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Mangroves and fisheries – Management strategies

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Introduction

Mangroves form an integral part of the estuarine and coastal lagoon systems. It is a life support system, an open system interacting with other ecosystems. World wide, mangroves occupy about 171,000 Km^2 yielding about one million tonnes of finfish and shellfish in subsistence capture and captive fisheries. This excludes the mangrove dependent component in the coastal capture fisheries and the aquaculture production from mangrove areas. The area under coverage of pond aquaculture for shrimp and milkish in South East Asia is estimated to be around 0.5 million ha and a sizable part of this lies in the mangrove or mangrove degraded areas. Aquaculture production from such areas from tidal-fed ponds is generally low accounting for much less than 1000 kg/ha/annum of fisheries and shrimp. Where pump-fed systems with supplemental feed have been introduced for the more efficient management of water quality and growth of the stock higher production have been achieved.

In India we have yet to precisely estimate the extent of mangrove areas, the areas already degraded, and areas converted for alternate uses such as for agriculture, salt production and other industrial uses. Besides such uses, in the Sunderbans of West Bengal, large areas have gone for urban development, leaving today hardly 418,888 ha of mangroves (Sidhu, 1963). Andhra Pradesh is no way better, as vast areas of coastal and estuarine mangroves have been clearfelled and extensive tracts recently given for salt production. An example of mangroves being almost completely replaced by other systems is seen in Kerala, in the Ernakulam district and adjacent areas bordering the Vembanad lake. Most of this area has been converted into coconut plantation, paddy cultivation and used for human settlement. Yet in places where human interference is not there, recolonization of mangrove takes place as can be seen from the patchy occurrence along some stretches of the Cochin backwaters. When accretion along the coast takes place colonization by mangrove is rapid. A good example is the extensive tracts north of Cochin harbour in Vypeen Island.

Biologically and economically, one of the most important aspects of man-mangrove interaction is the mangrove dependent or associated capture and captive fisheries and aquaculture. Hitherto in India, we have no proper evaluation of this, though the mangrove ecosystem as a nursery ground, or feeding ground, or spawning area for some of the inshore fishes, crustaceans and other invertebrates is well recognised. Multiple uses of mangroves have been identified, but what we perhaps lack is proper management for maintaining sustainable yields. If the destruction of mangrove for salt production is considered destructive, so also is the degradation of mangrove for pond aquaculture. Hence the imperative need for the proper seting of ponds for aquaculture in such areas to minimise damage

With this brief background I would like to touch on some of the important management issues and strategies concerning Mangrove ecosystems and Fisheries.

Management issues and strategies

We are considering the mangrove as an open system interrelated and interacting with other systems. In the Sunderbans, we find that there is considerable scope for the better and more effective management of the forests, land, water and aquatic resources. The situation in the Sunderbans may have some relevance to the mangrove associated lagoons and backwaters in other parts of the country, and at the same time, there may be some location specific problems. It is proposed to discuss here the issues and options open to us to upgrade and enhance the different linkages and integrate activities to achieve maximum output for a minimal input.

Survey of mangrove areas *versus* planning

An urgent and major effort is necessary to carry out precise surveys of the mangrove areas in the country. The information hitherto available is grossly incomplete. Land based, as well as remote sensing surveys combined with satellite imageries, are necessary for a rapid and precise update. The rate at which mangrove forests have been, and are being, degraded and cleared for other uses, and the amount of erosion and accretion with new areas being colonised by mangrove, necessitates periodic monitoring. The surveys may also enable better site selection for aquaculture development

based on dependable parameters of land truth and remote sensing data to avoid arbitrary allocations.

As for planning it is imperative that this be of a comprehensive nature involving the entire watershed and river basin, the coastal zone, the island – lagoon ecosystems, and mangrove – sea grass ecosystems. Better coordination through communication is necessary for developing an effective management system. Some flexibility to accommodate new information and technologies should be built into such a management system. We have the National Mangrove Committee constituted by the Department of Environment and Forest Government of India, which has to play a nodal role. Support to fisheries and aquaculture as compatible and sustainable activities in the mangroves as much as wild life and forestry, or even of greater value, need recognition. The Committee should help in enunciating public policy and develop guidelines for user activities such as fisheries and aquaculture in the mangrove ecosystem.

Mangrove and associated estuary/lagoon as a nursery ground

These act as sanctuaries for the life history migrations of several marine species of finfishes and crustaceans through larval ingress and growth, returning to the sea for spawning. They are also areas where some species migrate to spawn. The areas also support fortuitous distribution as well as diel and seasonal ingress of species from the inshore waters, besides harbouring a rich resident population of aquatic organisms. The mangrove ecosystem eventually provides an excellent supply of organic detrital matter as food. Such an abundance of particulate organic matter so important for life history stages of crustaceans, finfishes and filter feeders makes the ecosystem an excellent nursery ground and helps enhance recruitment to the neritic population of the concerned species. The problem is how best this could be maintained or the habitat improved to sustain a steady recruitment to inshore capture fisheries. It is imperative that Environment Impact Assessments and evaluations should become a part of any development in the area. Factors that affect the growth stages such as an increase in fishing pressure for juveniles, use of destructive gears and detructive methods of prawn and fish seed collection for captive fisheries and aquaculture with very high percentage of discards, are matters which could be easily regualted or stopped. Water quality monitoring and management will form part of maintenance of the nursery ground. In fact, an alternate strategy will be to have cheaper hatchery produced finfish and prawn seed, to dispense with collection from the wild, and go one step further and attmept ranching by releasing hatchery produced seed into the estuary to grow and emigartae to the inshore fishing grounds to enhance production in that sector as well.

Percentage of mangrove area to be considered for aquaculture development

In the light of large scale deforestation and degradation of mangrove areas, and present and future development plans for further in roads into the mangrove ecosystem along our coastal belt, it is felt that priority should be given to considering what fraction of the mangrove forests or associated lagoons/ estuarine area should be developed for aquaculture. The problem is highly debatable. A pointer could perhaps be taken from Malaysia which has developed guidelines permitting 20 per cent of mangrove areas to be developed for aquaculture. This figure by itself is admittedly arbitrary, but drives in the fact that hastily clearing and excavating vast areas of mangrove in the name of aquaculture is not what is to be done.

It is imperative that mangrove along the banks and embankments of rivers, creeks and canals be left undisturbed. In any area allocation, it will have to be decided whether clearfelling should be limited to only 20, 30, 40 or 50 per cent of the land; whether the mangrove should be left as fringe vegetation, or in reasonably broad strips or in any other manner. We have no standard, and the matter needs technical study. Suffice it to say that under no circumstance should hundreds of hectares of mangrove forests be cleared and made barren land for aquaculture as is being done in the Sunderbans, and Andhra Pradesh.

Determination of right size of fish pond

This is again a problem in a mangrove tidal or pump-fed system. In India, this has a bearing on economic viability as well, since smaller ponds of quarter or half hectares are being developed singly or in clusters to be handed over to marginal farmers and landless labour. The situation may differ from place to place depending on the cost of bunds, sluices, productivity, tidal amplitude and the many inputs such as seed and feed that go into the system. Excessive fragmentation which may give marginal returns immediately may eventually face many problems of management – availability of quality water, seed fertility of soil, recurring cost of maintenance and so on. Arbitrary planning may lead eventually to reclamation of pond for other uses including human settlement.

Management of acid sulphate soils

It is estimated that about 3,90,000 ha are affected by acid sulphate soils in India and the area could increase with poor or bad soil management. Large areas of brackishwater mangrove tidal swamp areas are characterised by such soil. Little attention has been paid to this and related aspects in our planning aquaculture development in magrove areas. A critical analysis would show that this is one of the important factors for abandoning of older brackishwater aquaculture farms in some areas in the Philippines and the still extensive systems of aquaculture practised in the brackishwater culture systems in degraded mangrove areas in the Philippines and Indonesia (Tampak sari system). The pokkali fields bordering the Cochin backwaters is yet another good example of low production due to acid sulphate soils. This condition further leads to the occurrence of 'soft prawns' in such ponds which often results in total mortality of the stock.

Procedures for reclamation and management of such soils in brackishwater fish ponds by liming and repetitive flushing and so on are available (Brinkman and Singh 1982, Singh 1982). In siting aquaculture farms in mangrove areas, this will be an important constraint but may be overcome by not excavating the pond deep and exposing the pyrite-bearing soils, and improved design and water management practices. The prospective fish farmer should be made aware of this and the package of practices that may be adopted. In fact, pump-fed system of ponds sited at higher elevations bordering mangrove areas may yield better production as better management practices can be used.

Mangrove research

While dedicated research is going on at some centres, the *in toto* research on mangroves is disjunct and needs greater coordination. A critique of what has been achieved, the gaps, and what needs to be done priority-wise for the different sectors of mangrove ecosystem, is lacking. In evaluating the fisheries, it is necessary to identify the mangrove dependent *versus* mangrove independent species and their respective roles. There are a whole array of scientific problems that could be listed as needing priority attention. The magnitude of the problems are such that many are inter-disciplinary and need inter-organizational programmes of basic and applied nature. Research could also be aimed at the sustainable uses of mangrove areas; reforestation of denuded areas where the benefits could be more than other uses, and determine the ecological value of mangrove resources. Some of the special problems relating to mangroves and fisheries (capture) and mangrove and aquaculture (captive and culture) have already been touched on. All are interlinked and an integrated approach is called for. From the standpoint of aquaculture, it is obligatory on the part of the research institutes to develop technologies for semi-intensive and inctensive culture of prawns and fin-fishes.

Adoption of semi – intensive aquaculture to reduce pressure on mangrove areas

At present we are practicing brackishwater aquaculture on an extensive systen where production levels are low parallel to what agriculture passed through before the introduction of high yielding varieties. The present system evisages greater unit area for production which can be substantially reduced if semi-intensive and intensive systems are adopted. In our situation of extensive brackishwater aquaculture, the production of finfish and prawns is still far below 1000 kg/ha/annum (Sunderbans from Bheris about 450 kg/ha/year, Kerala Pokkali fields about 600 kg/ha/year). In view of this, we may consider semi-intensive cultures to have production levels between 1000 kg - 5000/ha/annum and intensive culture plus 5000 kg/ha/annum. It is bound to take a long time before semi-intensive culture technology is widely adopted. Major constraints now are seed, feed, the health of the stock, and technology for sustained production.

The strategy would be to make it obligatory where large commercial farms are allotted land in mangrove and mangrove associated areas, that they should go in for semi-intensive levels of culture so that area allocation could be limited.

Economic evaluation and cost benefit anlaysis of subsistence activities and upgrading the same

It is extremely important that a proper economic evaluation of all subsistence activities in mangrove areas be undertaken with a view to see how best such activities could be enhanced to give better economic returns, without imparing the ecosystem. In addition such an evaluation, combined with our ecological evaluation would help in decision making on whether the subsistence activities are giving equal or better results.

Improved technological and financial inputs may be introduced to give better economic returns. For instance, activities not directly affecting the mangroves e.g. cage culture of fish and crustaceans; raft culture for bivlaves, oyser culture and so on, could be

introduced to enhance the subsistence activities. There is need for R & D inputs here. This approach is of considerable importance in places such as the Sunderbans.

"No mangrove, no prawns"

The right traditional of fishermen in subsistence activities should be respected. At the same time, an economic evaluation of various activities should help to clearly identify non-sustainable uses which could be limited or phased out. The restoration of degraded or destroyed mangrove areas which could be beneficial to fisheries and aquaculture should be taken up. in areas of accretion. Penaeid prawns-mangrove/backwater area linkage may have, broadly speaking, three types of interactions. All penaeid species do not need an estuarine phase for growth (e.g. *Parapenaeopsis stylifera*). Species of *Metapenaeus* spend part of the life cycle in the backwaters and adults are caught from the same area or from the adjacent inshore waters. In Cochin, Kerala, *Metapenaeus dobsoni* had been dominating the catch until excessive pressure from stake nets using small mesh, and the prawn filtration activities have overfished this resource in the backwater phase resulting in a steep fall in the inshore fishery for the species. Surprisingly, *P. stylifera* has now become a dominant element in the catch off Cochin, thereby still maintaining stability in overall production of prawns. The case of *P. indicus* and *P. monodon* are different. *P. indicus* may form anywhere from 7 to 15 per cent of the catch from Cochin prawn grounds, and *P. monodon* hardly one per cent or less. *P. indicus* has a predominant juvenile fihery off Cochin, and adults are caught from as-far away as 200 to 400 km as evidenced from tagging experiments. Thus in the management of prawn stocks associated with the mangrove ecosystems, caution and care have to be taken on what species to be monitored and for waht purpose. It is quite evident that some are mangrove dependent (*Penaeus indicus, P. monodon, Metapenaeus dobsoni, M. afflnis, M. monoceros*) whiley others, such as *Parapenaeopsis stylifera*, are non-dependent on the mangrove and associated estuarine and lagoon ecosystems. *P. indicus* and *P. monodon* are mangrove dependent, but have long distance migrating propensities, where adults are fished far away from non-mangrove coasts as in the case of *P. indicus*. Management of resources of such species will need a different approach than for categories I or III.

Mangrove and bisophere concept

The biosphere concept has been well recognised in India and a number of sanctuaries, national parks, and reserves have been created in the country. Some of these cover mangrove areas and form a source of added protection to the ecosystem. The more important along the coast are:

(i) In the Sunderbans we have the "Project Tiger" for *Panthera tigris* and its habitat started in 1974, and covering an area of about 200 sq. km. bordering Hooghly Muriganga, Saptamukhi, Thakuran, Goshaba, Vidya, Matlah and Hasinbhanga. The Tiger population has increased in the reserve area and this by itself is a source of protection to the habitat.

(ii) In Bhitarkanika mangrove in Orissa, a successful state run marsh crocodile farm (for *Crocodilusprosus*) has statred releasing farm reared crocodiles into the water – ways of the Sanctuary area. Subsistence activities such as fishing is in vogue in peripheral areas. The increase in crocodile population *verses* other activities need study in this dense mangrove sanctuary.

(iii) Bhitarkanika sanctuary also borders the *Gahirmatha* bench which witnesses the worlds largest arribada (aggregation of nesting sea turtles) of the olive ridley *Lepidochelys livacea* with as many as 200 000 to 300 000 famales nesting at night over a period of 5 to 10 days in a 10 km stretch of beach. The protection of this and adjacent areas along the coast has helped to protect the mangrove forests in this part of Orissa, which otherwise has witnessed large-scale degradation.

(iv) Some of the most vulnerable mangrove areas are in the East and West Godavari Districts and the Krishna District, where large scale degradation is underway.

(v) The Pichavaram mangrove area in Tamilnadu is protected but tourism is making inroads.

The idea of drawing attention to a few of these instances along the east coast of India is to show that sanctuaries, reserves, and parks also have a major role to play in the preservation of plant and animal genetic resoruces and help in habitat maintenance and upgradation. This may, no doubt, enhance mangrove-fisheries linkage and help maintain relatively undisturbed areas to augment recruitment of some species to the inshore fisheries. Thus in the overall mangorce management picture, these conservation measures have an important role to play.

In concluding I would like to stress that an economic evaluation should be made of past human interference in mangrove areas, whether it be for agriculture, industrial development, engineering works, or tourism and the like, atleast in selected areas to see whether if mistakes have been committed, they should be repeated. Compatible and sustainable activities are what we have to look for.