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Environmental challenges to the mangrove wetlands of North Malabar (Kerala), India: Their sustainable development and influence on local people

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ABSTRACT

Key-words: *wetlands, mangroves, ecosystem service value, environmental challenges, North Malabar*

Wetlands, including mangroves, perform several functions such as inundation control, and protection from erosion, storm, floods and tidal damage, and generate goods and products such as fish and forest resources. These functions are of fundamental importance for society. The present study aims to identify the challenges of the mangrove wetlands of north Malabar, their uses and socio-economic influence on local people, and the value of ecosystem services, and to suggest the way forward for sustainable development.

RÉSUMÉ

Les défis environnementaux dans les zones humides de mangrove au Nord-Malabar (Kerala) : le développement durable et son influence sur les populations

Mots-clés : *zones humides, mangrove, valeur des services écologiques, défi environnemental, Nord-Malabar*

Les zones humides, dont les mangroves, assurent plusieurs fonctions comme le contrôle des inondations, la protection contre l'érosion, les tempêtes, les inondations et les dommages dûs aux marées. Elles génèrent des biens et des produits comme les ressources piscicoles et forestières. Ces fonctions sont d'une importance essentielle pour la société. La présente étude identifie les problèmes des zones humides de mangrove du Nord-Malabar, les usages et leur influence socio-économique sur les populations locales, la valeur des services écologiques rendus et suggère des pistes pour un développement durable.

INTRODUCTION

Wetlands are a vital element in the biosphere and produce numerous benefits for society. They provide a critical nursery habitat for many species of fish and wildlife (Chakraborty and Naskar, 1988). By temporarily storing large quantities of water, wetlands play an important role in reducing flooding problems and recharging groundwater. They help to maintain water quality by filtering out pollutants and sediments, and serve to control erosion by trapping soil washed from nearby uplands. The high productivity of mangrove ecosystems means that they provide ample food supplies to maintain a complex food chain. They therefore provide

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Figure 1
Map showing the study areas in Kannur district, Kerala state, India.

Figure1
Carte présentant les sites étudiés dans la région de Kannur, état de Kerala, Inde.

fertile habitats and nursery grounds for many wild species of commercial importance, including shellfish and fish. Thus, the ecosystem service value is high. There are many challenges to mangrove wetlands, including anthropogenic ones. The mangrove forest found in the wetlands helps to prevent natural calamities such as Tsunami. In addition, wetlands are a source of recreation, timber and other natural products for commercial use (Khaleel, 2005a).

MATERIALS AND METHODS

> *STUDY AREAS*

Sample sites in Valapattanam, Vellikkeel and Kavvayi in North Malabar were selected for the study. Valapatanam is situated at 11° 57' N latitude and 75° 18' E longitude. It lies on the bank of Valapatanam river. Vellikkeel is situated at 12° 0' N and 75° 16' E. Kavvayi lies at 12° 5' N and 75° 13' E on the bank of Kavvayi kayal (Figure 1).

Valapatanam is rich in species diversity of mangroves (Khaleel, 2005b). The study aims to generate baseline data on the mangroves and wetlands of North Malabar and to review the pattern of resource use in the wetlands in terms of sustainable utilization of resources. This demands an inter-disciplinary approach with components of socio-economic, biodiversity,

and cartographic appraisal of the landscape units in different localities. Owing to this, the methods of investigation adopted in the present study range from household surveys, a review of the literature, foot surveys of biodiversity studies, and ecosystem value analysis. Data was collected through questionnaires and interviews with people from different walks of life – aged people, fisherman and other stakeholders. A detailed survey was conducted to obtain data regarding products, cost of labor, etc. Samples were collected for taxonomical studies. The method of Costanza *et al*. (1997) was followed to determine the ecosystem service value (ESV). The essence of the ecosystem value approach is to estimate values as subtractions from or additions to income that leave people equally economically satisfied with or without a change in the services provided by the mangrove ecosystem. Challenges and suggestions for sustainable developments are listed from the data.

A household survey as part of assessing the importance of wetland-related activities in the occupational pattern of the area was conducted in 50 randomly selected houses belonging to the three Panchayaths (provinces). Criteria used for selection were: proximity to the backwaters, type of soil (whether representing typical wetland alluvium, sand or silt), geomorphic features and features of vegetation of wetlands. Details of occupation, social and organizational affiliations, basic amenities, access to the basic resources, and the preferred mode of developmental input and participation of individuals in the people's movement were collected.

RESULTS AND DISCUSSION

The extent of mangrove forest in North Malabar from Calicut to Kasaragod Districts is 3750 ha. Kannur District has the major share of it. A large number of plants and animals depend on mangrove wetlands as their habitat. The mangrove wetlands of North Malabar contain 14 true mangrove species and 40 mangrove associates. The population of birds in the mangrove wetlands is 109 species, of which 34 are migratory. There are 16 species of fishes in the wetlands. The mangrove wetlands have strong linkages with the coastal environment and agriculture and are considered important areas for sustenance of the coastal communities. The stability of the functioning of these ecosystems depends on climate stability and coastal processes. Even a minor change in the global temperature and climate of the area would have a major bearing on the coastal wetlands and also on land- and water-based activities in the region. Most of the true mangroves are medicinally and economically important. Coastal communities are involved in *Kaipad* (salt wetland) cultivation, fishing, shrimp farming, clam collection, crab collection, etc. The percentage of benefit of stakeholders from the mangrove wetlands is given in Figure 2.

> *ECOSYSTEM SERVICE VALUE*

Global wetlands are called "the nursery of much life" because they are one of the most valuable resources for life on earth. They are the source of nutrition and habitation for many species. Wetlands are the world's most productive acres for nutrition in the food web, and are particularly efficient converters of solar energy. The plants present in the wetlands convert sunlight into plant material and produce oxygen as a by-product. This production is an integral part of the interdependent system of a food web.

The benefits of wetlands are many and generally recognized to include: (1) ecosystem function; (2) fish and shellfish habitat; (3) waterfowl and other birds' habitat; (4) wildlife habitat; (5) pollution filtration; (6) protection against Tsunami; (7) heavy metal removal; (8) oxygen production; (9) nutrient production and recycling; (10) chemical pollution absorption; (11) aquatic production; (12) microclimate regulation; (13) world climate (ozone layer) regulation; (14) flood control; (15) wave damage protection; (16) erosion control; (17) groundwater and recharge supply; (18) energy source; (19) livestock grazing; (20) fishing; (21) fertilizer industry; (22) hunting and trapping; (23) recreation; (24) preservation

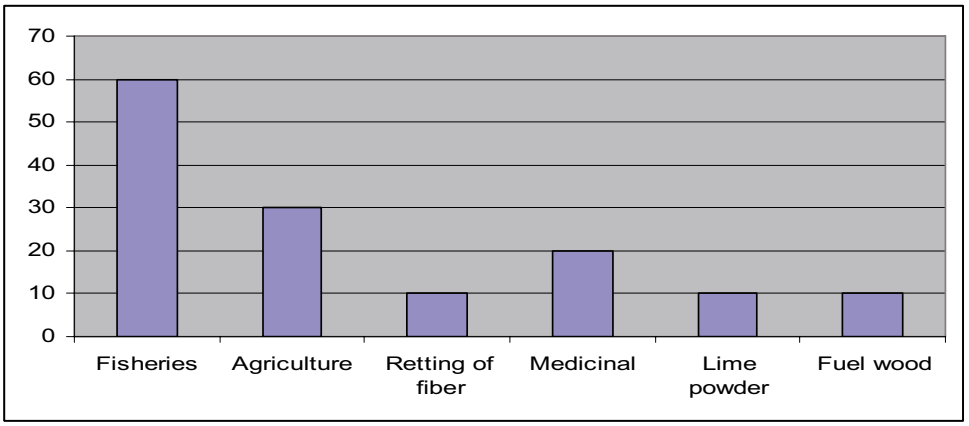

Figure2
The percent benefit of stakeholders from mangrove wetlands.

Figure 2
Répartition en pourcentage des bénéfices pour chaque partie prenante dans les zones humides de mangrove.

of the genetic inventory; (25) aesthetics, and (26) scientific research (Zhao *et al*., 2004). From this list of areas that wetlands affect, it is no wonder that global wetlands play a vital role in the earth's ecosystem.

By analyzing all the factors related to the ecosystem, the service value is calculated (Table I) as per the method of Costanza *et al*. (1997). As North Malabar has a total of 3750 ha of mangrove wetlands, the ecosystem service value per year can be calculated as 10 960 x 3750 = 41 100 000 US $. Approximately, it is equal to Rs. 164 crores and 40 lakhs.

> CHALLENGES TO MANGROVE WETLANDS

The challenges to mangrove wetlands are: (1) mangrove ecosystems have been exploited by a wide range of human activities and many livelihoods and local economies are strongly dependent upon access to mangrove resources. (2) Wetland reclamation is often carried out illegally due to the shortage of land in and around cities, which increases the risk of urban encroachment and squatting in marginal mangrove areas. (3) Mangroves may also be reduced by actions ranging from the construction of water-based recreational or residential facilities, such as canal estates, to the conversion of natural ponds for aquaculture. (4) In addition, mangrove areas are also lost through indirect actions, often carried out upstream in a catchment area, which impact on the quantity or quality of water supply to the site.

> SOCIO-ECONOMIC INFLUENCE ON LOCAL PEOPLE

The Kannur District has a population of 24 08 956. The population of Kunhimangalam is 17 279 and that of Cherukunnu is 16 246. Sample studies were carried out in different regions of the three places of study. Sample analysis was done on 1200 people, of whom 590 were males and 610 females. Out of a total of 760 earning individuals, 400 were males and 360 were females.

There are about 60 people who own the land in the Valapatanam area. Valapatanam covers about 67.71 ha of Pappinissery Panchayath. A part of the marshland was under cultivation until a decade ago. Increase in salinity, land reclamation and profit loss are the main reasons for giving up cultivation. The stakeholders of this area can now be classified into:

a. Fishermen
b. Those involved in shell mining and processing

Table I
Ecosystem service values of mangrove wetlands (in US $·ha^{-1}·year^{-1}).

Tableau I
Valeurs des services rendus par l'écosystème des zones humides de mangrove (en US $·ha^{-1}·an^{-1}).

Services	Value
1. Ecosystem function in terms of dry matter·ha^{-1}·year^{-1}	–150
2. Fish and shellfish habitat	–2000
3. Waterfowl and other birds' habitat	–1200
4. Wildlife habitat	–1000
5. Pollution filtration	260
6. Protection against Tsunami and wave damage	–1500
7. Heavy metal removal	–100
8. Oxygen production (20 kg·ha^{-1})	–40
9. Nutrient production and recycling	–450
10. Chemical pollution absorption	–300
11. Aquatic production	–350
12. Microclimate regulation	–800
13. World climate regulation	–100
14. Flood control	–600
15. Erosion control	–800
16. Groundwater and recharge supply	–60
17. Energy source	–80
18. Livestock grazing	–30
19. Fishing	–90
20. Fertilizer industry	–50
21. Recreation and aesthetics	–500
22. Preservation of gene pool	–200
23. Scientific research	–100
Total	–10 960

c. Coir retting workers
d. Sand miners
e. Ferry service
f. Crab catchers.

a. Fishermen

There are about one hundred fishermen in the Valapatanam area. Rented boats are used for fishing. Two persons use a single boat. Rent for the boats varies from Rs. 300–400 for one month. The best season for fishing is December to June. Each fisherman can earn about

Rs. 50 to 100 per day. A trap called a *pedal,* which is made of ribs of the leaves of coconut palm, is also used for fishing. It is mainly women who use these traps in shallow areas. Women make small mud enclosures in the shallow areas, and use the traps during ebbs to trap shrimps by rolling the *pedal* in an operation called *therekkal.* Some old fishermen revealed the above-mentioned facts. According to these fishermen, destruction of mangroves has reduced the availability of fishes considerably. The season for prawn catching is from December to June. The price of the prawn varies from Rs. 80–150 per kg. The prawn catching sites are auctioned by the *Panchayath*.

b. Those involved in clam collection, and shell mining and processing

More than 80 families are involved in this. *Elembakka* (clam – *Meretrix casta*) are collected from the wetlands near to mangroves. One *paatta* (tin containing 5 kg) costs Rs. 20. Clam mining is done from January to June. There is good demand for clams, and they are transported to Kasaragod and Karnataka. One can mine 30 tins a day. Two people use one boat. '*Uchuli*' or the shells of clams are collected by traveling in boats. Rs. 40 per day is paid as rent for the boat. Working hours are in the morning from 6–10 a.m. Shells can be mined throughout the year. They get a price of Rs. 20 per tin containing 20 kg shells. There is a choolah (boiler) owned by a family in Madakkara where the shells are made into lime powder. Mavoor rayon factory uses large amounts of shells for the treatment of industrial waste. Lime powder is used for whitewashing the houses. Some local people explained the details.

c. Coir retting workers

Coir retting is small-scale work in the Valapatanam area. The wetland is auctioned for lease for retting purposes. About 5 acres of land near Valapatanam bridge are now used. Mangroves are destroyed to a limited extent to prepare the land for retting of coconut husks. A worker gets Rs. 80–150 per day. The owner sends the fiber to coir factories and fiber bed industries. The launch of synthetic fibers and machine operated retting has reduced the demand for traditional fibers. Some people who live in this area were interviewed to obtain the details.

d. Sand miners

Sand mining causes destruction of the river bed of Valapatanam. It causes landslide and leaching out of well water from the adjoining land. Still, about 30 people are involved in sand mining activities. The *Panchayath* provides licenses to mine the sand by collecting a fee for it. Sand is mined mainly from the thuruth (small island), bridge area, Pappinissery and Madakkara. One boat of sand costs Rs. 40/-. About 20 loads are collected each day. The sand is transferred to a lorry waiting at the river bank at the bridge area. One worker can earn Rs. 3000 per month after deducting the boat rent.

e. Ferry services

In some places ferry services are conducted for transport from one bank of the river to the other. The *Panchayath* gives permission for ferry services by levying a fee. The service is available from 6 a.m. to 7 p.m. The usual ferry charge is Rs. 2.50 per head. There may be 12–20 people traveling in a boat. Average daily income is around Rs. 300.

f. Crab catchers

Ring nets tied with chicken legs are used for crab (*Scylla serrata*) catching. The season for crab catching is from December to May. The crab catchers get a good catch at night.

Rented canoes for Rs. 400 per month are used for this purpose. Currently, about nine small boats are involved in crab catching. Two persons go in a boat. Three to four crabs are caught in a ring net. A good catch is available during high tide. The price of the crab varies according to its size. 'Neelakkalan' is the large-sized one which costs Rs. 200·kg^{-1}. The ordinary type will cost Rs. 30·kg^{-1}. Each boat can catch 3–10 kg in a day. Each fisherman can earn Rs. 1000 to 2500 in a month. The best catch is available near the mangrove area.

> WETLAND MANAGEMENT

There is clearly a need to utilize wetland and mangrove resources on a sustainable basis, to reduce the levels of conversion to other land uses, and declare certain mangrove areas, especially those with pristine resources, as conservation and preservation zones (Blasco, 1977). These general objectives of resource conservation and mangrove land allocation should be properly spelt out in mangrove development plans to sustain the benefits of the resource over a long period of time and for a greater number of people.

The wetland ecosystem is a complex and open ecosystem. It is composed of various interrelated elements in the land/sea interface zone and is further intertwined with other natural systems in the coastal zone such as corals, sea grasses, coastal fisheries and beach vegetation (Finlayson and Moser, 1991). It is imperative, therefore, that wetland management should be pursued in an integrated manner and not in isolation from other sectoral developmental objectives; for example, fisheries, the coastal zone, forestry and other national, regional and site-specific development objectives. This approach should result in optimal multi-purpose or multiple uses of mangrove resources that can be sustained over time without degrading the ecosystem.

> SUGGESTIONS FOR SUSTAINABLE DEVELOPMENT

In each of the study areas people depend on mangrove wetlands for fishing, clam collection, crab collection, natural shrimp farming, retting of coir fiber, medicinal plants, fodder and many other uses. A participatory management strategy is suggested to get maximum benefit by conserving the wetland. The results show that mangrove wetlands form a highly valuable ecosystem. There is clearly a need to utilize wetland and mangrove resources on a sustainable basis, to reduce the levels of conversion to other land uses, and declare certain mangrove areas, especially those with pristine resources, as conservation and preservation zones. These general objectives of resource conservation and mangrove land allocation should be properly spelt out in mangrove development plans to sustain the benefits of the resource over a long period of time and for a greater number of people. The following suggestions may be adopted for management of the mangrove wetlands of north Malabar:

(1) Coastal structure in the proximity of mangrove areas should be designed in such a manner as to avoid excess sedimentation or erosion. Upstream structures should be made keeping in mind that landslide in the catchment area, construction of dams, etc., may be hazardous to mangroves by causing decrease or total stoppage of fresh water inputs or by burying the mangrove seedlings under excess silt. The hydrographic and topographic patterns should not be altered while planning strategies for marine or brackish water cultures: if manipulations must be carried out, care should be taken to ensure continuity of tidal flushing and to avoid stagnancy of water.

(2) Mangroves are highly productive and function as nurseries or feeding grounds for a variety of marine life. Therefore, preserve the undisturbed virgin areas and avoid dumping dredged material, sewage and industrial wastes there.

(3) An inventory should be taken of the resources that can be made available locally and an assessment should be made of their optimum potential output. A continuous monitoring of the ecosystems' reaction to the extraction of forest and fishery products should be maintained since the pace of regeneration rates of the ecosystem varies with season, site and biotic influences.

(4) Non-destructive aquaculture practices should be encouraged such as small sea level or above sea level ponds for agri-aquaculture, keeping mangroves intact. Locate aquaculture ponds behind or landwards from the mangroves, rather than inside them. Sylvi-aquacultural practices are the most sound types of exploitation and management of resources.

(5) The jetties and small residential houses should be constructed on stilts without damaging the forest.

(6) Extraction processes for timber and other products should not be damaging to the ecosystem.

(7) Only partial extraction or clear extraction in parallel alternate rows leaving behind the saplings for regeneration should be adopted on a large scale.

(8) Replanting of plant species should be done wherever on the sites the natural regrowth is insufficient.

(9) Ecotourism can be promoted to provide job opportunities for local people without disturbing the ecosystem.

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