Mangrove the Head of an Intricate Joint Family

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Abstract

A study of Mangrove is one of the wondrous experiences of man. Mangroves are one of the unique systems of vegetation in Nature; they live in symbiotic relationship with all creatures in and around its zone. It has not only its bounty but it protects humans and other creatures including the environment from external violence from Nature and other where.

It is one of the most familiar forms of vegetation occurring in the intertidal zones along coasts and river banks in the coastal areas in tropical and subtropical countries of the world. Mangrove forests are highly productive ecosystems and are a natural, renewable resource. They provide essential goods and services and play a very important role in the lives of men; coastal communities and others living in their surroundings.

Indonesia has the largest total area of mangrove forest while the Sundarbans swamp region in Bangladesh and India is the largest single chunk of mangrove forest in the world. Sundarbans is listed as a UNESCO World Heritage Site. Conservation and development of such natural systems benefit man and his environment. It is man's duty to preserve, protect and develop such a great creation of Nature.

Keywords: Mangrove, Bio-Diversity, Ecology, Forest, Awareness.

Introduction

Mangroves are sentinels of the border land; spreads their gnarled roots in the water while holding the land with trunk and multiple branches linking the land and water holding and protecting the creatures of both the regions. Mangroves are one of the most familiar forms of vegetation occurring in the intertidal zones along sheltered coasts and river banks in coastal areas in the tropical and subtropical countries of the world. Mangrove forests are highly productive ecosystems and are a natural, renewable resource. They provide essential goods and services and play a very important role in human lives, specially coastal communities besides many other creatures. In a nutshell Mangroves have been described in the *Handbook for Mangrove Area Management* as salt-tolerant forest ecosystems of tropical and subtropical inter-tidal regions of the world.

Through adaptations like viviparous germination, in separating freshwater from salt water and in conservation of freshwater, by their ability to strike roots soon after coming into contact with soil and to exchange gases through specialized root systems mangrove species have been able to deal with very adverse environmental conditions where few other plants would have survived.

Mangrove vegetation primarily comprises of trees and shrubs with a limited number of palms and lianas. The World Conservation Union's report on the global status of mangroves (IUCN, 1983) listed 61 species. Major mangrove species belong to less than 15 families. Most frequently occurring mangroves belong to the Rhizophoraceae, Sonneratiaceae and Avicenniaceae family. In the Sundarbans mangroves predominate in families Sterculiaceae and Euphorbiaceae; an exception to the usual occurrences elsewhere.

Seeds Exceptional

Another notable phenomenon in a large number of important mangrove species (like Rhizophora, Ceriops, Bruguiera, Kandelia and Nypa) is that their seeds develop into seedlings while they are still attached to the mother tree. This phenomenon is known as vivipary where the embryo ruptures the pericarp and grows beyond it. In a second group, which includes species of Aegiceras, Laguncularia, Pelliciera and Avicennia, the embryo while developing within the fruit does not enlarge sufficiently to rupture the pericarp. This has been termed as cryptovivipary by experts. Seeds of some species of mangrove like Excoecaria, Sonneratia, Heritiera and Xylocarpus are not viviparous. All of the above-mentioned species produce buoyant seeds which are dispersed exclusively by water and are capable of reaching any corner of the forest inundated by tidal water.

Most seeds that fall off mother trees during low tide stick to soft mud and quickly strike roots. The adventitious roots already present in the hypocotyl emerge and anchor the seedlings. Silt carried by subsequent high tides helps the seeds or seedlings to secure a better hold. Seeds or seedlings dropped in high tides continue to float in the water until they come into contact with a soil substrate and strike roots. It is interesting to note that most mangrove seeds retain viability for a long time while remaining in the saline environment but lose it soon after they are removed from that environment. Mangrove in saline water and all other creatures in it live in symbiotic relationship.

Mangrove Areas

The mangrove vegetation of the world can be divided into two broad groups. The old world mangroves occur in the Indo-Pacific region extending from the east coast of Africa to Samoa in the South Pacific. The second group, the new world mangroves, occur along the west

coast of Africa between Mauritania and Angola and in the Americas; on the east coast between Barbados and Brazil and on the west coast between Mexico and northern Peru. Indonesia has the largest total area of mangrove forest while the Sundarbans swamp region in Bangladesh and India is the largest single chunk of mangrove forest in the world. It is listed by the UNESCO as the World Heritage Site.

The mangrove forest cover increased from 4046 square kilometers in 1987 to 4639 square kilometers in 2007. The total mangrove coverage in the world is 1,50,000 square kilometers. Asia has the largest number of mangroves worldwide. The mangrove cover in India is 4,975 square kilometers or 1.2 million acres (0.15 per cent of its total geographical area) which is about 3.3 per cent of the world mangrove coverage. In India Sundarbans has the largest mangrove cover, occupying 43% and Gujarat has the second largest cover with 23% of total coverage in India.

Silviculture the Systematic way of cultivation and Conservation

Asian mangrove forests in Pakistan, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia have been under proper handling and management for a long time. Sundarbans in India and Bangladesh has been under sustainable management for more than 100 years. Silvicultural systems have been developed there based on selection and clear-felling. The modifications of silvicultural systems are carried out as per need to suit the local conditions. The system is divided in three groups as below for clear understanding.

Selection

The selection system is practiced in Pakistan, India, Bangladesh and Myanmar where trees above certain predetermined diameters are harvested from the annually stipulated coupes. The Sundarbans was managed under a selection system between 1892-1893 when the first

management plan for the forest was implemented and the modified selection system was fine tuned and adapted during the first three decades of the last century. Such practices proved to be very appropriate for the sustainable management of the forest. The depletion that occurred in the growing stock was the result of faulty management decisions other than usual silvicultural practices. The mangroves of the Sundarbans are managed under a selection-cum-improvement of silvicultural system. Separate annual coupes are laid out for timber; for fuelwood and pulpwood extraction. All types of harvest are carried out in a 20-year cycle including a single harvest operation carried out once in each 20-year period.

The specific process for Heritiera fomes which is the principal timber species in the Sundarbans forest (a medium-sized evergreen specific mangrove tree species which makes up about 70% of the trees in this area; known also by its traditional names; sunder, sundri, jekanazo and pinlekanazo; involves the laying out of the annual coupe (the marking of sound trees above a predetermined exploitable diameter provided their removal will not create any permanent gap in the canopy). The harvesting of timber is followed by the removal of dry lops and felling of all deformed trees and the thinning of dense stands. This conservative opening of the canopy ensures an adequate regeneration of this species which thrives in partial shade in its early stages discouraging the regeneration of any growth of trees less in demand and economically less desirable.

Excoecaria agallocha is exclusively used as pulpwood and matchwood. All trees above the exploitable diameter are harvested in a single operation. In the case of Sonneratia apetala all trees above 30 cm in diameter are removed provided such removal does not create any gap in the forest canopy. Within annual coupes where H. fomes, E. agallocha, Ceriops decandra and other

mangrove species have been established as understory, clear-felling of all trees like Sonneratia apetala is carried out to assist in the establishment of a more valuable crop.

S. apetala seedlings do not establish under a mature crop of the same species. C. decandra is used both for poles and fuelwood. Poles in a coupe are removed following selection and felling rules as described in the case of H. fomes. During the fuelwood harvest at least one healthy shoot is left in each branch.

The mangroves of the Rakhine and Irrawaddy regions of Myanmar are similar in composition to those of the Sundarbans and they too have been managed under a selection system. However, because of the severe depletion of the forest, the opportunity for managing them for productive purposes has become limited. Another modification of the selection system is practiced in Indonesia where 50 and 10 m wide "no felling zones" are maintained along the coasts and river banks.

Forty Rhizophora, Bruguiera and Ceriops trees above 20 cm in diameter are distributed at a distance of about 17 m from one another; retained as seed trees in each hectare of the forest. The forests are worked on a 30-year rotation, with a single thinning at age 15, and all trees above 20 cm in diameter except the seed trees are removed in the final felling.

Felling

Efferent adaptations of the clear-felling system are in practice in Thailand, Malaysia, Indonesia and Viet Nam. In order to avoid damage to regeneration during harvest operations, extraction is mostly carried out with axes and trees are cut into 1.6 m billets which are carried out of the forest manually so as to minimize damage to the remaining vegetation. Immediately after the final felling, Acrostichum ferns are uprooted from infested sites.

Plantation

The process of establishment of mangrove plantations includes selective planting for enrichment of the plantation to supplement natural regeneration particularly in areas under a clear-felling management system as practiced in Thailand and Malaysia. Reforestation of degraded mangrove are also done in Pakistan, Sri Lanka, Myanmar, Viet Nam, Indonesia and a host of other countries. Aforestation in newly acquiered coastal lands is done in Bangladesh where more than 120000 ha of such plantation have already been established. In most instances very limited, if any, site preparation is necessary. Propagules and pre-germinated seeds and seedlings can easily be collected from nature and planted to achieve the desired good results.

Uses for Human Utility

With the exception of Asia in most other continents with mangrove formations systematic silviculture or management is not applied to the resource for its proper utilisation. Countries where mangroves are harvested and used extensively as fuel wood, charcoal, thatching materials, timbers and poles and are used for construction, for boat-building and other uses formations are not required to be managed scientifically. It is also used as a source of tannin, etc. Mangrove is extensively used as fuel wood for domestic cooking and fish curing. All over the tropical world mangroves are regularly harvested by coastal communities to meet their needs but mangrove use is not confined to subsistence and small-scale harvesting only.

Because of their strength and durability small-sized mangrove poles of 2.5 to 14 cm diameter are extensively used for making the frames for mud-plastered walls and structures for supporting roofs (generally made of palm leaves) in Kenya and the United Republic of Tanzania. These poles are in high demand in Arab countries where they are exported in large numbers. In 1982 Kenya exported almost four million poles to Arab countries. This large-scale operation has

also continued to be carried out through the selection of trees according to market specifications without due silvicultural consideration.

Biodiversity

Biodiversity is a wonderful world of existence and coexistence. It is biotic and symbiotic relationship among all living things in congenial atmosphere. Biodiversity is usually defined at three levels, i.e. species, populations and ecosystems. It has been recommended as an ecological reference to several hierarchical levels.

Mangrove Biodiversity

In respect of Mangrove world it is very curious to observe how on one hand, as head of the family, they help all flora and fauna inclusive of humans and insects live and grow and on the other hand how crabs help mangrove not only to sustain and expand but helps all related organisms develop and interact with each other harmonizing their activities. It may be said that without the existence of crabs mangroves would not remain; so much is their dependence on crabs. Next are insects and birds which like some other organisms help the growth and sustenance of mangrove plants. Scientists are relentlessly working on the scene to find out the developments in their particular areas.

Mangrove biodiversity may be the same or similar to tropical estuarine ecosystems. Biodiversity components of tropical estuaries can refer to the high diversity of species, their life histories, habitats and links in food webs; the diverse pathways of energy flow and nutrient cycles which integrate terrestrial and marine ecosystems at the land-sea interface. In addition, coastal geomorphological landforms and geophysical processes represent diverse components that effectively modulate the properties of estuarine ecosystems. These fluctuating environmental conditions of estuaries result in diverse spatial and temporal patterns of habitat utilisation by

organisms. It is specially true in mangrove ecosystems, since they are open systems interacting with a high diversity of functional landscapes such as coastal ocean water borders with terrigenous fresh water and the prevailing atmosphere; the sediment-water interface. The properties of the mangrove ecosystem within the coastal landscape have different characteristics from the simple mangrove which is restricted to the characteristic spermatophyte in the intertidal zone. It needs to distinguish between mangrove ecology and mangrove as such, needs to integrate the diverse physical, chemical and biological characteristics of tropical coastal ecosystems. The diverse landforms of coastal regions can be considered as a unique infrastructure as biodiversity component of mangrove ecosystems. These regions can be classified into distinct geomorphological units.

A Dwarf Forest

Mangroves occur within five basic groups of coastal environments depending on a combination of geophysical energies including the relative influences of rainfall, river discharge, tidal amplitude, turbidity and wave power. These five environmental settings are all influenced by inputs from terrigenous materials. Mangroves also occur on carbonate platforms where environmental settings are dominated by calcareous sedimentary processes and nutrient-poor conditions. The structure and function of these carbonate platform communities provide an interesting contrast to those mangroves influenced more by terrigenous materials. The micro topographic factors of a region determine many of the hydrologic and chemical conditions of soil that control the patterns of forest physiognomy and zonation. In addition, tidal flooding frequency of the intertidal zone can influence the distribution of propagules and species although the influence of this mechanism ("tidal sorting") on forest structure has recently been questioned.

The ecological classification of mangroves is influenced by biological factors also such as predation on propagules (e.g. crabs), differential resource utilisation by seedlings, and physiological tolerance of trees that determine the patterns in physiognomy and zonation of mangrove trees. There are two types of classification systems; geomorphological and ecological which represent different levels of organisation of the coastal landscape. Together they can be used to integrate the different scales of environmental factors that control the attributes of forest structure.

The species richness of trees is another biodiversity component of mangrove ecosystems. The environmental settings and biological factors described above not only influence the formation of different geomorphological and ecological types of mangrove forests but they may also control species richness. It is clear that within a continental area changes in rainfall, temperature and tidal range may be important factors to determine the diversity of mangrove trees.

There are biogeographic factors that have resulted in an unbalanced global distribution of species richness. The diversity of mangrove tree species in the western hemisphere is less compared with the eastern hemisphere (over 30 species). This also results in more complex zonation patterns along the inter-tidal zone of Old World continents as compared with the simpler patterns in the neo tropics.

At present, general conceptual models have improved to explain the development of zonation and forest structure within specific continental regions but the development of specific ecological models to project change in species richness and ecological types of mangroves in response to land-use or global-climate changes is still limited due to lack of understanding of the manifold routes of coastal forest development.

Mangrove ecosystems support a variety of marine and estuarine food webs involving an extraordinarily large number of animal species. The export of particulate organic matter (POM) supports food webs originating with particulate feeders, whereas the sometime larger export of soluble (dissolved) organic matter forms the basis of the near-shore heterotrophic microorganism food web. Many of the species of fin fish and invertebrates that utilize the mangrove habitat and its organic resources are also components of offshore areas, a phenomenon that suggests intricate patterns of diet and seasonal migrations. In addition to the marine estuarine food webs and associated species, there are a relatively large number and variety of animals that range from terrestrial insects to birds which live in and or feed directly on mangrove vegetation. These include sessile organisms such as oysters and tunicates, arboreal feeders such as folivores and frugivores and ground-level seed predators.

In south Florida mangroves in four distinct spatial guilds may have been well over an estimated 200 species many of which are as yet uncatalogued. In addition there are over 200 species of insects in mangroves in the Florida Keys. For reference, the Florida mangroves consist of only three major tree species and one minor species of vascular plants. Based on these considerations one can conclude that the low species richness of mangroves in Florida supports a disproportionately rich diversity of animals the dimensions of which are now being documented. This same conclusion can be applied to other parts of the Caribbean. Even though there is a global difference in species richness of mangrove trees between the east and west hemispheres, there does not seem to be a corresponding contrast in the functional diversity of the associated fauna. It has been observed that species richness of fish communities in the tropical Atlantic Ocean region was less than in the Indo-Pacific areas.

The Effects of Leaf Litters on Nutrient Dynamics

Litter produced in the canopy of mangrove forests influences the cycling of inorganic nutrients on the forest floor and the outwelling of organic matter to adjacent coastal waters. Thus the dynamics of mangrove litter, including productivity, decomposition and export, influence the nutrient and organic matter budgets of mangrove ecosystems. Mangroves are forested ecosystems, many of the ecological functions of nutrient cycling described for terrestrial forests may also occur in these intertidal forests. The amount of litter produced and the quality of that litter contributes to the nutrient dynamics of forested ecosystems. Thus the nitrogen content released in the forest canopy impacts the nutrient dynamics in forest soils which is influenced by the species specific nutritional ecology of the trees. The accumulation of leaf litter in the forest of mangrove ecosystems can be an important site for nutrient immobilization during its decomposition. The concentration of nitrogen in leaf litter usually increases during decomposition on the forest floor.

Important Mangrove Family Members

Crabs

Crabs are one of the most important animal groups contributing to the high biodiversity in mangrove ecosystems. They are in Symbiotic Relationship with most other animals and insects. Not only their high species diversity but also their functional roles make crabs a fundamental component in the ecological diversity of mangrove. Crabs play a central role in the structure and energy flow of these coastal forested wetlands as well as influencing the structure and chemistry of mangrove soils. These roles are accomplished by predation on mangrove seedlings facilitating litter decomposition, formation and transfer of detritus to predator food chains.

There are about 4500 species of crabs which constitute the largest part of the decapoda.

The mangrove crab fauna is dominated by representatives of mainly two families; the Ocypodidae and Grapsidae. Indo Malayan region provides the richest zone with 30 species of Sesarma, then comes East Africa (9-16) followed by Australasia (8-14) and tropical America (3-5).

Relevant studies in Malaysia, Jamaica, South Africa, Kenya, India and Puerto Rico show that the crab density may be as high as 63 individuals per square metre. The crab community have significant effects on pathways of energy and carbon flow within the forest; the quantities of organic material available for export from forest and the cycling of nitrogen to support forest's primary production.

Leaf-burying crabs were a major link between primary and secondary production within mangrove forests in northeastern Australia. Leaf litter was the major component in the diet of the red mangrove crab, Sesarma meinerti, a dominant specics in the mangroves of south Africa. Further studies at different sites reported large quantities of leaf consumption by different species of crabs.

Leaf fall from mangrove trees provide food for about 50 species of invertebrates in the mangrove forest; they prevent mangrove leaf material from being washed out of the forest and make POM (particulate organic matter) available as a food source to detritivores which feed on fine POM. They regulate the size of POM in the environment, stimulate the colonization of POM by microfauna and microorganisms making nutrient available to trees. They simplify the structure and chemical composition of detrital particles that can facilitate degradation by microbial organisms.

In addition to the impact crabs have on export and decomposition of organic matter they may also affect forest structure and species composition along the intertidal zone by consumption of mangrove propagules.

On a global scale it was found that crabs are major consumers of propagules from the forest floor with varied differences between continents which suggests that the effects of invertebrate biodiversity on ecological function is not consistent globally. Crabs do not play an important role in the structure and function of mangroves in Florida. However, recent studies in Ecuador showed that mangrove crabs, Vcides occidentals, can influence the fate of leaf litter in the Churute Ecological Preserve. It has been suggested that crabs represent keystone species since they exert a major influence on mangrove ecosystem functions. It has been found that sesarmid crabs have an impact on soil ammonium at sulfide levels and has impact on forest productivity and reproductive status. It has been observed that crabs occupy a keystone position in Australian mangrove forests. Crabs play an important role in maintaining a high biodiversity linked to significant ecological functions in mangrove ecosystems.

Insects

Insects are essential members of the mangrove family. A thorough inventory of insects on small mangrove islands in the Florida keys uncovered 200 species. Insect habitats are diverse in mangroves; not only on the leaf surface of the canopy where inventories of species are more common but also in less obvious sites within twigs, trunks and prop roots of the trees. In general studies of herbivores of these and other diverse insect guilds have found that they can influence ecological processes such as root branching that enhances tree support, girdling of branches and trunks that causes formation of forest gaps and premature leaf abscission that changes

nutrient recycling in the forest canopy and predation on mangrove seedlings. Experts have opined that a thorough study of insects' role on herbivory of mangrove forest has yet to be made.

Mangrove rookeries (bird nesting sites) are enriched in nitrogen and phosphorous which stimulate the productivity of mangroves by a factor of 1.4. The density and diversity of herbivores is greater on mangrove island rookeries compared with proximal islands that lack nutrient enrichment. The increased herbivory by several foliovorous caterpillars and scolytid beetles on mangrove rookeries apparently maintains a constant standing crop, despite the increased rate of consumption. The enhanced growth rate of several herbivores and other fauna on the nutrient-enriched islands suggests that resource utilization may limit population size on the islands not sufficiently enriched. Other studies have found little enhancement of herbivory with increased levels of nutrients in either mangrove soil or leaves.

Indian Mangrove sites Visited

After foregoing study of the basic structure and cultural practices and discussion on the enlarged family members of the mangrove forest, after a discussion on the wonderful biodiversity and importance of the mangrove ecosystem and their utility to men, animals and insects it seems relevant to place on record visits to some such forests as eye witness.

Sundarbans

Located in the south-west of Bangladesh between the river Baleswar in the East and the Harinbanga in the West, adjoining to the Bay of Bengal is the largest contiguous mangrove forest in the world. When locating it from Indian site it may be said, a stretch of three hundred kilometer from the Hooghly river in West Bengal to the shore of Meghna river in Bangladesh (Meghna is actually Brahmaputra flowing in from beyond Assam in the North-East) is the Sundarbans forest containing thousands of islands forming an immense archipelago. It contains

the world's largest area of mangrove forests. A number of rare or endangered species live in the park, including tigers, aquatic mammals, birds and reptiles.

The Sundarbans is the world's largest mangrove delta that is spread over 10,200 square kilometres (sq km). While 4,200 sq km lies in West Bengal in India, the remaining 6,000 sq km falls in neighbouring Bangladesh. The forest was one in undivided India from its beginning which became parts of two countries after partition in 1947; India and Pakistan which was again divided in 1971; Bangladesh became a separate independent country, detached from Pakistan. Sundarbans in Nature remains a contiguous one; it does not recognise political divisions.

Sundarbans as seen from Bangladesh by Enayetullah Khan is like this,

An extensive flat, deltaic coastal land at the confluence of three mighty rivers; Ganga, Brahmaputra and Meghna (a channel of old Brahmaputra) is the Sundarbans Reserve Forest which includes three Wildlife Sanctuaries, viz, Sundarbans East, South and West sanctuaries, established in 1977 covering 6017 square kilometers of which 1874 square kilometers constitutes the river water area. It measures 4% of land area and 44% of the forest cover of Bangladesh. It represents majority of Natural forest there. The soil in the core area is deep alluvium silt of clay loam; rich in nutrients but usually unsuitable for human settlement and cultivation. Soil has high alkalinity and water is saline.

Tides high and low are the regular features of this tide and ebb country. Not only the mighty Ganga and Brahmaputra but their innumerable tributaries, channels and canals thread the fringe of the land running towards the sea. Sea enters into the rivers flooding the land throughout the stretch, sometimes destroying sometimes creating islands. Some islands have remained for ages some were born yesterdays to go soon. During high tides all become watery; most parts of the islands are lost. Again they rise up. The boundaries between land and water always mutate.

Some are the mighty rivers like Raimangal and Matla some are of few kilometer in length. The soil is almost always muddy.

The Antiquity of the Forest

Though there is no reliable archaeological record, by all research evidences it may be said that the Sundarbans evolved more than 5000 years ago. People foraged the forest for food and building materials; for fish, honey and game, for golpata (nipa palm) and perhaps for crabs ever since they set foot on the marshy low lands of Bengal.

History recorded that it was under Muryan Empire between 321-226 BC and between 320-415 of the Christian era it was under Gupta Dynasty, between 1204 and 1575 it was under Indo-Turkish Sultans and between 1575 and 1765 under the Mughal Empire. From fifteenth to eighteenth century it passed under Taluqdars paying revenues to Zamindrs. By 1830 the British Government cleared a large part of the forest for commercial use. By 1869 they had full control over the forest and declared it as Reserve forest in 1876. In 1997 UNESCO declared it as World Heritage Site.

Only those trees live there which are suited to that special climatic and soil conditions, like Sundari (the dominant mangrove species there), Keora, Garjan, Dhundal, Gol Pata and other trees including mangroves which thrive and protect the islands and save the country from ravages done by typhoon and flood. Innumerable mangroves and crabs are the two living species which maintain the ecological balance of the littoral forest. Besides the tigers, the dense canopy of the jungle is the abode of monkeys, boars, fishing cats and innumerable varieties of reptiles like harials in particular, king cobras, pythons, endangered Olive Ridley and other varieties of turtles. Besides fishes, demon like crocodiles and Gangetic dolphins finless porpoises are the

regular inhabitants of the water. Once Javan rhinoceroses roamed the land but now there's no trace of them!

For ages the land belonged to non-human beings, to be approached gradually by humans who began living there. The story fits in the tale of the early settlers. In modern times, in 1903, Sir David Mackinnon Hamilton, the Scotsman, bought ten thousand acres of the tide country from the British East India Company and started the first cooperative venture in the country, making new settlements in Gosaba, Rangabelia, Satjela, Lusibari and other places which had once been inhabited but abandoned due perhaps to natural calamities.

We moved twice through the waterways of the forest, crossing the rivers and viewing some animals, birds in particular. The vast beauty of the jungles is open to risk taking brave nature lovers, guarded by dangerous animals led by tigers and snakes. Not only mangrove trees with gnarled roots and branches in sometimes foul smelling muddy areas spread but there are glades in between where the rising moon shines at night spreading peace in the wild world far beyond the hum drums of the cities.

Humans worship Bonbibi, the presiding deity of the forest before going for such ventures like honey gathering and fishing besides collection of firewood. And with her are worshipped Gazi Saheb, Dakshin Ray and Pir Badar, all associates of her regime. Often some of them are killed by tigers as someone indicated showing an abandoned boat of a solitary fisherman who was suddenly caught and dragged by the dangerous king of the jungle from behind with his fresh catches in a small net.

An interesting tale to tell about the Sundarbans is its appreciation by a renowned poet Ted Hughes, a poet Laureate of Great Britain, who visited Sundarbans and commented; a poem in Visitor's book, on 22 November 1989:

Four things created by God-

For the Sundarbans God created the Royal

Bengal Tiger-

Whose eye

Keeps the world in awe.

For the singers God created

Her voice.

For the poet-

His words.

For Bangladesh-

The Sundarbans.

What happens to the Singer-

who loses her voice?

What happens to the Poet-

who loses his words?

Bangladesh take care-

of the Sundarbans.

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Pichhavaram

Pichhavaram in Tamil Nadu is not a sea beach. No sands, no waves to thrash its non-existent shores. As delta land we do not find rivers falling in it. Sea is the destination of rivers but Velar and Coleroon join the sea through its backwater, connecting delta land from vellava to collidam. It looks like big canals with lanes and by-lanes in water bodies. At each turn there is

muddy landmass or islands inhabited by different trees and shrubs, mangroves specially, spreading their branches and tubes all around. While the mangroves cover the land portions extending their gnarled roots hugging the water they hold the alluvial soil from erosion and extend their roots over the watery soil. Mangroves saved the islands from a greater destruction wrought by Tsunami as everywhere else. Mangroves either saved or mitigated the virulence of the attack on 26 December 2004.

Ever growing and protective, mangroves of Pichhavaram have their own beauty on earth and water, calm and serene as they are; sheltering birds, fishes and other living species. No big predators like Royal Bengal Tigers are there in this modest forest but it has its own character. Pichhavaram is considered as one of the three healthiest mangrove forests of the world. It is only at a distance 14 km from Chidambaram in Tamil Nadu. We moved in narrow boats through the quite water ways enjoying the calm quietness of Nature away from all hullabaloo of the human forest.

Mangrove Forest of Odisha- Bhitarkanika wildlife sanctuary

In Odisha mangroves are spread over an area of 221 sq. km. Bhitarkanika wildlife sanctuary is located on eastern coastal region of India. The area of Bhitarkanika forest block is 1712 ha, comprising of Dangmal 636 ha, Kakranasi 310 ha, and Thakurdia 272 ha. Two of the forest blocks, viz, Thakurdia and Kakranasi are situated closer to the Ekakula Nasi (sea) at Maipura River mouth region. The Dangmal and Bhitarkanika Blocks situated at a distance of about 15 kilometres from the Maipura River mouth constitute the core area of the Bhitarkanika wildlife sanctuary and are given maximum attention for conservation and management.

The Pleistocene deposits comprise of clay, sand, silt, and ‘kankar’ with reddish brown cemented pebbles and gravels due to high degree of oxidation. Human population of villages,

within the sanctuary and surrounding it, has been growing very fast due to heavy influx of refugees and other outsiders. Habitations are reported to have started by clearing mangrove forests. A total of 81 villages are situated adjacent to the mangrove forests. The human population increase is attributed as one of the reasons for decrease in the quality of mangrove cover. Thakurdia and Kakranasi blocks are more frequented by humans than Dangmal and Bhitarkanika blocks. All the forest blocks are islands of varying sizes. An Ecological Analysis of Mangroves Ecosystem of Odisha on the Eastern Coast of India comprising of 649 Climate Coastal regions of Odisha falls under the tropical monsoon climate. Here too brine water plays the major game in the coastal areas.

Most important weather phenomenon is the prevalence of tropical cyclones. The Bhitarkanika sanctuary is bounded by River Dhamra on the north, River Hansua on the west and Bay of Bengal remains on the eastern and southern portion of the landmass. The area is notified as marine sanctuary which covers 35 km seacoast known as 'Gahirmatha Coast'. This particular coast is famous for the migration and hatching of Olive Ridley Turtles in seasons. This area, with about 200 km of water body inside the sanctuary, is located in the eastern region of the rivers Brahmani, Baitarani, Kharasrota, Dhamra, Pathasala, Maipura, Hansua, and Hansina with numerous creeks, channels, and nallahs, thus providing the peculiar ecological niche. Let me quote here some lines from a poem where the laying of eggs by the turtles is celebrated:

Once in a year for the passionate call of Nature
they come together close in passionate grip that hold
each other; swimming, jostling and falling;
O behold, till the females conceive.
Once in a year for breeding, the pregnant mother

far away from their familiar habitat
deep into the womb of the vast warm ocean, sets out.
Negotiating the massive cross currents and huge waves
compelled by the pressure of Nature and Time
they reach the mouth of the river at the twilight hour
at the confluence of Rashikulya and the ocean sublime
in Odisha as in Mexico, Nicaragua, Costa Rica and Panama.
At the beginning of the darkness and the end of the light
the Olive Ridley turtles at last arrive: Arribada!
They walk and crawl, one after the other, with flippers on
arrive in hundreds, thousands and millions overnight.
They spread on the virgin beach aright
dig long tubular holes and lay down their eggs white
in large quantity in haste with untold frenzy
as if to get at last unburdened.
Then they prostrate on the beach in moonlit night
to dream in sleep a massive peace;
O behold, an uncanny scene synchronizing in time,
the yearly Turtle Breeding Festival, Nature's rhyme. 1

(Mukhopadhyay/ 2017/Arribada/ Environment 63)

A total of 29 mangrove species were recorded across all 4 sites. Hertiera littorasis and Tamarix troupii were found at Dangmal site, Instiga bijuga at Bhitarkanika and Avicennia marina at Thakurdia. Eight species of mangroves are pesent at all the four sites. Maximum

species turnover was observed in the case of Bhitarkanika followed by Kakranasi. Species evenness (also termed as equitability) and species richness influence the species diversity. Species evenness at Thakurdia and species richness at Bhitarkanika forest was greater.

In Odisha mangroves forests represent both riverine and estuarine habitats with large network of rivers and delta discharging fresh water sediments and nutrients in this region. Our results indicate that the riverine mangroves ecosystem of Odisha is favourable habitat for a diversity of mangroves species. (Article-PDF- "An Ecological Analysis . . . Coast of India" by Upadhyay and Mishra)

Of the three sites presented above, I visited some parts of the first two fields and witnessed the nearby sites of the Bhitarkanika in Odisha. I visited Chilika-Nalban bird sanctuary. In my view the expanse and volume of everything in Sundarbans is such that it may be compared to a vast and complicated human story making it a great and voluminous epic. The sleek and slim Pichhavaram is like a poem and Bhitarkanika is a reportage by experts of another wildlife area between the seas. It must have grown further and undergone some changes. It draws attention by the presence of the Olive Ridley turtles and other ever changing phenomena.

Threats to the Survival of Mangrove

The important eco-forests have become highly threatened by human actions; some governments declaring one as Wasteland using it for miscellaneous purposes including construction of bridges, roads and settlements, humans dumping pollutants in them have not only choked their life breath but have endangered human and animal lives around the coastal zones; the effects spreading to vaster areas. Diversion of water by construction of dams and bunds reduce its available fresh water resources. Urbanisation, salt production and shrimp culture are done at the cost of mangrove forests. Oil exposure damages its health. Herbicides and pesticides

used in coastal lands also affect its health. Fishers sometimes cut the trees to pave the way for anchoring boats near their sites. On the whole increased human population affects growth of mangrove forests in various ways. Survival of such forests is for the benefit of man and Nature; its survival and growth helps survival and growth of the others. Though Governments sometimes and Environmentalists take care and try to conserve their health, those efforts aren't enough unless everyone concerned is made aware of its importance and danger of losing its existence.

An Example of the Awareness

Excerpts from a report by the Indian Express on 12.2.2023 are cited below to show the awareness and actions of the Government and the people who are benefited by the mangrove forest in many ways:

"In May 2020, when super cyclone Amphan hit the coast of Sundarbans, wreaking havoc in the region, the mangroves played a big role in protecting the life and livelihood of millions of people by acting as a bio-shield and protecting the embankments. It was found that wherever the mangroves were deforested, lost and destroyed, the embankments were breached and saline waters inundated agricultural land and ponds causing further damage to the fragile terrain. It was then that 'Mangrove Mission' was conceived for eco-restoration of the area and also to protect the city of Kolkata from the wrath of cyclonic storms."

"THE RIVER bank adjacent to Dakshin Durgapur Ferry Ghat, off Mousuni Island in Namkhana block, South24Parganas district, is lined with two-foot-long mangrove trees. Local residents employed by the district administration are responsible for taking care of the trees, which were planted in 2020 and 2021 as part of the 'Mission Mangrove' initiative of the West Bengal government to protect the large area of Sundarbans from adverse effects of tropical cyclones."

"'The programme was undertaken by the district MGNREGA Cell and administration of South 24Parganas and implemented by the forest department, involving local communities, especially women. They were made aware of the adverse effects of cyclonic storms and the usefulness of mangrove trees. It is completely a project for the people of Sundarbans, which is being implemented with the help of local villagers. This has generated income for them as they are being employed under MGNREGA,' said South 24 Parganas District Magistrate Sumit Gupta, who is one of the recipients of the Indian Express Excellence in Governance awards." 2

(Indian Express-12.2.2023)

Conclusion

In most areas of the world mangrove formations have simply been exploited with little or no attempt to manage the resource on a sustainable basis. The management of mangrove forests under selection and clear-felling silvicultural systems is practiced in a limited number of countries, mostly in Asia. Only a small portion of global mangrove resources is currently under any active management. It is important that due attention be given to the management of this important resource and that all viable areas of mangrove forests be brought under active management through clearly formulated silvicultural regimes. It is heartening to note that recently several countries have seriously taken up management of mangrove plantation and the rehabilitation of degraded mangrove formations.

A look inside the mangrove forest may sometimes seem ugly, living there for humans may be problematic and cumbersome but viewing it from outside and around is soothing and pleasing, considering its overall effect on humans and environment; when it is realised how much they protect us from the vagaries of nature and how much they help humans and others

live better lives. The overall beauty of and benefit from the mangrove family received by all needs acceptance with gratitude.

Notes and References

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