Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

Vol. 9	No. 2	pp. 247-254	2010

Original Research Paper

Environmental Problems and Management Aspects of Vembanad Kol Wetlands in South West Coast of India

K. N. Remani, P. Jayakumar and T. K. Jalaja
Centre for Water Resources Development and Management, Kunnamangalam, Kozhikode-673 571, Kerala, India

Nat. Env. Poll. Tech.
ISSN: 0972-6268
Website: neptjournal.com

Key Words:
Vembanad Kol wetlands
Tropical estuary
Backwaters
Conservation and management

ABSTRACT

The Vembanad Kol wetlands, the largest tropical estuary in the southwest coast of India, identified as a Ramsar site, lies between 9°00' and 10°40' N latitude and 76°00' and 77°30' E longitude. The wetland system includes Vembanad backwaters, the lower reaches of six rivers with a drainage area of 16,200 km^2 and the adjoining low lying Kol lands spread over an area of 136.32 km^2. The system having all the values and attributes assigned to wetland such as fishery, waterfowl, mangroves, associated vegetation, agriculture, recreation, tourism and inland navigation is now found to be environmentally degraded. The ecology of the backwater system has become totally upset due to the construction of regulators, spillways, overexploitation of resources and uncontrolled urbanization. The paper reviews the general features, present status, problems faced by the wetland system and strategies for its conservation and management.

INTRODUCTION

Vembanad Kol wetland, the largest brackish humid tropical wetland ecosystem in Kerala State on the southwest coast of India is fed by ten rivers. The lake possesses unique physical characteristics in terms of physiography, climate and hydrology. The wetland is renowned for its rich biodiversity and supports the third largest water fowl population in India during winter. Overexploitation of resources and a range of interventions such as salinity barriers, flood water drains and industrial complexes in the drainage basins are found to have severe impact on the ecological status of the wetland leading to its degradation. Since it supports more than half of the population of Kerala, consequences of any destruction caused will be far reaching on the society. The present paper examines the major environmental problems caused by the developmental activities and hydrological interventions in Vembanad wetland and its vicinity. Important previous studies and survey reports were evaluated to develop the data set for preparing the management action plan. Waste management practices appropriate for the existing conditions of the region were considered for suggesting mitigation measures.

STUDY AREA

Characteristics of Vembanad wetland

Vembanad wetland, the largest estuary in the state of Kerala, lies between 09°00'-10° 40' N and 76° 00'-77°30' E (Fig. 1). The system possesses certain unique physical characteristics and covers an area of 16,200 km^2 with ten rivers draining into it (Table 1 and 2, Public Works Department 1974). The wetland also includes the Kol lands, the fertile low lying fields as the name implies, lying 0.5m to 1m below mean sea level, spread over an area of 136.32 km^2. Situated in the humid tropics, this

positive estuarine system with semidiurnal tidal cycle experiences fairly uniform temperature ranging from 21°C to 36°C. The average annual rainfall in the area is 3200 mm and salinity ranges from 10 to 22 ppt at surface during premonsoon.

Ecological Significance

Vembanad lake and the associated wetlands are exceptionally rich biological regions with high degree of endemism. A total of 150 species of fishes (Kurup & Samuel 1985) and commercially impor-

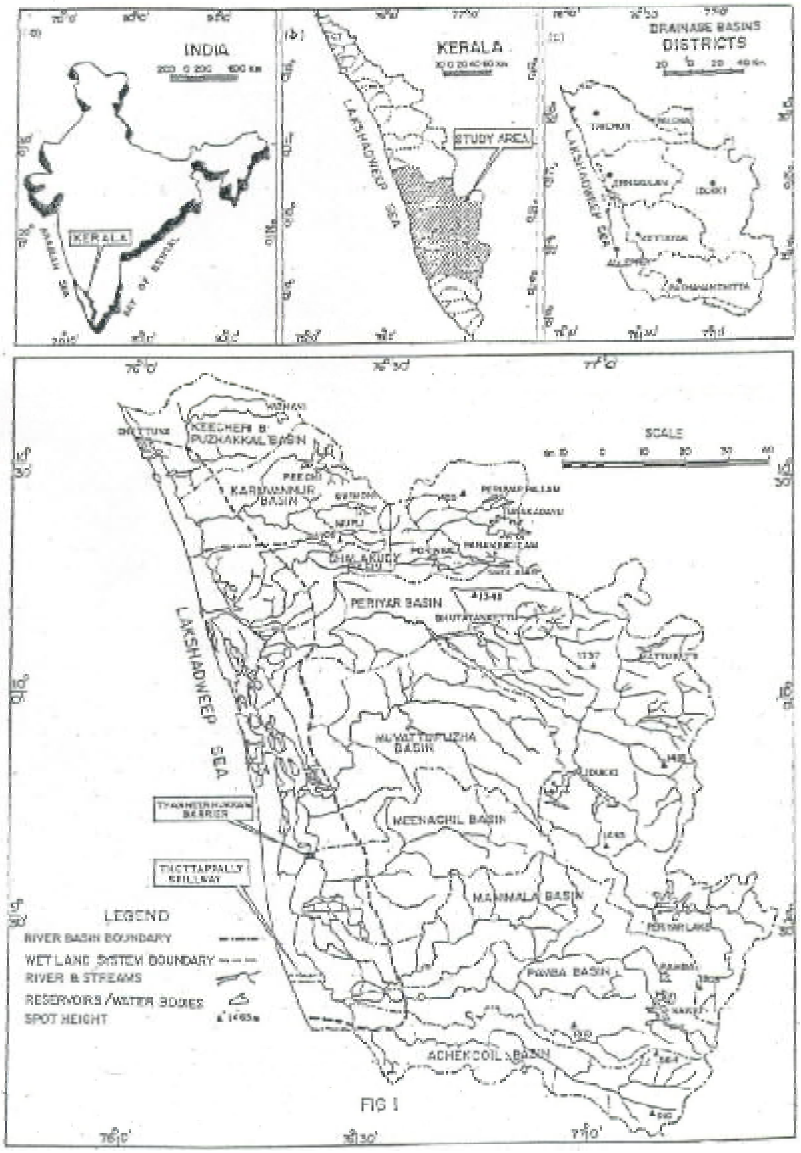

Fig. 1: Location map of Vembanad Kol wetlands.

tant marine prawns like *Penaeus indicus* and *Metapenaeus dobsoni* have been reported. The giant fresh water prawn *Macrobrachium rosenbergii* offers a lucrative fishery with a total production of 300-400 tonnes/yr. The wetland regularly supports a bird population of more than 20,000 during winter. The system also harbours several rare and endangered species of fishes and birds as given in Tables 3 and 4 (Vembanad Water Bird Count 2001, 2002, 2003). Mangrove species with associated fauna and flora, seen fringing the Vembanad lake, are *Avicennia officinalis, Rhizophora apiculata* and *Rhizophora mucronata.*

Economic Potential

The coastal wetlands comprise low lying regions, which is the deltaic formation of the rivers draining into the lake, called Kuttanad and the fertile kol lands which constitute about 24% of the paddy lands of the State. Retting of coconut husk in the wetland and production of coir is a major cottage industry predominant in the area. About 157 million coconut husks are retted every year in an area of 247 ha. Live clam collection is a major occupation of women and children and about 50 tonnes of clam shells are exported daily to different markets in the State. Annual fish landing is estimated to be about 746 tonnes. Tourism also generates revenue from house boat operation.

Major Interventions

Among the human interventions, the earliest one was the dredging of a natural harbour at Kochi and creation of a new island for harbouring port facilities. Subsequently, a spillway was built at Thottappally with a clear span of 304 m, to divert flood water from Vembanad lagoon into the sea. Yet another intervention is Thanneermukkam barrier constructed across Vembanad lake which is 1250 m long with 93 sluice gates each 12.2 m wide and 5.5 m high, to prevent salinity intrusion during dry seasons (Government of Kerala 1974, Government of Kerala 2002). Several minor spillway cum regulators were constructed in the Kol wetlands for controlling flood water and to prevent salinity intrusion. Interventions in the river basins of the wetland system include three completed irrigation projects and nine hydel projects.

Problems Encountered

Vembanad kol wetland system has undergone severe ecological backlashes. There has been progressive reduction in the depth of the lake due to excessive sedimentation. The total annual sediment yield from all rivers draining into the lake is estimated to be 32 million tonnes/year and the mean depth of the lake has been reduced from 6.7 m to 4.4 m and water carrying capacity to 0.6 km^3 from 2.4 km^3 (Padmakumar 2002).

Kuttanad and kol lands, the low lying regions along the lake are highly susceptible to floods. Thottapally spillway was constructed as a measure to prevent floods. But, due to structural limitations and changes made in the original design, the expected discharge of 19,500 m^3 could not be attained. Consequently, water level rises up to 2 m in the upper reaches of Kuttanad and by 5 m in kol lands during rainy season, destroying the crops. Further, the standing paddy crop is also damaged many a times due to the breaching of bunds of the approach channel to the spillway.

Due to improper maintenance and unscientific operation of the Thannermukkam regulator, saline water intrudes to several parts of the lake during premonsoon. The most appalling ecological outcome of the interventions is the disruption of the physical and biological continuity of the lake with coastal waters. This has resulted in the decline of fish production and species diversity of the

lake. The physical obstruction by Thannermukkam barrage has affected the lucrative commercial prawn fishery of *Macrobrachium rosenbergii*. The annual catch of the prawn during pre-barrage period was as high as 429 tonnes/year which has dwindled to 27 tonnes/year during 2000-2001 (Kurup et al. 1998). Indiscriminate exploitation of resources through unscientific methods like overfishing, use of banned gears, disruption of migratory grounds due to barriers, expansion for tourism and increasing pollution have contributed to the loss of biodiversity of the wetland.

The bird population has declined by 40% since 1993 and the migrant ducks from Siberia and Europe have ceased roosting in the lake (Vembanad Water Bird Count 2003). Another major problem encountered is the disappearance of the mangroves that fringed the estuarine shores. The existing 451 ha of mangrove forests are highly disturbed and appear in small patches. Reduction in the forest coverage in the catchment area has also resulted in excessive soil erosion and sedimentation (Forests Department 1992, Forests Department 1995).

Water quality in many parts of the lake has deteriorated. Nearly 260 million litres of trade effluents, containing hazardous pollutants like fluorides, mercury, chromium, sulphides and insecticides reach the lake daily from the industrial belt of Kerala. The level of organochlorine pesticides in the lake ranges from 12,000 to 22,000 ng/L (Kuttanad Water Balance Study 1989). Faecal coliform count up to 1800/100 mL has been reported in the lake. Coir retting also adds to the pollution due to release of enormous quantities of organic pollutants causing anoxic conditions.

The boom in the backwater tourism has accentuated the stress on the environment. Around 1,80,000 tourists visit the Vembanad wetland every year and 200 houseboats are operating in the lake. Wastes from the houseboats, resorts and hotels along the bank also reach the lake. Mangroves and trees are cleared off often for the development of tourism.

RESULTS AND DISCUSSION

In consideration of the present and anticipated problems the lake may encounter, the following management strategies are proposed.

Domestic wastes: The existing sewerage system in all cities and towns situated along the banks of the lake should be modified and their efficiency is to be enhanced to a great extent. The total volume of the urban sewage generated in the catchment area for the projected population of 2034 is given in Table 5. The sewage treatment plant in each of the above cases may adopt a treatment sequence consisting of bar screen, flotation unit with skimmer, clarifier, activated sludge unit with secondary clarifier and disinfection.

Estimates show that approximately 187 tonnes/day of solid wastes ultimately reach the lake. For the effective management of the solid wastes, municipal authorities should establish and maintain collection, transportation and treatment facilities. Biodegradable wastes should be processed by composting, vermicomposting, anaerobic digestion and biological processing. Nonbiodegradable wastes can be managed by adopting landfilling method.

Industrial Wastes: Industrial units discharging their effluent into the lake/rivers draining into the lake, may be directed to adopt waste treatment measures.

Regulation of coconut husk retting: The areas worst hit due to retting activity should be closed for a few years to allow their ecological restoration. Recently developed retting technology, which dispenses with natural retting process may be popularized.

Table 1: Physical characteristics of Vembanad Kol wetland system.

Sl. No.	Parameter	Value
1.	Geographic co-ordinates	9°00'-10°40' N latitude; 76°00'-77°30' E Longitude
2.	Drainage area	15769 km^2
3.	Average depth	4.4 m
4.	Elevation	0.6-2.2 m below MSL
5.	Total discharge into the lake	21900 Mm^3
6.	Average annual rainfall	3200 mm

Table 2: Rivers draining into Vembanad Kol wetland system.

Sl. No.	Name of river basin	Drainage area in km^2
1.	Keecheri	400
2.	Puzhakal	235
3.	Karuvannur	1054
4.	Chalakkudi	1404
5.	Periyar	5284
6.	Muvattupuzha	1554
7.	Meenachil	1272
8.	Manimala	847
9.	Pamba	2235
10	Achenkoil	1484

Table 3: Endangered species of fishes in Vembanad Kol wetland.

Sl.No.	Species Name	Family
1.	*Labeo dussumieri*	Cyprinidae
2.	*Horabagrus brachysoma*	Bagridae
3.	*Gonoproktopterus curmuca*	Cyprinidae
4.	*Wallago attu*	Siluridae
5.	*Nandus nandus*	Nandidae

Table 4: Endangered species of birds in Vembanad Kol wetland.

Sl.No.	Species Name	Family
1.	*Pelecanus philippensis* (Spot billed pelican)	Pelecanidae
2.	*Anhinga melanogaster* (Oriental darter)	Anhingidae
3.	*Gallicrex cinerea* (Water cock)	Rallidae
4.	*Gelochelidon nilotica* (Black billed tern)	Laridae

Table 5: Volume of sewage for the projected population of 2034.

Districts (Administrative unit)	Area in km^2	Population in 2001	Urban sewage generated (mld)	Projected population (2034)	Urban sewage generated (mld)
Ernakulam	94.88	1477085	138.6	2259503	203
Alappuzha	130.9	621457	71.5	1030566	92.75
Kottayam	53.7	299808	17.1	4942941	133

Table 6: Allocation of soil and water conservation measures.

Name of the River Basin	50% of the Total Catchment in ha	Pits & Trenches (25% of allocation)		Contour Bunds (25% of allocation)		Brushwood Check dam (5% of allocation)	Loose rock dam (5% of allocation)		Centrepetal Terraces (10% of allocation)		Vegetative Hedges			
											Pineapple (15% of allocation)		Fodder grass (15% of allocation)	
		Area in ha	Earth work in m^3($75m^3$/ha)	Area in ha	Earth work in m^3 ($75m^3$/ha)	No. of brushwood Check dam (1brush-wood dam/ha)	Area in ha	No. of Loose rock dams	Area in ha	Nos. (150 trees/ha)	Area in ha	Nos (150 sucker / ha)	Area in ha	Nos. (1000 cuttings/ ha)
Pamba	111750	27938	2095350	27938	2095350	5588	5588	5588	11175	1676250	16763	2514450	16763	16763000
Achenkovil	74200	18550	1391250	18550	1391250	3710	3710	3710	7420	1113000	11130	1669500	11130	11130000
Manimala	42350	10588	794063	10588	794063	2118	2118	2118	4235	635250	6353	952950	6353	6353000
Meenachil	63600	15900	1192500	15900	1192500	3180	3180	3180	6360	954000	9540	1431000	9540	9540000
Muvattupuzha	77700	19425	1456875	19425	1456875	3885	3885	3885	7770	1165500	11655	1748250	11655	11655000
Periyar	264200	66050	4953750	66050	4953750	13210	13210	13210	26420	3963000	39630	5944500	39630	39630000
Chalakkudy	70200	17550	1316250	17550	1316250	3510	3510	3510	7020	1053000	10530	1579500	10530	10530000
Karuvanur	52700	13175	988125	13175	988125	2635	2635	2635	5270	790500	7905	1185750	7905	7905000
Keecheri	20000	5000	375000	5000	375000	1000	1000	1000	2000	300000	3000	450000	3000	3000000
Puzhakkal	11750	2938	220350	2938	220350	588	588	588	1175	176250	1763	264450	1763	1763000

Management of fishery resources: Conservation of fishery resources can be achieved through ranching of endangered species in open waters and establishment of protected fish sanctuaries, observation of closed fishing seasons and regulation in the use of fishing gears.

Conservation of birds: Ecological reasons should be identified to determine the drastic reduction in the population of many groups of birds in the Vembanad kol wetlands. Suitable protected areas have to be identified for promoting natural recruitment.

Control of salinity intrusion: Studies should be conducted to demarcate the areas of salt water intrusion and their extent during various seasons. Water tightness of the Thanneermukkam barrier should be ensured during the period of closure of the shutters. Scientific operation policy of the barrier has to be implemented.

Flood control measures: A detailed evaluation of rainfall, river discharges, flood water extent and duration should be undertaken and structural limitations of Thottapally spillway has to be rectified.

Tourism: The houseboats must be provided with separate collection chamber for human excreta, plastics and solid wastes. The terminals should have facilities for treatment of such wastes.

Afforestation: Vast stretches of forests along the banks of the lake have been destroyed for developmental activities which has resulted in soil erosion and sedimentation. The total forest cover destroyed is estimated to be 1,54,000 ha. Since 75% of the area is already taken for developmental activities the rest 38,500 ha is proposed for afforestation with indigenous species like *Albizzia lebbek*, *Artocarpus* sp., *Careya arborea, Caryota urens, Cassia fistula,* C*innamomum zeyalinicum, Dysoxylum malabaricum, Erythroxylon monogynum* and *Eugenia* sp.

Conservation of mangroves: Afforestation of mangroves can be done in ecologically selected areas with species like *Avicennia officinalis, Rhizophora mucronata, Kandelia candel* and *Exocoecaria agallocha*.

Soil and water conservation: The soil and water conservation measures are proposed to be adopted in 50% of the total catchment area of 16,200 km^2. The standard norms and criteria of the Department of Agriculture of Kerala State are adopted for selection and allocation of the soil and water conservation measures (Department of Agriculture, Kerala 1990). The allocation for various soil and water conservation measures has been made as 25% each for pits-trenches and contour bunds, 5% each for brushwood check dams and loose rock dam, 10% for centripetal terraces, 15% each for vegetative hedges like pineapple and fodder grass (Table 6).

Monitoring and evaluation: It is proposed that the aspects like hydrological characteristics, water quality parameters and biodiversity components have to be monitored periodically to study the status of the lake and the ecosystem, so as to suggest corrective measures in the management action.

CONCLUSION

Due to human intervention and ever increasing pollution, the Vembanad lake and associated wetlands are facing an acute environmental and ecological crisis. Decline in fishery, avifauna, mangrove vegetation, degradation of water quality, floods, intensive sedimentation and decrease in the depth of the lake are the major impacts on the wetland system. It is imperative to take a holistic approach for the conservation and management of wetland system. The management strategies recommended for biodiversity conservation include bio-reserve for birds and fishes, and restoration and regeneration of forest and mangrove ecosystem. Controlling pollution from tourism related activities, improvement of water quality by solid and liquid waste management and adopting catchment area treatment

covering soil and water conservation measures should also be done for the effective management of the lake. Monitoring is also essential for evaluating the effectiveness of the measures adopted, based on which necessary changes have to be made in the action plan.

ACKNOWLEDGEMENT

The authors are indebted to KSCSTE for the financial support for the study and are also grateful to Executive Director, CWRDM, for the necessary guidance and help rendered.

REFERENCES

Department of Agriculture, Kerala (Soil and Water Conservation Unit) 1990. Techniques of Soil and Water Conservation Measures Adopted in Kerala. Department of Agriculture, Kerala.

Forest Statistics 1992. Department of Forests, Government of Kerala.

Forest Statistics 1995. Department of Forests, Government of Kerala.

Government of Kerala 1974. Kuttanad Development Project Report, Government of Kerala, Kerala.

Government of Kerala 2002. Report of the Technical Expert Committee on Operation of Thanneermukkom Barrier, Government of Kerala, Kerala.

Kurup, B.M. and Samuel, C.T. 1985. Fish and Fishery Resources of Vembanad Lake. Harvest and Post Harvest Technology of Fish, 77-82.

Kurup, B.M., Harikrishnan, M. and Sureshkumar, S. 1998. Population structure and yield characteristics of a prawn *Macrobrachium rosenbergii* reared in polders under monoculture system. Indian J. Marine Sc., 27: 396-401.

Kuttanad Water Balance Study 1989. Kingdom of the Netherlands, Ministry of Foreign Affairs and Republic of India, State of Kerala, Vol II, Annex C, 37.

Padmakumar, K.G., Anuradha Krishnan, Radhika, R., Manu, P.S. and Shiny, C.K. 2002. Open water fishery interventions in Kuttanad, Kerala with reference to fishery decline and ecosystem changes. Proc. Nat. Sem. Riverine & Reservoir Fisheries of India, Cochin, 15-24.

Public Works Department 1974. Water Resources of Kerala, Public Works Department, Government of Kerala.

Vembanad Water Bird Count 2001. Department of Forests and Wild Life, Govt. of Kerala, Kerala.

Vembanad Water Bird Count 2002. Department of Forests and Wild Life, Govt. of Kerala, Kerala.

Vembanad Water Bird Count 2003. Department of Forests and Wild Life, Govt. of Kerala, Kerala.