Archives of Agriculture and Environmental Science 7(4): 559-563 (2022)
https://doi.org/10.26832/24566632.2022.0704012

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes

ORIGINAL RESEARCH ARTICLE

Impact of changing environmental scenario on biodiversity of mangrove forest of Sundarbans Delta Region, India

Nelofar Tanveer* and **Meena**

Assistant Professor, Department of Chemistry, Vivek College of Education, Bijnor (U.P.) INDIA
*Corresponding author's E-mail: tanveernelofar597@gmail.com

ARTICLE HISTORY

Received: 25 October 2022
Revised received: 09 December 2022
Accepted: 19 December 2022

Keywords

Biodiversity
Climate change
Mangrove Forest
Sundarbans

ABSTRACT

Sundarbans is the world's largest contiguous mangrove forest and is a designated world heritage site, shared by India and Bangladesh, it is home to several species including tigers. The habitat supports approximately 4.37 million people. Mangrove ecosystem is a unique, fragile, highly productive ecosystem in the sea-land interphase, is the conglomerations of plants, animals and microorganisms acclimatized in the fluctuating environment of tropical intertidal zone. This ecosystem is a highly valued ecosystem in terms of economy, environment and ecology. This mangrove ecosystem of Indian subcontinent is well known not only for the aerial extent, but also for the species diversity. The biodiversity of Sundarbans includes numerous species of phytoplankton, zooplankton, microorganisms, benthic invertebrates, molluscs, amphibians and mammals. As per the research conducted it is believed that the Sundarbans have soaked in 4.15 crore tonnes of carbon dioxide. But the scenario has been changed during past few decades. Due to climate change the Sundarbans faces several challenges. Recorded data shows that a huge number of flora and fauna were compelled to be eliminated due to the consequences of climate change during the last century. Climate change components that affect mangroves and its inhabitants include changes in sea-level, high-water events, storminess, precipitation, temperature, atmospheric CO_2 concentration and ocean circulation patterns. The study was conducted to identify the threats on the diversity and its effect on the socio-economic condition of the local community. With risk of the Sundarbans submerging, there is an urgent need for global reduction of emissions and replacement of fossil fuels with renewable energy.

Citation of this article: Tanveer, N., & Meena (2022). Impact of changing environmental scenario on biodiversity of mangrove forest of Sundarbans Delta Region, India. *Archives of Agriculture and Environmental Science*, *7*(4), 559-563, https://dx.doi.org/10.26832/24566632.2022.0704012

INTRODUCTION

The Sundarbans covering about one million hectares in the delta of river Ganga, Brahmaputra and Meghna is shared between Bangladesh (~60%) and India (40%) is the world's largest coastal wetland. The Sundarbans has a great diversity of mangroves species (26 true mangroves and 36 mangrove associates). Mangroves are the only woody plants occupying the margin between land and sea in low latitudes. Today, approximately 70 genetically diverse species constitute the mangrove flora (Spaulding *et al.*, 2010). The mangrove forests of the Sundarbans are also the most significant strongholds of the Royal Bengal Tiger, an endangered species. The region is also unique because the human population that exists on the fringes of the coastal forest in land has been slowly adapted to cultivation over the last two centuries confronting challenges from land, air and sea that few other local populations face. It is also a unique region as it is one of the most important Biosphere reserves among the 269 of the 74 countries worldwide. It is further unique because of the floral and faunal diversity of the delta (Blasco, 1975). Evolutionarily adapted to coastal environment, an ecologically distinct group of halophytic plant communities found in tropical and

subtropical shores may be defined as mangroves. Some workers viewed those plants growing in between the highest and the lowest tidal limits may be considered as 'mangrove' (Blasco *et al*., 1977). The mangroves of the forest present a natural buffer, against coastal erosion and sea water ingress into one of the most densely populated regions of the world (Datta, 2012). Mangroves are a group of highly adaptive salt tolerant plant species inhabiting intertidal zones of tropical and subtropical coastlines (Blasco, 1984) They require temporary supply of fresh, non-saline water for growth and survival (Rahaman, 2000; Liang *et al*., 2008). Ironically Sundarbans is the eco region with both in its uniqueness and its unique fragility. India and Bangladesh share the largest single track of mangrove forests in the world which is globally known as the Sundarbans. It spans about 10,000 sq. km about 4,262 sq. km of which is in India alone, with a larger portion in Bangladesh. The total area falls within the latitude between 21°13´N - 22°40´N and longitude 88°05´E-89°06´E. Among 102 islands 54 are densely populated and 48 are covered by forest areas (Liang *et al*., 2008).

Mangroves are broadly classified into two groups, i) true mangroves and ii) mangrove associates. True mangrove species only grow in intertidal zones, e.g., Heritiera fomes, Bruguiera gymnorrhiza, Avicennia alba and Rhizophora mucronata, whereas mangrove associates can survive in both littoral and terrestrial environments, e.g., Hibicus tilisaceus, Suaeda nudiflora and Thespesia populnea. Mangroves possess important ecological and socio-economical functions: i) they increase soil/sediment accretion and stabilize shorelines, ii) they trap nutrient and heavy metals and facilitate improved water quality (Alongi, 1996; Clark, 1998; Aksornkoae *et al*., 1993), iii) they serve as a reserve of food, fuel and fodder for coastal communities (Guebas *et al*., 2000; Bandaranayake, 1998). iv) some mangrove species have medicinal values (Cornejo *et al*., 2005; Pattanaik *et al*., 2008; Guebas, 2005). v) mangrove habitats act as a breeding ground for different types of amphibians, fishes, prawn, shellfishes and crustaceans vi) they serve as a home for large numbers of mammals, birds and reptiles and vii) they act as a barrier against natural disasters in coastal areas, e.g., cyclones, typhoons or tsunamis (Wells, 2006; Bahuguna, 2008; Kathiresan, 2001) Despite their ecologic, social and economic functions, these ecosystems are continuously under the threat due to anthropogenic activity and climatic vulnerability. Their monetary value is about 0.5 million rupees per hectare per year and this is greater than that of coral reefs, continental shelves and/or the open (Giesen *et al*., 2007) In south India, a mangrove species 'Thillai' is worshipped as a 'temple tree' at Chidambaram.

Distributions of mangrove forest- global mangrove cover

Total mangrove cover globally is 156,220 sq. km which constituting 62,880 sq. km in Asia, 30,270 sq. km in Africa, 23,870 sq. km in North and Central America, 21,610 sq. km in South America and 17,590 sq. km in Oceania (Table 1). Indonesia alone constitutes 23% of global mangrove cover followed by Australia (7.1%) and Brazil (7%). Food and Agriculture Organization (FAO) of the United Nations estimated reduction in mangrove cover by 18% within a span of last three decades. In Asia, Africa, Oceania and North and Central America, mangrove cover was reduced by 19%. Whereas, mangrove cover was almost remained unchanged in South America where reduction is only by 2.8% (Giesen, 2007; FAO, 2010)

Indian mangrove cover

Mangrove habitat covers an area of 4,628 sq. km along Indian coastlines which comprises of ~3% of world's mangrove forests (FSI, 2013) (Table 2). These include 1,351 sq. km of very dense, 1,457 sq. km of moderate and 1,819 sq. km of open mangroves. Indian mangrove forest was increased over the last two decades concurrent with the strict conservation and afforestation program implemented by the Government of India to recover from decline during 1990's.

Table 1. Worldwide distribution of mangrove vegetation cover (Source: FAO, 2007 and 2010).

Location	Area (sq. km)					% Change
	1980	1990	2000	2005	2010	
Asia	77,690	61,960	66,270	64,660	62,880	-19
Africa	36,700	34,140	31,780	31,020	30,270	-17
North and CentralAmerica	29,510	24,160	23,100	23,420	23,870	-19
Oceania	21,810	18,600	18,410	15,370	17,590	-19
South America	22,220	22,250	21,870	21,750	21,610	-2.8
Total	189,910	161,110	161,430	156,220	156,220	-18

Table 2. Total mangrove vegetation cover in India (Source: FSI, 2013).

State/UnionTerritory	Area (sq. km)						% change
	1987	1993	1999	2005	2011	2013	
West Bengal	2,076	2,119	2,125	2,136	2,155	2,097	-1.01
Andhra Pradesh	495	378	397	354	352	352	28.89
Odissa	199	195	215	217	222	213	-7.04
Tamil Nadu	23	21	21	36	39	39	-69.57
East coast	3,479	3,679	3,724	3,378	3,386	3,306	4.97
Gujarat	427	419	1,031	911	1,058	1,103	-158.31
Maharashtra	140	155	108	186	186	186	-32.86
Goa	0	3	5	16	22	22	100.00
West coast	567	577	1,147	1,122	1,276	1,322	-133.16
Total	4,046	4,256	4,871	4,500	4,662	4,628	-14.38

METHODOLOGY

Sunderban mangroves are a part of the world's largest delta of India and Bangladesh. The delta has formed in the estuarine region of Ganga- Brahmaputra and Meghna River. This paper is written on the basis of various available data from the citations of different authors or different agencies. For the purpose of writing this paper, we have reviewed and analysed secondary data, information and literature that is available in the public domain, including information available on official websites of several governmental agencies, scientific data and reports.

RESULTS AND DISCUSSION

Sundarbans area is cyclone-prone, monsoonal and low-lying, as a result of which changes in climate have significantly impacted the area, flora, fauna and the population living within it. In the past 25 years, sea level has risen at a rate almost double the global average. This is due to a combination of factors including land subsistence patterns. Due to continuous submergence in higher water, as an implication of rise of sea level, the plants are being noted to be shorter and narrower with fewer branches and leaves resulting in lower rates of photosynthesis and regeneration of the mangroves. The sea level rise is also affecting the availability of sediment, directly impeding the establishment of new groves.

Changes in rainfall patterns and its impact

There is widespread agreement that rainfall patterns are changing over the Sundarbans. There is evidence that rainfall has decreased during a certain phase of the season, and the pattern of rainfall has changed, making conventional cultivation of crops difficult for farmers but the amount of total rainfall has increased during last two decades (Danda *et al*., 2011). During the survey we found that traditional methods of cultivation have been put at risk, and today the farmer in the Sundarbans does not know what to grow when. Farmers in the Sundarbans complained of decreasing rainfall. They also complained of extreme and extended summers and erratic monsoons. They say that this has affected both the productivity of crops, and has made them more disease-prone, requiring larger amounts of pesticides and fertilizer to ensure adequate harvest. The most puzzling part of the rainfall changes cited by the people indicates that most of the rains do not come in the monsoons. Rainfall has shifted to the post-monsoon period. This has severe implications for agricultural productivity. The people of the Sundarbans sustain themselves mostly on rain-fed paddy. Any change in the rainfall pattern means that the rains do not come when seeds are sown. They come when the harvest is to be reaped. As a result, a large percentage of the standing crop is lost. And since most of the farmers in the Sundarbans are single crop farmers, a direct loss of livelihood resulting threat to food security occur. When it comes to rainfall, both the studies from 1990 to 2000 and 2001 to 2008 show that amount of rainfall has actually been increased over the Sundarbans. The earlier study shows that between the years 1990 and 2000, there has been a marginal increase in the monsoon and post monsoon rainfalls. The annual average rainfall of the Sundarbans is 1625 mm. However, in high rainfall years it goes up to 2000 mm and in low rainfall years it falls to 1300 mm. The 2001 to 2008 study shows a similar pattern. It concludes that in the years under study (2003-2009), overall rainfall as well as monsoon rainfall has increased over the Bay of Bengal. Therefore, at first glance, it does not appear that the complaints of decreased rainfall over the Sundarbans are borne out by scientific data. However, the marginal increase in the monsoon and post monsoon rainfall may actually be making it difficult for cultivators because they are yet to adjust to the temporal shift in precipitation which might have adverse impact on agricultural productivity.

Changes due to aquaculture and agriculture expansion

A large fraction of the mangroves in India was destroyed due to aquaculture and agriculture expansion. In India and Bangladesh, about 1,50,000 ha of mangroves were destroyed for agricultural purposes during the past 100 years. Mangroves are destroyed and reclaimed with rain water for reducing the salinity of the soil. hence, these areas were protected from soil water intrusion by forming embankments. After salt is leached from soil, these areas are used for raising plantation of coconut or paddy. Aquaculture in mangrove areas is another pressure on regeneration and survival of mangrove seedlings (Shaikh, 2013). Sometimes for aquaculture expansion people destroyed whole patches.

Changes in average temperature and its impact

The major problem in the Sundarbans appears to be that while the ambient temperature is increasing resulting in thermal expansion of water, more and more land is being degraded and eroded by the sea. It was found that there is a clear rise in air temperature over both land and sea. The observed rise is 0.019 ^{0}C per year over the Bay of Bengal, and a similar rising trend is also observed in the Sundarbans. Thus, it is found that increase in temperature has a relation to the sea level rise of the region. So, it can be concluded that increase in average temperature have worsen the factors affecting mangrove response to sea level because it can alter the freshwater inflow to mangroves, the sediment and nutrient inputs and the salinity regime and cause sulphide soil toxicity. A change in atmospheric CO_2 is another consequence relating to the increase of which will directly affect the carbonate system of the ocean thus bearing a direct impact on rich fishery resources.

Changes in salinity of sea water and its impact

Due to the consequences of global warming and melting of glaciers, salinity of the water system of the entire delta has been changing. In western part of the delta region, salinity decreases but salinity rises in the eastern part of the delta region. Metropolitan wastes are also responsible for increasing salinity. Changes in salinity are affecting the entire eco-system of the delta especially the aquatic biota. Due to increase in salinity Sundari is replaced by Gewa (*Excoecaria agallocha*) and Gewa is replaced by Goran (*Ceriops decandra*) as salinity (> 10 ppt) and high sedimentation causes top-dying (Aga-mora) of Sundari.

Table 3. Environmental threats on different floral groups of Sundarbans delta region.

Floral groups	Environmental threats
Microbes	Change in habitat & land use pattern
Lichens	Decline in vegetation cover, Developmental activities, Fuelwood collection, Impact of climate change.
Mangroves	Devoid of any high elevation zone (landward side) for the species to re-establish due to sea level rise, Habitat degradation due to industrial pollution, Timber poaching and fuel-wood collection
Algae	Increase sea surface temperature and pollution, Change inwater quality of rivers estuaries and other aquatic bodies
Phytoplanktons	Rise in atmospheric CO_2 concentration-alters thephysicochemical conditions, Acid base imbalance, reduced oxygen transport capacity.

Table 4. Environmental threats on different faunal groups of Sundarbans delta region.

Faunal groups	Environmental threats
Insects	Climatic invariability (trends in precipitation, soil temperature, moisture & organic carbon-affecting the detritus web).
Fish and crustacea	Pollution from inland waters, Usage of destructive fishing gear such as mosquito nets, Indiscriminate seed collection andshrinking of tiger prawn population.
Birds	Degradation of forest area, scarcity of food.
Mammals	Urbanization, Change in crop pattern, Breaches in embankments along the river banks due to flood.

Changes in frequency and magnitude of extreme weather events

Cyclone Aila of 2009 was the most dramatic of the climatic disasters to have recently hit the Indian Sundarbans. Residents say that the storm incidences are on the rise over the years, both in frequency and in intensity. Although the months of July to October were always the season for storms, the storms now come more often, and do much more damage than before. The people of the Sundarbans feel much more vulnerable, and they have little to protect them when these storms strike (Khosla, 2010). Pre- and post-monsoon storms are more violent than the storms of the monsoon season. Life span of a severe cyclonic storm in Indian seas averages about four days from the time it forms until the time it enters the land. Severe cyclonic storms over the Bay of Bengal have registered a 26 per cent increase over the last 120 years, intensifying in the post-monsoon period (Singh, 2007). The actual incidence of storms has actually gone down in the last decade. However, their intensity has gone up. The decadal frequency of storms in the Bay of Bengal from 1891 to 1961 as per the 1964 records of the IMD indicates that 56 cyclones occurred during 1921- 1930, while 32 storms were reported for the period 1951-1960 (Gopinath, 2005). However, the intensity of these events appears to be increasing, possibly as a result of rising sea surface temperature (Hazra *et al*., 2007). Mangrove forest protects the coastal zone against the influences of ocean as it is located in the edge of sea and land. Mangroves act as buffer against tsunami, the role of mangroves as living barriers was neglected prior to the tsunami event of December 2004, and many mangrove forests had already been destroyed or damaged. Impact of the direct and indirect effects of the climate change is represented in the (Tables 3 and 4)

Conclusion

The largest mangrove forest Sundarbans is therefore contributing to the sustenance as well as safety of living beings in the most densely populated part of the world. Unethical human interventions are the major threat to nature. Similarly, climate change: the fallout of exaggerated interventions in the name of development is horrifying the nature, including the Sundarbans. Flowing water in the rivers, canals etc. through and around the Sundarbans flush out saline water intrusion from the sea. Increase in salinity intrusion due to anticipated sea level rise is one of the major threats to the Sundari trees, which are already under threat due to increased salinity levels. Thus, the total ecosystem is now facing the peril of extinction. Some essential steps should be taken by the local administrative bodies or governing agencies or government to retard the rate of destruction of this ecosystem. Only a suitable practice of sustainable development can ensure the steady management of the biotic as well as abiotic resources of the Delta region.

REFERENCES

Aksornkoae, S., Paphavasit, N., & Wattayakorn, G. (1993). Mangroves of Thailand: Present status of conservation, use and management. International Tropical Timber Organisation, *Japan International Association for Mangroves and International Society for Mangrove Ecosystems. Okinawa, Japan.*

Alongi, D. M. (1996). The Dynamics of Benthic Nutrient Pools and Fluxes in Tropical Mangrove Forests. *Journal of Marine Research, 54*: 123-148.

Bahuguna, A., Nayak, S., & Roy, D. (2008). Impact of the tsunami and earthquake of 26th December 2004 on the vital coastal ecosystems of the Andaman and Nicobar Islands assessed using RESOURCESAT AWIFS data, *International Journal of Applied Earth Observation Geoinformation,10*: 229-237.

Bandaranayake, W. M., (1998) Traditional and medicinal uses of mangroves. *Mangroves Marshes.* 2: 133-148.

Blasco, F. (1975). The mangroves of India. Institute Francais Pondicherry. *Travaux Section Scientific Technologies*, 1: 1-175.

Blasco, F., Caratini, C., Chandra, S., & Thanikaimani, G. (1977). Main characteristics of Indian mangroves. *Proc. Int. Symp Biol Mgt Mangroves, Honolulu*, 1: 71-87.

Blasco, F. (1984). In Mangrove Ecosystem: Climatic factors and the biology of mangrove plants Research Methods (eds Snedaker, S.C. and Snedaker, J. G.), UNESCO, Paris.

Clark, M. W. (1998) Management implications of metal transfer pathways from a refuse tip to mangrove sediments. *Science of the Total Environment*, 222: 1-2, 17-34.

Cornejo, R. H., Koedam, N., Luna, A. R., Troell, M & Guebas, F. D. (2005). Remote Sensing and Ethnobotanical Assessment of the Mangrove Forest Changes in the Navachiste-San Ignacio- Mecapule Lagoon Complex, Sinaloa, Mexico. *Ecology and Society*, *10* (1), 16-24.

Datta, D., Chattopadhyay, R. N., & Guha, P. (2012). Community based mangrove management: A review on status and sustainability. *Journal of Environmental Management*, 107: 84-95.

Danda A. A., Sriskanthan G., & Ghosh, A. (2011). Indian Sundarban delta a vision. Copyright WWF-India, New Delhi. 1- 40.

FAO Forestry (2010). Global Forest Resources Assessment. *Food and Agriculture Organization of the United Nations*, Rome, Italy.

Forest Survey of India, (2013). State of Forest Report, Forest Survey of India, Dehradun, India.

Gopinath, G. & Seralathan, P. (2005). Rapid coastal erosion of the Sagar Island, West Bengal, *Environmental Geology*, *Springer Berlin Heidelberg*, *48*, 8, 1058-1067.

Guha Bakshi, D. N., Sanyal, P., & Naskar, K. R. (2000). *Sundarbans Mangal*, *Naya Prokash*,Calcutta, 20–89.

Giesen, W., Wulffraat, S., Zieren, M., & Scholten L. (2006) Mangrove Guidebookfor Southeast Asia Bangkok; Rap publication Food & Agriculture Organization of the United Nations. *Regional Office for Asia and the pacific*, 769.

Guebas, FD., Hettiarachchi, S., Seen, DL., Batelaan, O., & Sooriyarachchi S, et al. (2005). Transitions in ancient inland freshwater resource management in Sri Lanka affect biota and human populations in and around coastal lagoons. *Current Biology*, 15: 579-586.

Guebas, F. D., Mathenge, C., Kairo, J. G., & Koedam N. (2000). Utilization of mangrovewood products around mida creek (Kenya) amongst subsistence and commercial users. *Economic Botany*, 54: 513-527.

Hazra, S., Ghosh T., Dasgupta R. and Gautam S. (2002) Sea level and associated changes in the Sundarbans, *Science and Culture*, *68*, 9-12, pp. 309-321.

Kathiresan, K & Bongham, B. L. (2001) Biology of Mangroves and Mangrove Ecosystems, *Advances in Marine Biology*, 40: 81-251.

Khosla, A. (2010). How Does the Impact on Climate Change Affect the Biodiversity Loss? WWF in India. *Proceedings of 9th Asia- Europe (9THAEC-NET) Conference*, Gurgaon NCR of Delhi, India .12 -16 NOV, 1-11.

Liang, S., Zhou, R., Dong, S. S., & Shi., S. H. (2008). Adaptation to salinity in Mangroves: Implication on the evolution of salt-tolerance. SP Sci China Press, China. *Chinese Science Bulletin*, 53: 1708-1715.

Pattanaik, C., Reddy, C. S., & Dhal, N. K. (2008). Phytomedicinal study of coastal sand dune species of Orissa. *Indian Journal of Traditional Knowledge*, 7: 263-268.

Rahaman M. R, Asaduzzaman June-December (2010) Ecology of Sundarban, Bangladesh, *Journal of Science Foundation*, 8(1&2): ISSN-1728-7855. 35-47.

Shaikh, M. H. A, Srivastava, R. K. (2013) Status of mangrove conservation and management in Karnataka: *In Mangroves in India: their biology and uses*, *38*, 71-78.

Singh, O. P. (2007). Long-term trends in the frequency of severe cyclones of Bay of Bengal: observations and simulations. *Mausam*, *58*(1), 59-66.

Spaulding, M, Kainuma, M, & Collins, L. (2010) *World Atlas of mangroves*, London, Earthscan.

Wells, S., Ravilious, C., & Corcoran, E. (2006) In the Front Line: Shoreline Protection and other Ecosystem Services from Mangroves and Coral Reefs. *UNEP/ Earthprint*, England.