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Review Article

Towards Greater Sustainability in The Sundarbans

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Abstract

The remote geographical location of the Sundarbans with its proximity to the sea, complex river system - crisscrossing of tidal streams, channels and creeks, renders it extremely vulnerable to natural calamities like sporadic floods and cyclonic storms. This results in intrusion of saline water causing frequent damage to crops; insufficient sweet water resources necessary for drinking purpose, pisciculture, fisheries; occasional floods and cyclonic hazards causing loss of life and property – habitats of people are washed away by floods every year. Added to this is the highly onerous task of monitoring the huge length of embankments, lack of proper drainage facilities, inadequate electricity supply and lack of adequate communication facilities.

The problems enumerated above need to be addressed on an urgent basis for greater resilience, ecological viability and sustainability in the Sunderbans, overcoming the obstacles faced due to the changing climatic scenario. Radical solutions to these problems may be achieved by taking the following measures: Construction of closure dams across the main estuaries and interconnecting them by strong dykes encircling the entire western Sundarbans; the electricity problem may be solved by generating electricity by utilisation of unconventional energy (renewable energy) sources like wind, tides, solar energy etc. Eco tourism to be encouraged and developed, as this would ultimately benefit the local people economically. The adherence to precepts necessary for maintaining ecological balance will obviously engender environmental equilibrium. A deep water international port may be constructed in the vicinity of the Sundarbans, considering the fact that the Kolkata Port and Haldia Port are facing huge siltation problem. This will automatically foster the growth of allied industries centring around these ports and give a boost to the economy.

Detailed discussion regarding an overall development of The Sunderbans is given below.

Keywords: Sundarbans; Embankments; Tides; Agriculture; Fisheries; Eco-tourism; Renewable Energy

Introduction

Famously known as home to the Bengal Tiger-the national animal and the pride of India, the total expanse of the Sundarbans (meaning 'beautiful forest' in Bengali, or perhaps deriving its name from the Sundari or Sundri trees – the local name for the mangrove trees which comprise the dense mangrove forests), stretches across an area of about 10,000 km^2 (3,900 sq miles), of which forests in Bangladesh›s Khulna Division extend over 6,017 km^2 (2,323 sq miles) and 4,260 km^2 (1,640 sq miles) across the South 24 Parganas and North 24 Parganas districtsin West Bengal [8]. Originating from the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal, the Sundarbans Delta spans the coastal forest belt of the Bay of Bengal on the southernmost fringes of West Bengal. Comprising part of the Gangetic Delta lying between the Hooghly on the West and the Padma-Meghna on the northeast, the Sunderbans delta has been built primarily by the silt carried down by the Ganga and Brahmaputra river system. The portion lying in West Bengal is generally referred to as Western Sundarbans. The high fertility of the area attracted attention and

attempts were made to utilise the portion of the forest belt close to habitation as early as 1770. The survey, originally started under the initiative of Ensign Prinsep in 1822, was complete in 1830 at the time of Mr. William Dampier-Commissioner and Lt. Hodges-Surveyor for the Sundarbans Commission. With the demarcation of the northern boundary of the forest area for the first time by the Survey of India, the Sundarbans came into existence and thus began systematic settlement of parts of the area. This northern boundary of the forest belt has come to be known as the Dampiers-Hodges Line. At that point of time, the total expanse of the Sundarbans was about 2.05million hectares (8,000 square miles) out of which 0.791 million hectares (3,089 square miles) was in the district of 24 – Parganas in the state of West Bengal and the rest in Bangladesh [1]. The river estuaries in Bangladesh Sundarbans are wider compared to those in Western Sundarbans and there is more siltation. And so, the delta formation process is more active in eastern Sundarbans lying in Bangladesh than in Western Sundarbans under the periphery of West Bengal in India. As the delta formation in the eastern part of Sundarbans is more active and the siltation rate in Western Sundarbans is poor, the eastern Sundarbanss delta is getting elevated compared to the Western Sundarbans. It has been observed in the last few decades, that there has been consistent erosion in the left banks of the Ganga river at the upstream of Farakka barrage in Malda district. Now if the Ganga river changes its course at the upstream of Farakka barrage and flows through Pagla-Kalindi river into the Brahmaputra river, then there is a possibility of acute scarcity of water in the Western Sundarbans area. The higher the elevation of eastern Sundarbans gets, the lower the Western Sundarbans delta becomes and greater becomes the risk of Western Sundarbans from natural calamity like Tsunami. The roots of the vulnerability and susceptibility of Sundarbans to natural calamities can be traced back to the premature reclamation of land when the delta formation process was in progress by the laws of Nature. Under the patronage of the East India Company during the British regime, a number of private enterprises comprising mainly of ex-zamindars in a bid to extend their landed property, were allowed to engage in premature reclamation of land in the Sundarbans delta. During the tidal periods, the islands used to remain submerged under water most of the time. Therefore to protect the land from flooding by tidal waves, they constructed marginal dams around their lands. However these dams were not constructed in a scientific manner and the materials used were not of good quality as they were procured in haste from the nearby areas. As a result, there was greater siltation near the dams and the farther the land from the vicinity of the river, the lower it became. Thus this unplanned way of constructing the marginal dams triggered complications like acute drainage problem, dam-breaking at weaker points and water logging in agricultural land resulting in damage of crops and harvest.

Problems

The major problems in the Western Sundarbans area are lack of adequate protection against tides and waves resulting in unwanted inundation of the land causing occasional damage to crops; loss of life and property; difficulties in maintenance of a huge length of embankments; lack of proper drainage facilities; and insufficient sweet water resources. These have posedas major hindrances to the all-round development of the region having immense natural resources.

Time and again, natural disasters have posed as menace to the Sundarbans and caused huge devastation in the area. Western Sundarbans was badly hit by the cyclone Aila which made its landfall on 25th May, 2009 in the Sagar Islands in the Sundarbans with a wind speed of 100-110 km per hour [6] causing huge damage to life and property, washing away habitats. Huge number of people were rendered homeless; arable land and aquaculture ponds remained submerged in saline water for days together. As an aftermath of the tidal upheaval fuelled by Aila, almost 400 km of the existing dykes were damaged. This year the cyclone Amphan struck Sundarbans on 20th May and its impact was devastating for the millions of inhabitants of the Sundarbans as their homes were swept away, the embankments destroyed and farms inundated with saline water rendering them unfit for cultivation. Only the dense mangrove forests succeeded in dissipating some of the cyclone's wild rampage, thereby protecting a densely populated city like Kolkata to an extent.

Any scheme for planned improvement of the Sundarbans on modern lines must take these factors into consideration and aim at solving them first. The Western Sundarbans area has great possibilities for the development of agriculture, fisheries, eco-tourism, tidal power generation, and allied industries. Amenities like good

road communications, medical facilities, educational institution etc., strengthening of the embankments and increasing sweet water availability would not only help in considerable dispersal of population in the area easing great pressure on habitable land in the State of West Bengal, but also ensure greater sustainability and resilience to calamities. The development of the Sundarbans would thus be a boon to the State, and need to be addressed on an urgent basis.

Solution to the problems

These huge embankments are not all of adequate height and stability to withstand the impact of tidal waters and sea waves, and there have been occasional cases of inundation of cultivated areas through overtopping or breaches of these embankments. The raising and strengthening of the huge 3,500 km length of embankments is not only a cumbersome task to be dealt with proper expertise and care, but also involves huge recurring expenditure every year for proper maintenance of the existing embankments.

The problems enumerated above may be radically solved by reduction in the length of the embankment. The embankments along the banks of dying creeks, whose hydraulic efficiency has already been greatly reduced, may be abandoned. Construction of a master embankment of sufficient strength encircling the area might drastically reduce the length of embankments as well as afford adequate protection. This would involve closure of some of the estuarine rivers and creeks with dams along with provision of drainage sluices. In the Netherlands, similar coastal problems have been successfully tackled in this manner and the so called Dutch Delta Plan has already been executed to solve the estuarine problems in a comprehensive manner. The coastal areas of the Netherlands and West Bengal have some similarity, and it was contemplated if similar works could be carried out in the Sundarbans.

Steps to be taken

For greater resilience and sustainability in the Western Sunderbans, the following measures could be undertaken.

Implementation of engineering structure

The total length of the embankments stretches across 3500 km which have not been constructed at a time or in a scientific manner, and sourcing materials based not on quality but availability in the vicinity. As such there is no fixed pattern or uniformity and a lack of adequate strength in their construction. Thus, maintenance of this huge stretch of embankments is an enormous task, no doubt. Attempts have however been made to address this major problematic issue in the area. The marginal dykes that exist at present along the creeks in the Sundarbans area have been constructed from time to time according to individual necessity and have been effective in providing security against the occasional surge and inroads of tides and waves. Therefore, not all embankments have the required height and stability to withstand the full blast of the tidal water upsurge or the sea waves gushing over. Consequently the area has faced sporadic inundation of agricultural land by overtopping of these embankments, resulting in irreparable damage to the crops and cultivation. A possible solution could be raising and strengthening the embankments sufficiently enough all along the entire 3500 km stretch. This would not only be a very tedious and irksome task, but would also require considerable manpower and involve a huge recurring expenditure every year. Reduction in the length of the embankments could be effected to some extent by abandoning some of the embankments along the banks of the dying creeks whose hydraulic efficiency has suffered already. The method would involve closing the mouths of such creeks with sluices for drainage disposal and connecting them with the alignment of the existing embankments along the main river into which such creeks fall. Anyway this would only partially eliminate the risk of inundation. Keeping all these factors in mind, evolved the idea of Master Embankment of sufficient strength encircling the entire area which would drastically reduce the length of embankment as well as provide greater protection, in the line of the Dutch Delta Plan implemented in the Netherlands. Four years after the acquisition of the estates by the Government (in 1955), a team of expert engineers from the Netherlands Rijkswaterstaat (of the Dutch Delta Plan fame) visited the Sundarbans in February 1959 and submitted a Report with two possible schemes – the Great Master Plan,

and the Reduced Master Plan [3] to be fitted into the earlier plan. As it is not a feasible idea from the technical point of view to undertake works on the closure dams all at the same time, splitting up the project plan into different independent complete successive phases which could then be eventually integrated into one system, based on the natural divisions of the area into different separate zones, each zone governed chiefly by a single estuary (indicated by the hydrological conditions of the river systems in the area) could be done. This execution of the project in phases has an added advantage. The benefits can be enjoyed directly on completion of one particular phase and the experience gained as also the equipment used during that phase could be utilised in the following phase. However, with the passage of time, the geographical area has undergone changes in places, and even the river systems have undergone changes due to implementation of different engineering structures. Hence, the project can be reviewed in a new light and updated keeping in mind the present changed characteristics of the Sundarbans. Taking into consideration the remote location of the Sundarbans, cut off from the mainland and its vulnerability to natural disasters, and to know about the present existing conditions, study/survey to be undertaken immediately are:

- Extensive topographic survey is to be carried out island wise, in order to locate the reaches of weak and depressed embankments
- Hydrographical survey of each river to be conducted on regular basis at certain interval of time
- Velocity, velocity direction, gauge, sedimentation rate data to be collected on regular basis at certain interval of time. Permanent Gauge Stations are to be installed to monitor tidal waves.

Sweet water reservoirs

- Intrusion of saline water from the sea causes damage to agricultural land and cultivation and also resulting in scarcity of sweet water for drinking, pisciculture, fisheries etc. In the Sundarbans, the sweet water is available 300 to 400 metres below the surface level. For some of the villages in the area, tube wells could be installed to procure sweet water. If the Master Plan project is implemented, we can use the upstream of the rivers closed by dams as a fresh water storage reservoir. Rain water harvesting for sweet water which could then be stored in reservoirs created for the purpose by clearing the silted canals and ponds, in some villages.
- Dying estuaries need to be identified and resuscitation works are to be carried out to these channels. These estuaries can be used as sweet water reservoirs by providing sluices at the outfall point.

Eco-tourism

The Sundarbans is renowned for its abundance of rich flora and fauna within its unique ecosystem and is one of the most preferred wildlife habitats. A variety of predators and chiefly the famous Bengal tiger lurk behind the canopy of the thick mangrove forests. Other fauna species found are birds, spotted deer, crocodiles and snakes. A 1991 study has revealed that the Indian part of the Sundarbans supports diverse biological resources including at least 150 species of commercially important fish, 270 species of birds, 42 species of mammals, 35 reptiles and 8 amphibian species, although new ones are being discovered. Despite four protected areas in the Sundarbans being enlisted as UNESCO World Heritage Sites, viz. Sundarbans National Park, Sundarbans West, Sundarbans South and Sundarbans East Wildlife Sanctuaries, the Indian Sundarbans were considered endangered in a 2020 assessment under the IUCN Red List of Ecosystems framework. There is a total ban on all killing or capture of wildlife other than fish and some invertebrates in this eco region. However a consistent pattern of depleted biodiversity or loss of species has been noted in the Sundarbans, as a result of which the ecological quality of the forest is on the decline. The Sundarbans are under threat from both natural calamities and humans - like poaching which have proved highly detrimental to the ecosystem of the region and pose as major threats, despite preservation commitments and attempts from both Governments. Moreover the rich fertile soils of the delta have attracted settlers and the ecoregion has mostly been

converted to intensive agricultural land, with few enclaves of forest remaining. It is of utmost importance to maintain the Sundarbans as a pristine pollution free eco region and actively foster ecotourism in this zone which could in turn benefit the inhabitants of the area immensely in terms of increased scope of employment and finance. The mangrove forests ought to be further intensified and plantation of sundari, keora, goran trees to be increased for ecological harmony and habitat for the birds, animals and wildlife.

Mangrove forests

Other than being home to the predators and especially the endangered tiger, mangroves play a vital role in coastal risk reduction. Wind and wind generated waves or surface gravity waves are quickly reduced as they make their way through the thick mangroves, thereby depleting wave damage during storms and cyclones. The dense roots of mangroves also help to bind and build soils. The ground roots of the mangrove as well as those above the ground slow down the water flow, encourage deposition of sediments and reduce erosion. As such further mangrove plants to be planted for the sake of reduced erosion in the Sundarbans.

Utilisation of renewable energy sources

The Sundarbans is the only area in India where substantial tidal energy can be generated, because the mean tidal height here is adequate for the purpose, other than the Gulf of Kutch and Khambat in Gujarat. The tidal height varies between 3.5 to 5 meters [2]. Approx. 100 MW can be generated from both Matlaand Saptamukhi rivers. Small tidal power projects are also possible at Gangadhuani, Belladona creek and Pitts creek. However, Tidal energy projects have both merits and demerits. These projects require no fuel cost and even the running cost is low, which is less than 0.5% of the cost of the project. Besides, the longevity of such projects are very high – they can last a whole life time and added to that, they are non-polluting and also substitute coal and hydro carbon fuels. Another great advantage is that it has no significant impact on the estuarine eco system. However, we have to keep in mind that in the initial stages, the capital cost per MW is rather high. Construction in water requires sound expertise and is a lengthy process. For project design and implementation, we can look at the working tidal plants like Rance tidal power station of France (since 1966-240 MW) and Sihwa Lake tidal power plant of SouthKorea (since 2011-254 MW).

Wind electricity can be generated in the island like Gosaba and other islands as well, since there is continuous wind flow through the islands in Sundarbans. The quantity of wind electricity generation has increased significantly in the past 30 years across the globe, chiefly because rapid advances in wind energy technology have cut down the cost of producing electricity from wind. Besides, government and other incentives in the United States and other countries have acted as catalysts for growth in wind power. The total annual wind electricity generation in the United States increased from about 6 billion kilowatthours (kWh) in 2000 to about 300 billion kWh in 2019.

International deep water port

Technically located on the river Hooghly but physically outside the geographical jurisdiction of the Sundarbans, there does exista distinct link between Kolkata Port and the Sundarbans. This is because the drainage system of Kolkata Port is dependent on the Sundarbans. The Kolkata Port is located 240 km from the sea face and the deep dock system at Haldia is situated 120 km from the sea face [4]. Over 20 million m^3 of sediment per year are generated by the erosion of the banks in the Hooghly estuary. While 18 million m^3 of sediments are dredged from isolated length of the navigation channel in the estuary, the direct sediment from the upland flow is around 11 million m^3 per year. The suspended sediment concentration varies between 1gm per litre and 3.2gm per litre [4]. There is always a wash load of around1gm per litre in the concentration. However, from a holistic perspective, we have to take into consideration the possibility of a decline in the port facilities at Kolkata and Haldia due to silting (the silting in Sundarbans in general is estimated at 12 mm/year) and due to the reduction in the flow of water from Farakka barrage, in the future. Thus, it is important that we look for a relatively better alternative site (although it may not be an ideal one) for an international deep water port. The idea of a future international port has already been thought of long back but not yet put into action as such. The site to the south of Sagar Island (which has less silting than Hooghly) could be considered in this respect.

Eco-friendly buildings

Designingeco-friendly buildings and shelters simulating and continuously adapting to native vegetation and flora would actually be a step forward in reaching a sustainable solution to multiple

environmental issues. Ecosystems house a myriad species yet they survive the ravages of nature by adapting themselves to the needs of the environment. So our job as an advanced race would be to learn from them and develop ways to monitor the behaviour of such ecosystems. We can't expect nature to conform to our needs. On the contrary, if we can simply simulate the adaptations of the ecosystems, specific to western Sundarbans area, to our building systems, we may succeed in creating a building ecosystem that is in harmony with its surroundings. We can use existing and cutting edge technology to simulate ecosystem behaviour and adapt to the changes in the natural ecosystems triggered by environmental changes, in buildings and smaller rural homes, to reduce the energy consumption of buildings and reduce its negative impact on the environment. These buildings will have to be equipped in such a manner so as to produce their own energy and be responsible for their heating and cooling. Another future endeavour would be to equip the buildings to house not only humans but include a few endangered native bird species as well, that might be able to co-exist harmoniously with the humans. This will be particularly beneficial here in the Sundarbans, where shelters are washed away by floods almost every year. BIM along with technological innovations including electrochromic glass, green roofs, grid hybrid systems and IoT sensors to be employed in the model to achieve maximum efficiency.

Conclusion

The objective of this paper is to present the concepts at the level of possibility. Technical feasibility of hydraulic structure for a portion of work was carried out long before in the year 1968. Here a concept is given for all round development of Western Sundarbans. All the points discussed above have an inter relationship of needs and sustainability. In fact they are justified and supplement each other to a certain extent to make overall sustainable development of the area. The natural conditions of the area are considered for the ideas and hence these measures can be implemented successfully and expected to be feasible and sustainable, which in turn will decrease the problems to a great extent and engender economic growth on the other hand.

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