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Research Article

THREATS DYNAMICS ON FISHERY SECTOR AND ITS ASSOCIATED ENVIRONMENT IN THREE ESTUARIES OF NORTH-EAST COAST OF INDIA

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A B S T R A C T

Habitat alteration, urbanization, industrialization, population growth, environmental pollution as well as degradation, deforestation, desertification, global worming as well as global cooling- these are few popularly known term in present world. In the north-east coast of India, there are three diversified estuary, i.e. Bhagirathi estuary of Bhagirathi-Hooghly river, Talsary estuary of Subarnarekha river, Bhitarkanika estuary of Mahanadi river. The catchment area, flow and volume of water, number of tributary and sub-tributary, source region, length of the river, shape and size of river valley, nature and volume of runoff, micro and macro landform are the key controlling factors of estuarine dynamics of these three rivers. As the factors may vary from one rive to another, so the estuarine water and sediment variety also differs in respect of time and place. The river Ganga is the prime and influential perennial river in India, which gives an integrated socio-economic platform and also makes a huge delta in estuary region as a continue manner. One of the largest settlements (built up area) and huge fertile agricultural lands are found along with the river valley. So the two major types of surface runoff, like agricultural runoff and household runoff are the main elements, which mixing up with the river. Besides that, different thermal power plant and heavy and light industries are built up along with the river for sufficient water availibity. These wastages also mixing up with this water. Subarnarekha valley is a mining based valley, where maximum mining based runoff water is mixed up with water. Different dams are built on this river, which is reduced the supply of fresh water. As a result of it, water salinity in estuary will increase. On the other hand, Mahanadi has a valley based on mining and mining based industry. So water quality also influenced by mining industry based run off. Presently river barrage also constructed on the Mahanadi river, which is the also causing factor of water salinity increases at Bhitarkanika region. This is also a causing factor of disturbance of local hydrological cycle. Apart from this, few reasons are directly operating to make an impact on fishery sector and its associated environments.

INTRODUCTION

India is a monsoon based agriculture dominant country, in which there is a major portion of agricultural land directly or indirectly dependent on river. River network is so unique, complex, scattered and dynamic for the result of presence of active tectonic Himalayan Zone and uneven nature of monsoon climate. On the other hand, the coast line of India is around 7516 km long, spanning across 9 States, 2 Union and 2 Island territories. Out of the total length of Indian coast line, West Bengal coast line occupies a length of around 220 km and Odisha has a length of around 480 km. The coastal zone of these two states has diverse types of fisheries and the local community and island dwellers greatly depend on the fishery resources of the state.

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There are several fish landing stations in West Bengal and Odisha, where the data on fish diversity and landing quantum are available. It has been observed that the diversity is gradually decreasing in both the maritime states and a compositional variation is also observed. In this long estuary,

Study Site

The Indian Sundarbans Delta (ISD) in coastal West Bengal is a hot spot of West Bengal coastal fishery. It is part of the delta of the Ganga-Brahmaputra-Meghna (GBM) basin in Asia. The Sundarbans shared between Indian and Bangladesh is home to one of the largest mangrove forest in the World. The ISD spreads over about 9630 km^2 between 21°40'04" N and 22°09'21"N latitude, and 88°01'56" E and 89°06'01" E longitude, is the smaller and lies in the western part of the complete Su The Indian Sundarbans Delta is bounded by the Ichamati-Raimangal River in the east, by the Hooghly River in

the west, by the Bay of Bengal in the South, and the Dampier-Hodges line drawn in 1829-1830 in the north. A little over half of this area has human settlements on 54 deltaic islands the remaining portion is under mangrove vegetation. Soils of ISD are principally Alfisols (older and alluvial soil) and Ardisols (coastal saline soil).

The landscape is characterized by a web of tidal water systems. The average tidal amplitude is between 3.5m to 5m, with the highest amplitudes in July-August and the lowest in December-January. Of the 8 rivers that dominate the landscape only the Hugli and Ichamati-Raimangal carry freshwater flow of some significance. Being the moribund part of the lower delta plain of the GBM system, the ISD is experiencing both declining freshwater supplies and net erosion, as has been recorded since 1969 (Hazra *et al,* 2002; Hazra, 2010).

The Indian Sundarbans at the apex of the Bay of Bengal (between $21^0$13'N to $22^0$40'N latitude and $88^0$03'E to $89^0$07'E longitude) is located on the southern fringe of the state of West Bengal (a maritime state in the north-east coast of India). The area of the Indian Sundarbans is 9630 sq. Km. of which the forest area is about 4200 sq. Km. With a considerable degree of maritime characteristics in major portion of the ecosystem, the important morphotypes of deltaic Sundarbans are beaches, mud flats, coastal dunes, sand flats, estuaries, creeks, inlets and mangrove swamps.

The rivers are the live matrix of deltaic complex, on which the unique spectrum of biological diversity is embedded. In Indian Sundarbans, approximately 2069 sq. Km. area is occupied by tidal river system or estuaries which finally end up in the Bay of Bengal. The deltaic complex of Indian Sundarbans is also noted for its seasonality in terms of climatic condition and wind action as highlighted here in brief. Frequent Nor-westers are also common in the premonsoon season.

The state of Odisha (Orissa) covers an area of 1,55,707 sq.km having a coastline of about 480 km on the Bay of Bengal. It lies between 17° 31' and 22° 31' The Western Rolling Uplands are lower in elevation, 153-305 m and have bedrock of hard soil and a lot of flora and fauna. 31' N latitude and 81° 31' and 87° 3°' E longitude. Bounded by West Bengal in the northeast, Jharkhand in the North, Andhra Pradesh in the South, Chhattisgarh in the West, the State is open to the Bay of Bengal on the East.

Morphologically it can be broadly divided into five major regions. The coastal plains in the East, the middle mountainous and highlands region of north and northwest, the central plateaus, the Western rolling uplands and the major flood plains.

Accounting for about ten percent of total surface area, the coastal plains belong to the post tertiary period and are formed by the alluvial deposits of the six major rivers-the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. The region stretches from the West Bengal border i.e. from the river Subarnarekha in the north to the river Rushikulya in the South. This region slopes eastwards, maximum width in the middle (the Mahanadi delta), narrow in the North (Balasore plain comprising deltas of the Subarnarekha and the Budhabalanga) and narrowest in the South (Ganjam plain comprising smaller delta of the Rushikulya). The South coastal plain also comprises the laccustrine plains of Chilika Lake. The long stretch of land covers the districts of Balasore, Cuttack, Puri and a part of Ganjam with miles and miles of paddy fields constituting the 'rice bowl' of the State.

Objectives

On this background the major objectives of the present study are as follows.

1. Evaluation of the present status of coastal fish diversity in Odisha and West Bengal
2. Analysis of threats operating on the coastal fish community of these two states
3. Scaling of the threats with score on the basis of the magnitude (dimension) of the threats
4. Development of conservation measures to preserve the fish germplasm in the coastal water of these two maritime states.

Factors Operating

i. Construction and operation of ports and harbours, disposition of municipal and industrial wastes, navigation, and exploitation of minerals impacting the fishery resources.
ii. Mangroves and coastal wetlands (estuaries, backwaters, lakes and lagoons) are under pressure for a variety of reasons, including, expansion of urban settlements, and exploitation for fuel, agricultural development and construction of fish and shrimp ponds. Apart from the loss of mangrove habitat, there is evidence of impacts on water quality, for example, salination of freshwater, loadings of nutrients and organic matter and pollution from illegal pond sediment disposal and growing use of a variety of chemical products.
iii. Coastal fisheries are coming under increasing pressure as human populations increase. In addition to heavily increased fishing pressure, there is a reduction in the carrying capacity of coastal ecosystems due to increased siltation and land runoff. Where there is no tradition of subsistence harvest, fisheries are more commercial and targeted on a narrower range of high-value species. Such systems are more unstable and are more prone to catastrophic collapse.
iv. The Coastal zone is undergoing great stress due to the discharge of wastes from industries and other human activities. The discharge of huge quantities of untreated sewerage into the sea will result in eutrophication of coastal areas, leading to production of toxic algal blooms or "red-tides". Discharges of industrial wastes to municipal sewage systems compound this problem. Such discharges pose a threat to health and are also a major source of litter. Even with primary or secondary treatment, municipal sewage systems are responsible for the discharge of nutrients, which may result in toxic blooms of phytoplankton and cause major problems for fisheries. The expansion of coastal cities and suburbs is often accompanied by shoreline modification, which cause further disturbance.
v. There is increasing fishing pressure along the inshore areas and use of destructive types of fishing gears and fishing practices. Some of the destructive methods of fishing are known to adversely affect coastal fishery resources, leading to removal of even the juveniles, the young ones of all the commercial varieties of fish/ shellfish, etc.

vi. Human influences on fisheries ecosystems are often interlinked and effects are often devastating. Freshwater diversion and blockages to access by tides on aquatic fauna and flora present an increasingly widespread threat to fisheries habitats in estuaries and coastal streams. Human interference further influences production in the fisheries. Such interference includes clearing vegetation in adjacent catchment areas, run-off of silt and pesticides, discharge from adjacent industrial development, and dredging.
vii. Fishing also has an impact on the environment. The removal of fish from fisheries not only affects the number of target fish species, but also the food chain of other marine animals and the avian fauna that feed on them.
viii. Coastal environmental degradation through erosion, siltation and eutrophication, resulting in reduction of fishery carrying capacity will exacerbate the problems caused by increased subsistence fishing pressure and will accelerate collapse of coastal fisheries.
ix. Urbanisation and population concentration encourages construction and production of domestic sewage; intensive agriculture requires fertiliser and pesticides, and non-selective logging leads to erosion, all of which have adverse effects on the fishery. The process of urbanisation often results in the loss of fishing space and/or rights for the fishing community where traditional fishing grounds and small ports give way to other developments.
x. The environmental impact of large ports is also significant, including problems of erosion of adjacent shoreline, loss of inter-tidal habitat and damage to coastal ecosystems caused by the dredging and filling of wetlands during construction. Ports are also major sources of pollution as a result of discharges of waste, bilge washing and the use of toxic chemicals and paints. Inland urbanization has also impacts on coastal regions. For example, the depletion of groundwater may have an impact on river and ultimately coastal systems that can lead to salt water intrusion into underground aquifers.
xi. Due to the increasing human intervention such as mining, clearance of land for agriculture, urbanisation, industrialisation etc., the quantity of suspended sediments is increasing day by day. Most of the silt settles near the river mouths and in the coastal areas, decreasing their productivity and thus depleting their fishery resources. Increased suspended sediments and sedimentation and consequent erosion have a serious impact on biodiversity. Sediment deposition, particularly through its influence on the mortality of eggs and larvae in the spawning species, is the most significant cause for decline in the fish population.
xii. River runoffs, mechanized and chemical weathering of the rocks and all industrial plants are the major sources of metallic pollution in the coastal and estuarine waters. Cadmium, copper, lead, mercury, nickel and zinc are the heavy metals found in the coastal waters.
xiii. Inadequate information on the fisheries resources and the state of the aquatic environment to guide management decisions.
xiv. Inappropriate regulatory framework and inappropriate mechanisms for controlling access to fisheries resources.
xv. Inadequate monitoring, control, surveillance and enforcement mechanisms.
xvi. Inadequate mobilisation and involvement of the communities in development and management of fisheries resources.
xvii. Inadequacy of extension services critically hindering capture fisheries and aquaculture development.
xviii. Inadequate fisheries infrastructure.
xix. Difficulty in imposing any limitation or stringent action on over-fishing, as fishing is a livelihood option for majority of the fishers.
xx. Conversion of fallow land along Chilika and other estuaries/backwaters for coastal aquaculture.
xxi. Siltation/sedimentation of the fishery harbours and fish landing centres due to the natural littoral drift, and human pressures making most of them non-operational.
xxii. Natural calamities such as unprecedented rain, cyclones and floods, leading to destruction of coastal structures, fish/ aquaculture ponds and systems.

In the context of increased threats and pressures from unsustainable fishing practices, climate change and the impact of other competing developments, leading to rapid decline in the benefits generated by the sector, efforts are needed to reform the fisheries sector.

Data Analysis

DISCUSSION

The entire network of the present study includes assessment of fish diversity (using Shannon Weiner Species Diversity Index as proxy), scaling of threats on fish diversity, and development of conservation oriented management action plan. The various steps for this approach are listed here.

The anthropogenic threats like pollution gradually decrease as one proceeds from western to eastern sectors of Indian Sundarbans mainly because of the presence of industrial belt along the Hoogly River in the western sector and reserve forest in the eastern sector (Mitra, 2013; Mitra and Zaman, 2016). We therefore attempted to segregate the CTS for three different sectors of Indian Sundarbans and observed contrasting spatial variation.

The results generated after the present excersise revealed few interesting findings as listed here.

For western Indian Sundarbans, the order of CTS is pollution (986.4) > erosion (583.2) > natural disaster (499.1) > siltation (237.3) > sea level rise (100.4) > over exploitation of natural resources (37.9).

- ✓ The coastal fishery diversity will be assessed from the catch primarily from the landing stations. The species wise catch (in tonnes) will be transformed to Shannon Weiner Species Diversity Index to know the condition of the environment in terms of stress.
- ✓ Assess the threats operating on fish community through stakeholders meet and interactive with local people.
- ✓ Scaling the threats with score to develop conservation oriented management.

The scores may be categorized in to various types as listed

1. Prawn seed collection
2. Irregular fishing
3. Mangrove deforestation

4. Siltation and sedimentation
5. Deterioration of water quality
6. Natural calamities like cyclones, Tsunami etc.
7. Harmful algal bloom
8. Capital dredging of river beds
9. Miscellaneous.

Bhitarkanika: Erosion>Siltation> Exploitation of Natural Resources> Natural Disaster>Pollution
Mahanadi: Pollution>Natural Disaster>Erosion>Exploitation of Natural Resources>Siltation
Chilika**:** Siltation**>**Natural Disaster**>**Pollution**>**Exploitation.

Measures

Due to factors such as human modifications to the environment, overexploitation, habitat loss, exotic species and others, aquatic biodiversity is greatly threatened. In order to preserve these threatened areas and species for future generations, immediate action in the form of aquatic biodiversity conservation strategies are necessary. The conservation policy should promote the management practices that maintain integrity of aquatic ecosystem, prevent endangerment and enhance recovery of the threatened species [50-60].

Through probability of inbreeding in hatchery-bred seed normally cannot be ruled out, conservation aquaculture is gaining importance in rehabilitation programmes of endangered/threatened fishes. Interestingly, sea bass *(Lates calcarifer*) a vulnerable species of the brackish water, has been successfully cultured in West Bengal for about 6 months by stocking the hatchery-produced seed.

The Department of Fisheries, Government of West Bengal is trying to conserve these species with the following objectives

1. Brood stock management: Artificial breeding of threatened species for restocking in their natural habitat and to establish gene banks using cryopreservation techniques.
2. To overcome disease problems in larval rearing tanks and culture ponds.
3. To generate income, self-employment and skill for interested farmers through demonstration and training.
4. To provide technical support to private hatchery owners to help them to maximize production of quality seed.
5. For conservation purposes, artificial reproduction techniques are applied to establish an Endangered Fish Species Breeding Programme. The two main components of this programme are a) a live gene bank and b) gamete/embryo bank

Apart from the Central government act there are also some state government acts are also in West Bengal [61-70]. In West Bengal it was with the enactment of the West Bengal Inland Fisheries Act, 1984 that environmental concerns regarding water bodies became a part of policy.

CONCLUSION

Bio-geographical dynamism always influenced to estuarine biodiversity. Each an every river has its own life. But when we try to obstract their life flow, it became more hazardous and dengerous to human life. River erosional process is shown at high altitude where land elevation is high and gravitational force is high. Therefore corrosion and abrasion process is come into force. Though the Himalayan region is highly techtonic event prone zone, therefore dynamics of land elevation is shown. During channel flow of the river Ganga, it gets more power from that. As a result of it, huge amount of sediment is carried out with this flow and deposited in low elevational zone especially in lower or detaic part in the Indian Sundarban. During rainy season huge amount of agricultural wastage (with chemical component) is coming from flood plain of the river Ganga. As a result of it, estuarine water salinity decreases. But due to presence of mangrove, phyto-plankton

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