	Daily dependence by stakeholders for irrigation, washing and bathing purposes
5	Erosion control (regulating)	Protect and stream banks against erosion action.	5	Act as buffer against run off , also provide drainage and natural irrigation
6	Habitat for biodiversity (supporting)	Global recognition and biodiversity conservation	6	Diverse species of wild flora and fauna have been identified
7	Nursery for fishes (supporting)	Breeding area for fishes	7	High diversity of fishes

Source: Household Survey, 2016

Recreational services were ranked to be the third most significant services. Kuttanad is an important tourist destination across the world. The lush green paddy polders and the cross connected back waters of the area attract many tourists from within and across the country. The average tourist inflow to the wetlands is more than two lakhs per annum (DTPC, 2014). Another important ecosystem service upon which the stakeholders depend on a day to day basis is the water. Water from the canals is used for irrigation in the paddy fields and other crops. It is also used for washing and bathing purposes by the residents. The wetlands also provide services like erosion control and also act as a habitat for biodiversity. It also acts as a nursery for fishes and supports a diversity of fishes, wild flora and fauna.

Local dependency on Kuttanad wetland and its services

Paddy farming is the major livelihood in the Kuttanad area. The paddy farmers earned an average income of ₹60079 per hectare, while the fishermen earned an average of ₹330580 per annum. Fishing was found to be the second most important livelihood strategy. The major

varieties of fishes harvested were pearl spot, prawns, red snapper and Mackerel. Besides these, tourism, business (boat houses, farm stays, and small scale hotels), agricultural labour, and government employment were other livelihood strategies found in the area. Tourism employment, such as guiding for house boats and bird watching is an emerging livelihood option among the young.

Majority of the livelihood strategies were directly linked to the ecosystem services provided by the Kuttanad wetlands. Almost all the fishermen were primarily occupied with fishing, while in case of paddy farmers; the primary occupation was not agriculture. Most of the paddy farmers were part time farmers who were primarily employed in government services or in business.

Drivers of Deterioration

The analysis of household surveys and personal interviews revealed eight direct and three indirect drivers of change in ecosystem services. These drivers of change were both natural and human induced (Table 3). The improper implementation of the Kuttanad Package, closing of Thannermukkom bund, population growth and real estate market were reported as indirect drivers of change. Sewage, invasive species, unmanaged tourism, encroachment, over-exploitation and emissions from motorized boats areas were reported as direct drivers of change threatening the wetland ecosystem. Illegal use of undersized mesh (less than 12 mm), fishing during the breeding season (May–July) and catching of gravid and juvenile fish resulting in the depletion of fish stocks were also reported. Closing of Thannermukkom bunds to support a second season paddy cropping was also identified as a major reason for depleting the lakes as well as the wetland. According to the local residents, the entry of saline water during the summer from the Arabian Sea purifies the lake and the removes the effluents from the lake which is essential for fish breeding as well as to prevent the invasive species growth.

Table 3. Drivers of Deterioration in Kuttanad wetland ecosystem

Drivers of Deterioration	Direct/ Indirect	Rank
Household sewage and water contamination	Direct	1
Unmanaged tourism. e.g., Excessive use of motor boats	Direct	2
Over-exploitation	Indirect	3
Improper implementation of management plan	Indirect	4
Invasive species	Direct	5
Encroachment and illegal agriculture farming	Direct	6
Population growth	Indirect	7
Sand mining	Direct	8

Source: Household Survey, 2016

Institutional arrangements for managing Kuttanad wetland ecosystem

The Kuttanad floodplains comprise marshy low lying areas below mean sea level, coastal alluvial belt, uplands of higher elevation, river networks and backwaters, contributing to a unique ecology. The ecological character of the wetland is the capacity to provide a wide range of naturally occurring 'ecosystem services'. Kuttanad wetland is used as multiple uses and multiple user system. These wetlands are crucial to sustaining wetland ecosystem and, if properly managed, can serve as a sustainable source of national income through appropriate management technologies and appropriate level of harvesting. These wetlands are the common property resource and under different management regimes. Multiple institutions play its role through ownership and control over the fisheries of wetlands. A large number of stakeholders are associated directly and indirectly with the wetland, these include paddy farmers, fishermen, various state government departments, research institutes, NGO's etc. Presently, the prominent stakeholders are the

paddy farmers. These farmers are aware and concerned regarding the ecological imbalance and deterioration of Kuttanad wetlands. This stakeholder group is of the view that enormous levels of human intervention and over-exploitation are reasons behind the deterioration. The farmers also reckon that this ecological imbalance has had a negative impact on the farming scenario and the agricultural productivity as well. The major issue that the farmers want to be resolved soon is related to the Thaneermukkom bund operation and reconstruction of it. The farmers in the region also hold more influence on the issues compared to the fishing communities due to large land holdings and resources. Fishing community of Kuttanad area is another stakeholder category. This group is mainly comprised of poor and marginal fishermen who are solely dependent on the wetland for their livelihoods and fishing is their primary occupation. Every year Kuttanad faces the fishermen-farmer conflict regarding the opening and closing of the Thannermukkom bund shutters. The fishing community wants the shutters of the bund to be open for longer periods so that along with saline water more fishes can come in for breeding, while the farmers want the shutters to be open for a shorter time period However, the fishermen are of the view that farmers receive more support from the government on this issue. The fishing community also feels that there is a need to shift the focus primarily from agriculture to issues related to fishing as well. Some of the stakeholders such as ecologists and Non-Governmental Organisations (NGOs) are of the opinion that Kuttanad needs to be managed in a holistic view in order to have a sustainable development of the wetland. Human interventions are denoted as major driver of deterioration by them. They also suggest addressing the issues related to environment which would in turn address the issues of other sectors too. The Government has taken steps to restore the ecology of the wetlands following the report by MS Swaminathan Research Foundation on Kuttanad regarding the agrarian distress in the area. The report was adopted by the Government as 'Kuttanad Package' for the region. However, the local residents are pointing out the improper implementation of the package. They point out that the package mainly focuses on construction activity rather than other major issues like ecological balance, backwater pollution, fishermen-farmer conflicts etc.

DISCUSSION

The present study focuses on different aspects of wetland ecosystems, its services and drivers of deterioration and the institutional arrangements for managing the Kuttanad wetland of Kerala, India. Based on the primary survey results, the study reveals 22 major ecosystem services, on which the livelihood of the local residents are dependent. The key ecosystem services identified by the residents are the provisioning services such as paddy farming, fishing, and water for drinking and bathing, and cultural services such as tourism. Economic valuation of a wetland in Bardhaman district of West Bengal as reported by Mukherjee[18] also showed similar results. Human dependence on provisioning services is widely acknowledged, especially in developing countries, as people are highly dependent on natural resource[4]. Kumar revealed that the poor are more vulnerable to the loss of ecosystems functions restricting the supply of public good type of services. Guo *et. al*[11] on the other hand, reported that economic growth has actually made humans more dependent upon ecosystem services. Perceived declining trends in the availability or supply of these services threaten the livelihoods of local communities. The results of this study show that the main drivers of deterioration of the ecosystem are household sewage and water contamination, unmanaged tourism and over-exploitation. Another major indirect driver of change was the improper management of the wetland. Urgent action is required from government and local NGOs to address this concern. The use of illegal fishing nets and fishing during the fish-breeding season clearly indicate that the implementation and

monitoring of the rules and regulations are weak but also underlines the people's dependency on these wetland resources. Hence, improper management plans are other major drivers of deterioration of Kuttanad wetland. Meinzen-Dick and Bakker[15] argued that accommodation of stakeholders in participatory management of water system is important to enhance the productivity of the system. Instead of single use system, multiple use systems generate large benefits to the society and they accrue to different groups of people. Hence, a holistic and participatory action plan that connects the multiple benefits of the wetland should be undertaken, which would ultimately bring back the ecological balance in the area, thereby reducing the pressure on the wetlands. Direct drivers of ecosystem deterioration are sewage and water contamination, followed by unmanaged tourism and encroachment, invasive weed species and illegal agricultural farming. Adekola and Mitchell[1] also reported these reasons in their study in Niger Delta wetlands. There is an urgent need to plan participatory actions for sustainable management of the wetlands and reducing the direct pressures on the area. Promoting livelihood options which maintain the ecological balance of the wetlands and promoting ecotourism in the area might help reduce the direct pressures.

CONCLUSION

The study reveals that Kuttanad is a unique multiple-use, multiple-user wetland ecosystem providing various services mainly paddy farming, fishing, tourism and water for the local residents for their livelihoods. The major direct drivers of deterioration are sewage and water contamination, followed by unmanaged tourism and encroachment, invasive weed species and illegal agricultural farming. On the other hand, over-exploitation and improper management are the indirect drivers. A holistic and participatory action plan that connects the multiple sectors of the wetland is necessary to maintain the ecological balance of the wetlands as well as to reduce the pressure on the wetlands. Monetary valuation of the services provided by the ecosystem would also help to understand its importance and the need for its better management and conservation by highlighting the direct and indirect benefits of wetlands to the society.

Acknowledgment

The author whole-heartedly acknowledges the timely fellowship support provided by Department of Science and Technology: Innovation in Science Pursuit for Inspired Research (DST-INSPIRE) during the Ph.D. Programme.

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