

The Role of Mangrove in Managing Ecosystem in Indian Sundarban

Abstract

Sundarban is a storehouse of the largest tract of mangrove forest in the world. Stretching approximately 10,000km¹ the Sundarbans in the Northern Bay of Bengal is the largest adjacent mangrove forest on earth. This mangrove ecosystem of Indian subcontinent is well-known for providing for food, fuel medicine, timber, and valuable ecological and economic resources. The Sundarbans also works as a shield against coastal erosion wards off cyclones and their devastating effects. The ecological system of the Sundarbans is endangered and fragile over the years. The major threats to mangroves are urban development,upstream development mining, aquaculture, and unusual weather events, slow onset of climate change effects and excessive exploitation and human intervention of other resources of the Sundarbans.The paper explores how the mangroves of Sundarbansacting as a catalyst of maintaining ecosystem and biodiversity offers different strategies for the conservation of mangroves not altering the local livelihood.

Keywords: Mangroves; Biodiversity; Sundarbans; Environmental Change; Ecosystem.

Introduction

The Sundarbans is the largest single tract of mangrove ecosystem in the world (Hussain&Karim 1994; Anon. 2001b; Siddiqi2001). But day-by-day mangrove deforestation is occurring at a rate of 1-2% per year, which clearly indicates an unusual imbalance in nature. The present rate of global warming upsets the survival of entire ecosystems. Among the most prone-risk of ecosystems are the mangroves. Most of the people take recourse to Sundarbans ecosystem for their livelihood and sustenance through fishing, collection of honey and fuelwood/timber (Zoological Survey of India, Annual Report 2009-10).These people are poor and have fewer years of education, employment and income, therefore their dependence on mangrove is greater (Hussain and Badola, 2010).²But a few people can apprehend the importance of these goods and raw materials in terms of their multiplier effects at local and national levels in terms of their economic value, or their utility of local livelihoods and poverty alleviation. In spite of multiple benefits, mangroves are under severe pressure from competing resource uses, boosted commercial activities and urban development demands.

There is no substantial change in the total area of mangrove forests over the last few centuries. Mangrove communities are recognized as highly productive ecosystems that provide large quantities of organic matter to adjacent coastal waters in the form of detritus and live animals.³The instability arises because nutrients, particularly nitrogen, stimulate growth of shoots relative to roots,⁴ thereby enhancing productivity during favourable periods but increasing vulnerability to water stress during drought. Participation of the local people for the conservation of the forests and effective integration of the interests and primacies of the local people into forest management are necessary. The availability of adequate fresh water is a determining factor in upholding the ecosystem of the Sundarbans. Mangroves can subsist in areas where there is sufficient fresh water flow. The process of aquaculture in mangrove area acts as a barrier to regeneration and survival of mangrove seedlings.⁵

The Main Text

The Sundarbans is the largest mangrove forest and the only mangrove tiger land in the world. The Sundarbans figures among the other mangrove forests for its extraordinary wildlife diversity. There are arguments about the first settlements in the Sundarbans.However, permanent human habitation was made possible after the clearing of the forest in low-lying tracts and the construction of circuit embankments while



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the area was still in a condition of immaturity. Settlement in the Sundarbans mainly included migrant population from the adjoining districts of Midnapur, and also from central India, mostly the marginalized and tribal populations who came in search of work and land who were initially recruited by the British to make the embankments.

The Sundarbans biosphere reserve programme undertook in the early 1970s. The chief objective was to preserve the biodiversity of the region and create a new knowledge base about it. It is significant to involve humans into the integral part of the ecosystem by way of bringing the local communities into the ambit of the conservation programme. Global climate change is one of the major debates that are getting a lot of attention to be focused on. The mangroves are the most prone-risk ecosystem that gets major focus. Mangrove species have established plentiful tolerances to change in sea level, salinity, and storm. But of late mangrove deforestation is occurring at a rate of 1-2% per year, which clearly speciesthat most forests will vanish within this century. The aim of the review is to critically examine the impact of climate change on the mangrove ecosystems and the policies to be taken to stop the fast deteriorating rate of mangrove. Mangroves have considerable flexibility to vacillations in sea level due to their ability to actively adopt their environment through surface elevation change processes, and their ability to migrate inland over successive generation.⁶Mangrove forests promote sediment trapping and retention through a variety of mechanisms including (1) slowing water velocities through aerial roots thus promoting deposition of sediment.⁷(2) microbial filamentous algal mats trapping and binding sediment; (3) accumulation of litter and woody debris.⁸

The purpose of this paper is to highlight problems associated with current situation of the Sundarbans mangrove wetlands ecosystems. A contribution towards the development and implementation of management plan for mangrove wetlands resources to ensure that fresh water is supplied to the Sundarbans by the Ganges have been proposed. In this situation, water salinity simulation and modeling would be an appropriate tool for decision making and aid planners to protect the Sundarbans ecosystems in future. Analysis of problems from ecological perspective as well as socio-economic and transboundary water allocation and governance analysis could be a better understanding of Sundarbans coastal mangrove wetlands and a means for improving management policies to protect these globally significant natural resources.

Imbalance of Ecosystem in the Sundarbans

The Sundarbans mangrove ecosystem is delicate, dynamic and complex and its principal parameters are the environmental, the flora, the fauna and human interference.(Chaudhury 1984).⁹They protect the vulnerable embankment from tidal surges and act as bio shield against storms (Sathirathi and Barbier, 2001)¹⁰Most of the people depend on Sundarbans ecosystem for their livelihood and

sustenance through fishing, collection of honey and fuelwood/timber (Zoological Survey of India, Annual Report 2009-10).These people are poor and have fewer years of education, employment and income, therefore their dependence on mangrove is greater (Hussain and Badola, 2010)¹¹. But very few people can realise the importance of this rear ecosystem. Every year mangroves are being demolished during prawn seed collection by the villagers or swallowed by their domesticated animals. Therefore, the rivers channels in the Sundarbans turning silted and the landscapes are altering. Such activities can, therefore, have a far-reaching impact on the well-being of mangrove.(Central Inland Fisheries Research Institute, Barrackpore, Kolkata-700120(West Bengal). The balance will become fragile, because excessive exploitation can undermine the resource availability (Chowdhury, 2010)¹².

Major challenges to the survival of Mangrove

Mangrove forests are among the most endangered habitats in the world, mangrove loss is widespread across the globe. The greatest menace to the world's mangrove forests is fast expanding shrimp aquaculture industry. Hundreds of thousands of acres of lush wetlands have been cleared to pave the way for artificial ponds that are densely packed with shrimps. Aquaculture and agriculture growth acted as a major threat to the destruction of mangrove forest. For lessening the salinity of the soil mangroves are ruined and reclaimed with rain water. Then it required making embankments for protecting soil water intrusion. Undoubtedly, the process of aquaculture in mangrove area acts as a barrier to regeneration and survival of mangrove seedlings.¹³High salinity restricts the growth of mangrove vegetation which brining about changes in species composition. The recent increase in water and soil salinity has upset the natural equilibrium of the delicate ecological balance required for the healthy growth and existence of the rich flora and fauna (Khan et al. 1994).¹⁴

Severing of mangroves for fuel, timber and charcoal

More than half of the population depend heavily on the goods and services that the forests offer. Wood is an important source of forest revenue and contributes over 80% of the income generated in the Sundarbans¹⁵.Mangrove has intrinsically high calorific value of wood and high strength. But people are destroying mangroves for firewood, charcoal and timber collection.¹⁶ Mangrove wood is in high demand for chipboard and paper industry. Because of its high industrial value, mangroves are arbitrarily cut down. The annual value of the wood products removed from the Sundarbans reserve forest is about100 million United States dollars. Apiculture is widespread within the Sundarbans mangrove forests and offers honey and wax. Approximately, 2000 people are involved in beekeeping in the Indian Sundarbans, producing nearly 90% of the total natural honey production in India.¹⁷The mangrove proper is the only basis for shrimp larvae supplying the aquacultures. The mangrove forests are an important source of fuel wood for the local population as well as other markets of Bangladesh.¹⁸ If this process continues unabatedly

biodiversity conservation and management of the Sundarbans will jeopardise the ecological balance of the Sundarbans.

Reduction of Fresh Water and Tidal Water Flow

The availability of adequate fresh water is very important to maintain the ecosystem of the Sundarbans. Mangroves can grow in areas where there is adequate fresh water flow. But it has been observed that the landscapes undertook changes during the early 19th century upsetting the saline fresh water balance.

Along with the effects on the vegetation, human intervention also disturbs faunal communities, in particular fishes. Extreme pollution, sediment load, and salinity in water has incremental effects on the faunal reproduction and growth, as well as disturbing composition and distribution patterns.¹⁹ Indiscriminate construction of circuit embankments to make the island habitable since the British period, but it resulted in altering natural geomorphological processes of delta formation.²⁰ Paucity of fresh water and tidal water influx increased the salinity making room for poor germination, growth and regeneration of mangroves. Due to reduction of fresh water inputs, species such as *Heritiera fomes* and *Nypa fruticans* are reducing in their population.²¹ The recent surge in water and soil salinity has dishevelled the natural equilibrium of the subtle ecological balance needed for the healthy growth and existence of the rich flora and fauna. No doubt, these degrading processes may have adverse effects on different interrelated components of the Sundarbans' biodiversity.²²

Mangrove acts a shield to nature fury and climate change

Mangroves provide a wide range of ecosystem services, including nutrient cycling, soil formation, wood production, and fish spawning grounds, ecotourism and carbon (C) storage.²³ Mangrove forests act as a shield to freak of nature especially tropical storms and tsunamis. Though a series of cyclones such as Sidr in 2007, Nardis in 2008, Aila in 2009 and above all Fani in 2019 mangroves works as a buffer to these distressing events, there is no denying the fact that the capacity of the regeneration of mangroves has been deteriorated. Recent study indicates a further increase in the frequency of cyclones, particularly in the late monsoon season,²⁴ as well as a higher intensity of storms in the months of May and June between 2070 and 2100. The mangroves have an intrinsic capacity to recover themselves though being smashed by storms.²⁵ Most importantly, the vast tracts of mangroves can protect adjacent land and human populations from storm surges of water caused by high intensity coastal storms and hurricanes.²⁶ Besides devastating cyclones such as Aila, tidal bores and high tides, though in a minimal intensity is equally damaging, has play an incapacitating effect on the ecosystem. The other significant and palpable change is the rise of sea-level, due to global warming, anthropogenic drivers, and land subsidence, which eventually affects the mangrove forest and vulnerable, coastal communities.²⁷ Thus mangroves play a

dynamic role in erosion control as well as protecting from tropical storms and tsunami.

Problem

The Sundarbans mangrove forest is used for a range of forest products, including lumber, thatching materials, and wood for fuel. Transportation and retailing activities are the main sources of income for a large number of people in the southwestern part of the country (Hasan and Rahman, 2001)²⁸

The Sundarbans ecosystem rests on the availability of adequate fresh water. However, the landscapes started to change during the early 19th century when part of the Sundarbans failed to maintain the saline fresh water balance. Salinity levels swelled in the Sundarbans when intake-mouths of the Mathabhanga, Kobadak and other rivers that used to carry fresh water from the Ganges to the south were silted up and thus snapped their connection with the Ganges. Consequently, the regeneration of Sundari, the leading timber species in the forest was decreased in the southwestern part of the Sundarbans.

The growing salinity and pollution has also jeopardised the health of the forest. This is apparent from the top-dying of sundari (*Heritiera fomes*) trees. In addition to changes triggered by the construction of the Farraka Barrage, the landscapes around the Sundarbans have further been changed by enormous shrimp cultivating operations and the vegetation is disappearing owing to high salinity and chemical fertilizer used in the shrimp farms. Every day fifty thousand fishermen and local stakeholders enter the Sundarbans for fishing and the collection of natural resources. Besides, construction, urbanization and tourism activities inside the forest are instrumental in changing the mangrove landscapes in Sundarbans areas. The ecological and economic importance of mangrove ecosystems is confirmed by various studies claiming a correlation between the protective function of mangroves and the loss of lives and property caused by coastal hazards. Significantly, the degradation of this unique ecosystem holds out a matter of concern highlighting the fact that fruitful conservation of natural resources is an urgent need.

Review of Literature

W.W. Hunter (1875)-A Statistical Account of Bengal: Districts of the 24 Parganas and Sundarbans covers the part of the revenue history of the Sundarbans.

W.W. Hunter (1903-1904) The Imperial Gazetteer of Bengal listed place's names and gave statistics and other information of Sundarbans.

F.D. Ascoli (1921) A Revenue History of The Sundarban looks at the area bounded on the north by the limits of Permanent Settlement in 24-Parganas, Khulna and Bakarganj districts and on the south by the sea face stretching from the Hughli estuary to the mouth of the Meghna River.

S.J. Curtis (1933) Working Plan for the Forests of the Sundarbans Division (1931051) Vol.1 conducted the inventory and prepared the map by physical survey of the Sundarbans.

Annu Jalais (2010) Forest of Tigers: People Politics & Environment in the Sundarbans explores

what do tigers mean for the islanders of the Sundarbans. He also discusses the diverse origins and current occupations of the local population.

Nirmal Kumar Halder and Swan Wagner (2012)-Climate Change Effect in the Sundarbans tries to do a case study on the last severe cyclone SIDR (2007) of Bangladesh and its damaging effects on natural resources like forest, agriculture land livestock, infrastructure etc.

Subodh Chandra Pal and MonisaShit (2013)-Mangrove Forest, Sundarbans, West Bengal highlights different aspects of destruction and degeneration of mangrove of Sundarbans. Emphasis is also given to the germination, seedling morphology, their growth and development beyond the intertidal zone.

Amal Kumar Sarkar(2015)-Mangroves and their Ecological Impact on Sundarbans Ecosystem of India deals with the identification, phonological observation, seedling growth and development of different mangrove species of Indian Sundarbans. It is also a holistic approach towards conservation and management of the vulnerable ecosystem of the Sundarbans.

AmitavGhosh (2016)-The Hungry Tide explores topics like humanism and environmentalism of the people living in the Sundarbans.

Prashant Kumar Sharma (2018)-The Impact of Climate Change on Sundarbans focuses on the likely impact of climate change on ecology and biodiversity of the Sundarbans examining issues like loss of mangrove forest, salinity intrusion, coastal erosion, tidal inundation, livelihood conditions socio-cultural ramification, cross-border security displacement and illegal migration and refugee movement.

Selvarani Selvaraja (2019) Stripes of Sunderbaniputs emphasis on the swamps of Sundarban in India. It also speaks of local myths, many other inhabitants of the swamp and an inspiring tale of a local girl with growth mindset.

Hypothesis

The ability of mangroves to deliver protection against tropical storm surges has been debated since 1970. Theoretical models imply that mangroves reduce shorter wave's more than longer waves and field experiments endorse that relatively narrow strips of mangrove can substantially lower the energy of wind-driven waves. Widespread tracts of mangroves can save adjacent land and human populations from storm surges of water wrought by high intensity coastal storms and hurricanes. A healthy mangrove forest can also stop salt water intrusion avoiding damage of freshwater ecosystems and agricultural areas. Mangrove forests lessen the rage of cyclonic storms and gales and minimize the effect of the rising of sea level due to global warming. The physical stability of mangroves helps to check shoreline erosion, protecting inland areas from severe damage during hurricanes and tidal waves. Mangroves can be spoiled by storms or freezes but usually recuperate. Aquaculture in mangrove areas is another burden on regeneration and existence of mangrove seedlings. People are exploiting mangroves for firewood, charcoal and timber collection. Pollution Mangrove

patches in cities such as Mumbai and Kolkata are upset by discharge of large amounts of solid wastes and effluents from various sources. Pollution has made the habitats problematic for mangrove survival and growth. Natural calamities frequent occurrences of tropical cyclones, storms and tsunamis, have smashed the mangroves of India. The tsunami that occurred in 2004 triggered huge damage of mangroves in the south coast of India and Andaman and Nicobar Islands. Embankment construction and siltation at the river mouth impede tidal water flow in to mangrove swamps. Decrease in fresh water and tidal water inflow increases the salinity of these areas, resulting in poor germination, growth and regeneration of mangroves. In Sundarbans, due to reduction in fresh water inputs, species such as *Heritiera* fomes and *Nypa* fruticans are diminishing in their population. According to Duke, this may lead to the population at greater risk of local extinction. Most mangrove regions in India are suffering from hostile species which disorder the ecological balance and dynamics of the mangrove ecosystem. For example, in Tamil Nadu and Andhra Pradesh, the fast invasion of *Prosopis* species can be considered for Invasive species. Climate change is one of the most important environmental hazards impacting mangroves in India. The local people were aware of and valued the functions performed by the mangrove forests in protecting their lives and property from cyclones and were ready to cooperate with the forest department with regard to mangrove restoration. Tropical cyclones and storms are more common in the Bay of Bengal thus severely disturbing the east and south Indian coast as compared to the Arabian Sea. However, mangroves lessen the fury of cyclones and act as defensive towards this natural calamity. Scientists who have studied coastal vegetation have demanded that coastal vegetation, both mangrove and beach forests, offer protection from "extreme" events such as tsunamis as well as "during less energetic but more recurrent events, such as tropical storms". However, post-tsunami observations showed that the damage in the form of lives and other property loss in villages which were behind mangrove wetlands were less. It has been noticed that several villages of Pichavaram mangrove region of Tamil Nadu which are under direct physical coverage of the mangroves were protected from wrath of the tsunami, though they are close to sea. It clearly implies that mangrove forests played a vital role in alleviating the impact of tsunami. The role of mangroves in lessening tsunami waves has been proved scientifically and it depends on the water depth, the wave period, the wave height, the species of mangrove trees, the thickness of mangrove forest and diameter of mangrove roots and trunks. My hypothesis is to assess the value of mangroves in terms of economy, ecology, environment, sustainability and maintenance of balance between nature and human beings. I have also mentioned the means and ways to protect the degrading position of mangroves of the Sundarbans.

Research Design

Case study on the coastal belt of the Sundarbans is to be done. First of all the collection of

data on the studied areas is to be gathered. A multi-faceted approach on the basis of historical maps was used to ascertain the changes in the mangrove-covered area over a span of about 100 years. In spite of umpteen interests in the protective value of mangroves systems, refining the methodology for evaluating their coastal protection benefits is an urgent need. Previously, a lot of studies have been carried out to assess the flood and natural calamity mitigation services by way of replacement of coastal habitat.

Undoubtedly, the human-made alternative method is hardly the most expensive means of providing services. Alternatively, if we put emphasis on the growing wetland area, namely through ecological restoration and nature-centric approaches, then the loss of human lives might comparatively be eschewed. This will help us in devising ways of protecting the loss of mangroves and keeping the ecological balance. I have also used primary and secondary sources to substantiate the article. Face – face interviews have also been conducted with the local people living in the areas to evaluate the importance of mangroves. In this way a better way of solving the problem is to be sorted out.

Findings

Ecosystem always consists of a coastal wetland, such as a marsh or mangrove. It is true that a proportion of wetlands is vanished or converted; the ecological landscape is bound to be shrunk. More wetland area refers to more protection. Mangrove ecosystem should be assumed as a means of protection rather than as market-centric services. Apart from this, there needs to be an adequate number and variety of constructive policies should be undertaken by the government to stem the gradual erosion of mangroves. But the governmental policies are not sufficient to attain these objectives. The involvement of local knowledge in controlling the ecological balance in the coastal areas is the need of the hour. My proposition is that along with the governmental monitoring the knowledge and perception of the local people of the coastal area and expansion of mangrove-infected area is optimal importance. Moreover, it is to be comprehended the drivers behind socio-economic constraints, livelihood choices and the nature of socio-ecological interface among the people living near the coastal area. The alienation of islanders from the coastal area of the Sundarbans will only exaggerate the problem. Hence, a mutual co-existence between nature and human beings is to be maintained.

Conclusions

Sundarbans mangrove forest is inimitable in its characteristic. It functions as a habitat for many species as well as the house of rare and protected Royal Bengal tiger. It also supplies food and water for millions of its inhabitants and potential ecological shield against various natural hazards. The Sundarbans creates significant economic value from the provisioning and cultural services. Therefore, the importance of the Sundarbans has extended beyond its boundary and arrests the attention of the global forum. But over the years the ecosystem services of

the Sundarbans mangrove have endured significant changes by way of human intervention as well as climate changes and extreme weather events. Climate change along with other natural and anthropogenic factors is destroying this unique mangrove ecosystem. It is, therefore, important to mention that necessary management schemes should be espoused to lessen the impact the climate change and ameliorate the potential benefits of the ecosystem that caters to the needs for the forest dependent livelihoods in present and future. What is more important is that it is essential to design a new paradigm of management bearing in mind the potential impacts of climate change, ecological integrity and sustainable development along with inclusion of local perceptions through a thoughtful and concerted manner, but not taking conservation and climate change adaptation inversely. Finally, a deeper perspective of guaranteeing environmental security, reducing disaster risks and as a pre-emptive adaption measure necessarily upholds the clue for futuristic sustainable environmental and ecological development.

Suggestion

Significantly, the impending and perceptible threats and challenges to the mangroves of Sundarbans are taken more seriously in overall coastal management. After Tsunami in 2004, Indonesia and Malaysia made it obligatory for coastal barrier plantation. But India is still lagging behind developing similar policies. The Environmental Protection Act of 1986 is unquestionably a positive step towards the protection of fabulous coastal resources of India. But it entails a robust implementation for the sustainable management of mangroves of Sundarbans. Moreover, appropriate management plans should be kicked off to realise the properties and proper functioning of ecosystem of mangroves. Mobilisation of the local people for the conservation of the forests and fruitful integration of the interests and priorities of the local people into forest management are required.

Endnotes

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