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# **ENVIRONMENTAL AND SOCIAL ISSUES IN COASTAL AQUACULTURE**

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## **1. Introduction**

Aquaculture has grown rapidly in the recent years and has promise for further potential growth. This rapid expansion was possibly because of the growing demand for aquatic products and the failure of the global capture fishery, which has been exploited, to or beyond its potential. When the global catch statistics remains standstill between 80-100 million metric tons per year, the global aquaculture production is registering an overwhelming annual growth of 8-14% producing between 20-25 million tons per year. Of the aquaculture practices, coastal shrimp farming has registered the maximum growth of about 400% in the last decade. The two factors resulting to its boom were the increasing demand for Indian shrimp and the improved farming techniques

Traditional aquaculture has a long history in the Indian states of West Bengal, Kerala, and Karnataka. In the lands adjoining the sea, rice is cultivated for several months and shrimp and some species of fish for the rest of year. The two types of cultivation complemented each other, bringing yields to both farming and fishing communities. The same cannot be said for modern shrimp aquaculture, which was introduced into India only in the last four or five years and is having serious environmental and social consequences in Andhra Pradesh and Tamilnadu, where 77,000 hectares are already under shrimp cultivation. It is estimated that country has a potential 1.4 million hectares that are suitable for brackish water aquaculture however, aquaculture is coming of age at a time of increased ecological awareness and environmental activism. Ecological concern and better environmental management are very much important to ensure mankind's survival in this overcrowded planet. Actually ecological conditions are also necessary for the culture of aquatic organisms and it is the self-interest of aquaculture to protect the surrounding environment. Nevertheless, this tremendous boom of aquaculture weathered instances of ecological damages. Hence, the need of the hour is the practice of ecologically responsible and sustainable aquaculture.

## **Impacts of Coastal Aquaculture**

Some forms of coastal and inland aquaculture have imposed costs on the environment, on fish and human health, and on biodiversity. Intensive farming in ponds, pens, or cages produces organic matter that settles to the bottom of the pond or pen, or below the cages. Some of the suspended waste matter from excessive artificial feeding, fish excreta, and the application of chemicals is flushed out of the enclosures and pollutes adjacent waterways. The aquaculture subsector itself has suffered from such pollution. The decline

of intensive shrimp farming in Taipei, China, has been attributed to massive mortality from the reuse of polluted water discharged from ponds. Intensive shrimp farming has also had significant negative environmental impacts in PRC, India, Indonesia, Thailand, and Vietnam. In some instances, aquaculture has affected biodiversity through competition between indigenous species and introduced species that have escaped into the wild and produced self-sustaining populations. Legislation may be necessary to regulate the disposal of aquaculture wastes and thereby contain pollution from aquaculture. Environmentally sound technologies for more intensive aquaculture need to be developed and popularized into sound farm management practices. The challenge is to ensure that aquaculture development is integrated into social and environmental systems, in balance with other existing or potential users of common resources.

### **A. Environmental Impact**

Aquaculture, which is often regarded as the 'under water agriculture', has been accused of causing many negative environmental and social impacts. Destruction of wet lands, mangrove forests, large scale conversion of agricultural land to aquaculture ponds, water pollution, biodiversity reduction, salination of fresh waters, displacement of poor artisanal fishermen and loss of access to fishing grounds by the artisanal fishermen and colleagues. The unscientific shrimp culture practices were the main culprits, which led to the above said problems. Apart from its effects on the local-economy, unregulated intensive shrimp culture is contributing to serious environmental degradation in Tamilnadu with implications for both agriculturists and fish workers. A major problem is the salinisations of drinking water. Excessive pumping of ground water, which is needed for mixing with sea water to maintain the correct salinity for growing shrimps, has led to the penetration of sea water into the water table, while the storage of saline water in ponds for several months at a time results in seepage underground. This affects not only ground water, but also water-stored intents. There is also the contamination created by shrimp form effluents being discharged from the ponds.

The impact of shrimp culture on the environment depends on the type of culture adopted. The traditional extensive and modified extensive practices followed till the early 1990's have had no adverse effect on the environment. But over the years the yield intensifying practices like intensive and super intensive cultures, stocking enormous number of seed and dumping in huge amount of aqua feeds into the water came into vogue. Though this yielded heavily initially, heavy organic load and environmental stress exposed the animal to conditions leading to heavy out burst of diseases.

### **Pollution**

The oceans and all bodies of water are the global sinks for many pollutants from both land-based (e.g., mine tailings, untreated domestic effluents, and sediments from soil erosion) and water-based (e.g., oil spills and waste from shipping) industries. Almost all forms of water pollutants diminish

the capacity of water bodies to support aquatic life if they reduce the amount of dissolved oxygen. Chemicals in polluted waters also affect fish populations adversely. Some river systems in major urban centers in some DMCs have been declared biologically dead. The contamination of aquatic species with pollutants, primarily with sewage and toxic substances, and the occurrence of toxic algal blooms have also rendered them unfit for human consumption. Intra sectoral interactions in the coastal zone should be considered in fisheries planning activities. The coastal zone, which is the usual geographic planning unit, should be expanded to include the whole watershed and include terrestrial activities that directly affect coastal fisheries such as logging and mining in the uplands.

Half the world's population, and over 70 percent in Southeast Asia, lives in coastal regions. This indicates the intense pressure that competing demands for and multiple use of resources place on the coastal aquatic ecosystems. Efforts are needed to identify and evaluate the externally generated impacts on fishing resources and coastal aquatic ecosystems, and the internally generated impacts that have downstream effects, and to devise the appropriate interventions for integrated coastal fisheries management (ICFM). ICFM recognizes externally generated changes or changes caused by the use of resources outside the fishery sector but that have an impact upon it, and internally generated changes or changes that originate from actions inside the fishery sector and have an impact within it and/or outside it. ICFM thereby develops interactions between the fishery sector and other sectors or interests, to anticipate or resolve conflict and develop synergies and opportunities, e.g., for the development of alternative employment opportunities.

The untreated effluents discharged from shrimp farms directly or indirectly have polluted coastal waters, estuaries, creeks and backwaters. Residual chemicals, drugs, antibiotics, decomposed and unused artificial feeds contributed to toxic nature of the effluents. The heavy nutrient load in the water lead to hyper eutrophication developing massive algal blooms and reduction of oxygen, over accumulation of detritus at pond bottom and poor quality of water leading to profusion of ciliates and other protozoan which cause respiratory and gill diseases in shrimps. However, limited organic enrichment may be beneficial to marine fisheries by causing an increase in phytoplankton and other fish food organisms

## **2. Destruction of mangroves**

Despite the growing awareness and concern, coastal and other aquatic ecosystems continue to be degraded by pollution and unsound forms of utilization. These negatively impact on fisheries as shallow-water fish habitats such as mangroves, sea grass beds, coral reefs, estuaries, bays, rivers, lakes, and swamps are biologically the most productive and the most ecologically diverse aquatic environments. These are important fish breeding and nursery grounds, where many species reproduce. The loss of mangroves has ecological, economic, and social consequences. Their removal has several implications on the sustainability of many coastal activities. The major effects

are the coastal erosion, changes in pattern of sedimentation and shoreline configuration making coastal zones more vulnerable for storm erosion, salinity intrusion, loss of breeding and nursery grounds of fishes and crustaceans, decline of availability of larvae and post larvae, decline in traditional fish catches, reduction of fishery recruitment to sea, loss of filtration capacity of soil, changes in physico-chemical properties of water, reduction of biodiversity and disturbances in the ecological balance.

### **3. Impact on coastal land use**

While development of shrimp culture increased the efficiency of utilization of coastal land (unutilized agricultural lands, derelict salt pans, deltaic regions, lake areas, mud flats traditional shrimp farms etc) leading to higher income generation. But the mass scale conversion of coastal agricultural lands to shrimp farms lead to the salinisation of soil and ground water leading to the desertification of adjacent productive lands. The casuarinas and coconut plantations have been affected. Construction of pond lead to accelerated soil erosion.

### **4. Nutrient enrichment:**

Eutrophication of coastal waters due to nutrient rich effluent discharge often results in nuisance algal blooms, which reduces species diversity especially in ecologically flimsy areas like the coral reefs. Phosphate enrichment of coastal reef waters may directly inhibit hard coral growth through phosphate inhibition of calcium carbonate deposition, which is an essential process of healthy coral reef growth. Sea grass and mangroves are less susceptible to such eutrophicated waters as they have a capacity to absorb high levels of nutrients. Nevertheless, high organic loading in these systems may cause anoxia and increase in turbidity levels where resilience and diversity of these systems is adversely affected. Bioaccumulation of toxic heavy metals from effluent waters is another serious problem, but the source of it certainly from the industrial out flows rather than the shrimp farms.

### **5. Effect of aquaculture on other coastal users**

The effects of aquaculture operations need to be considered in terms of the other present users, and also on potential effects on future users of the particular resources. The concern of the present user is mainly centered on the sustainability of coastal resources, which include access to the coast and equity considerations arising from conflicting uses among different user groups. Pre-emption of access either by design, congestion or by ignorance of local usage pattern is one of the major effects of aquaculture on the other users. Exclusive use of shoreline (foreshores) of estuaries and bays for aquaculture often leads to conflicts with the other users.

The effect of aquaculture on the future users are often over looked in the impact analyses. Any allocation of land or water involves the choice. It involves the best use of a particular piece of water taking into consideration the total

benefits that would have been attainable with some other future use of that water. This concept of 'opportunity cost' can be applied to future uses of a particular area. Thus the benefits and costs of using a particular area for a particular purpose now must be considered against benefits and costs which are potentially attainable for a particular use of the area in the future. Thus the cost of forgoing future benefits need to be considered during aquaculture planning itself.

## **6. Indirect effects on biota**

### **6.1 Shading and night illumination**

Floating structures like pontoons, cages or aeration equipments can shade significant areas of bottom, which may seriously affect the ecology of areas like coral reefs or sea grass beds. Most of the corals and associated fishes have photosensitive feeding behaviour. In contrast to shading, shoreline night lighting or illuminated floating structures may influence the movement of light sensitive species including fish, squid and hatchlings of turtles, resulting in an inland movement rather than their natural movement towards sea.

### **6.2. Introduction of exotic species**

Movement of or bringing in of species outside its present geographical area for aquaculture may seriously affect the native fauna. The worldwide transplantation of *Tilapia* is a vivid example for this. The recent nuisance created by the introduction of *Clarius garipenaesus* (African catfish) is also causing concern in the Indian waters. In addition to altering or improving the natural biodiversity of the ecosystem, through competition and inbreeding, it may cause the transfer of a new disease causing agents to native waters. Unfortunately the ecological impact assessment studies due to the introduction of exotic species are not carried out in developing countries like India. This new sector of Biological impact assay (BIA) needs to be considered at least at these late hours.

### **6.3. Indiscriminate use of antibiotic drugs**

The recent out burst of many bacterial and viral diseases led to the indiscriminate use of many broad-spectrum antibiotics. These are only therapeutic agents and are not prophylactic in nature. The environmental changes associated with the use of chemotherapeutics in aquaculture are as follows:

1. Quantitative and qualitative changes in the soil and water microflora.
2. Toxic effects on wild organisms living in a particular area.
3. Development of antibiotic resistance in fish pathogens  
(Antibiotic resistant strains)
4. Transfer of antibiotic resistance to human pathogens.

#### **6.4 Effect of coastal aquaculture**

Large-scale cultivation of filter feeders such as oysters and mussels tend to affect the natural food web of marine ecosystem. They remove the phytoplankton and detritus as well as compete with other plankton feeders. 50,000 to 60,000 cultured oysters, showing that the removal rate is considerably significant, can remove about 75-90% of seston in the natural environment. Such impacts are highly pronounced in semi-enclosed embayment. Ear marked area is not available for the culture of sea weed creates problem between the fisher folk and fish farmers

#### **6.5 Availability of sheltered areas**

Coastal areas that have large-scale concentrations of cage/raft culture may provide shelter to fin and shellfish stocks from intensive fishing operations. This may be beneficial in conservation of these marine stocks by offering limited protection against over fishing

#### **6.6 Coral Reef Degradation and Loss of Inter-tidal Areas and Wetlands**

The coastal ecosystem provides an important habitat for aquatic resources in the extensive mangroves, coral reefs, estuaries, lagoons, and bays. The biodiversity of coral reefs is very high, rivaling that of tropical rainforests. The productivity of coral reef systems is also very high; however, these are fragile ecosystems that are easily degraded by siltation, eutrophication, and contamination by pollutants, physical damage, and overexploitation, all of which have negative effects on productivity. An estimated 60 percent of Southeast Asian coral reefs have been either destroyed or severely degraded. In the reef-rich archipelagos nations of Indonesia and the Philippines, reefs are threatened by hazardous and destructive harvesting practices such as dynamite, cyanide, and muro-ami fishing (herding of fish into giant nets while banging numerous rocks across the top of a coral reef). Coral reefs are in serious jeopardy in the Gulf of Thailand from pollution and sedimentation stemming primarily from rivers. On the southern and western coasts of Sri Lanka, coral reefs are estimated to be disappearing at the rate of 10 percent annually.

### **B. Social impacts**

Intensive shrimp farming in coastal areas of SE Asia has denied the use of these areas to local residents for traditional activities such as fishing, gathering, construction materials, food collection, fuel gathering. The benefits of shrimp farming development are for the most part confined to a limited number of entrepreneurs. Local residents suffer because of the loss of traditional livelihoods such as fishing and woodcutting to be replaced by low wage employment of shrimp farms.

## **Impact on Agriculturists**

Apart from the plight of the farmers who have sold their land, the conversion of agricultural land into shrimp farms has had serious consequences for farm labourers, of which there are very large numbers in Tamilnadu: paddy, which is mostly cultivated in this area, is a highly labour intensive crop. Thus, the conversion of paddy lands into shrimp farms has resulted in massive unemployment among agricultural labourers, many of who have had to migrate to other parts of India,

## **Impact on Fish workers**

Fishermen are losing access to the sea and their fishing grounds because of the huge tanks and pumps being installed along the coast in order to supply the ponds with seawater. Massive excavation operations are also impeding access to the beach for others involved in fishing activities, such as fish vendors and head workers, who now have to travel long distances by circuitous routes to reach their homes and markets. Fishermen are also having problems now in setting their nets, which are being damaged by the pipelines going out into the sea. When they try to rescue their nets, they risk being sucked into the high-powered pumps. Declining fish catches due to loss of mangrove habitats adversely affect traditional fishermen.

## **Need for 'sustainable aquaculture'**

Traditional methods of aquaculture with some improvements, may provide alternatives. Semi-intensive methods should be tried in areas where land is not suitable for rice cultivation. Restrictions must be placed on the utilization of ground water, even in these areas, as it may affect distant reservoirs of ground water. Moreover, when licenses are issued for shrimp farms, priority should be given to cooperatives (and other organization of local fishermen and farmers).

Environmental assessments and monitoring must be undertaken in order to minimize adverse ecological changes and socio-economic consequences arising from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities.

A sustainable aquaculture system is an adaptable aquaculture production technology system whose ecological and economic viability can persist indefinitely. Sustainable development is the management and conservation of the natural resources base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development conserves land, water, plant, and animal resources and is environmentally non-degrading, technically appropriate, economically viable, ecologically sound, culturally compatible, financially feasible and socially acceptable.



Any aquaculture development should stick on with all the above-mentioned characters. Sustainable aquaculture enables to organise economic activities so as to promote economic development without unduly depleting the resources or wantonly destroying the environment. Conducting shrimp farming in the traditional way is a case in point. Community participation in the management of natural resources is an essential aspect of shrimp farming. Therefore it is necessary to evolve a development process that would lead to greater equity, growth and sustainability.

Precautionary principle and Polluter pay principle are also essential features of sustainability. The precautionary principle provides for the prevention of environmental degradation and the polluter pays principle provides compensation for the pollution affected people as well as the cost of reversing the damaged ecology. These two principles are stressed, as they are the most important adverse effects of aquaculture.

### **Pragmatic and practical approach to aqua farming**

Environmental assessments and monitoring must be undertaken in order to minimize address ecological changes and socioeconomic consequences arising from water extraction, land use, discharge of effluents, use of drugs and chemicals and other aquaculture activities is beyond doubts that the aquaculture development is quite suited for Asian countries, including India, because of the geographical location in the tropics, the vast resources and apt climatic conditions. But the development was unusually rapid and unscientific with utter disregard to environmental and socio-economic considerations. Diversification from shrimp farming using other species of shrimps, fin fishes, crabs, mussels, lobsters pearl oysters and seaweed is a better alternative towards attainment of sustainable aquafarming.

Once the problem like pollution, salination and disease problems are not curbed, the future of aquaculture seems to be meager. It is high time realise that success cannot be achieved simply by dumping money. Lessons have not been learned from experiences of other countries. Prevention is always better than cure. Hence, the following pragmatic measures may help to attain a sustainable development in aquaculture scenario;

- Aquaculture in brackish waters should be done only in small-holdings, not exceeding 10 ha each. It should not be high productive, but ecofriendly and sustainable.
- The farms should not be too clustered together, so that pollution of environment is avoided.
- Modification of CRZ rule, bringing in farms to be located very close to estuaries, brackish waters, backwaters, lagoons, rivermouths and deltaic

regions to avoid pollution, sedimentation, salinization of water and soil taking advantage of natural conditions.

- Ensure that aquaculture development or operations do, not affect the artisanal fishermen and dependent coastal communities and their access to community resources, including extensive, semi-intensive and intensive aquaculture practices.
- Ensure the study of environmental, social and biological impact assessment i.e. EIA, SIA and BIA respectively, prior to aquaculture development (during planning stage itself) and their continuous monitoring.
- Ecologically sensitive coastal areas like the mangrove wetlands and coral reefs should not be destroyed any more for aquaculture practices. Further planting of mangrove buffer zones must be made to restore the already depleted mangroves and thus save further degradation of coastal zones.
- Laying of long distance pipelines for pumping in seawater, construction of jetties into the sea, indiscriminate usage of ground water and fencing of farms should be prohibited.
- Prohibit the unabated use of therapeutics like, broad-spectrum antibiotics and practice the use of ecofriendly prophylactics like immunostimulants and probiotics.
- Prohibit the use of genetically modified exotic organisms without proper studies of its impact on native species.
- Avoid the unscientific transplantation of exotic species to native waters.
- Laboratories equipped with disease diagnostic kits should come up in the government sector ensuring access to even small scale farmer to prevent disease out break.
- Prohibit the whole sale conversion of agricultural lands to aquafields.
- Ensure that the collection of larvae from the wild does not affect adversely the species diversity of the waters.
- Implementation of integrated coastal management planning which includes the meaningful participation of all coastal user groups.
- Ensure that the abandoned or degraded aquaculture sites are ecologically rehabilitated and the companies/industries, responsible for it bear the cost of rehabilitation.

## **Effluent treatment should be made mandatory**

1. Diversification from the prevailing tiger prawn farming to more suitable species and performance of crop rotation.
2. Educating the farmers and extending the scientific know-how from the lab to the land.
3. A total review of the shrimp farming at village, district, and state levels ensuring that the developments are sustainable, socially equitable and ecologically sound.
4. Ensure that the multilateral development banks, bilateral aid agencies, the UN / FAO and other relevant national and international organisations do not fund or otherwise promote aquaculture development inconsistent with the above criteria.