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The Coastal Mangrove Wetland Ecosystems in the Ganges Delta: A Case Study on the Sundarbans in Bangladesh

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Introduction

The Ganges delta is one of the largest deltas in the world. It is the part of Ganges, Brahmaputra and Meghna River (GBM) systems and the area of GBM drainage basin is 1.76 million km² of which 7.5 % is in Bangladesh. The Sundarbans mangrove is situated in the Ganges delta and it came into existence about 5000 to 7000 years ago, which is a relatively short age compared with global age of mangrove. The entire Sundarbans mangrove covers an area of 10,000 km² and 62 % lies in Bangladesh and the remaining 38 % is in India. It is the hotspot of biodiversity with about 334 species of plants, 282 species of birds, 49 species of mammals, 210 species of fishes, 63 species of reptiles, and 10 each of amphibians and molluscs. In the Bangladesh Sundarbans 66 species have been recorded of which about 55 % are exclusive mangroves, while the remaining 45% are obligate mangroves. The Ganges fresh water plays a vital role in regional economy, floodplain fertility and keeps the mangrove ecosystem in a balance. The Ganges water has reduced due to the construction of the Farakka Barrage in 1975 by India; salinity level has increased which is a high threat for mangrove wetland ecosystems. Bangladesh needs water from the Ganges basin in the dry season (February-June) to protect the downstream ecosystems of the mangrove wetland in the coastal region. The research finding has been asserted that India's diversion of water had resulted in a loss of biodiversity and rice output of 236,000 tons in 1976 just after constructed the Farakka Barrage. The dominate species Sundari *(Heritiera fomes)*, and Goran (*Cariops decandra*) are affected by top-dying disease. Water salinity approximation and GIS Arc view 9.1 applications in environmental data visualization would be the appropriate tools for the decision makers. The paper has been prepared based on the primary and secondary data sources. The objective of this paper is to understand about the Ganges water sharing conflict and its negative impacts on deltaic mangrove wetland ecosystems in the Sundarbans. Prepare an alternative management plan for the Sundarbans mangrove wetlands in the Ganges delta in Bangladesh.

Results and Discussion

For understanding the real situation in the Sundarbans region 13 important rivers which are located around the case area have been chosen for investigating of water salinity approximation. The time series approximation is the tool which can display the real situation. This is why the time series model has got the priority in my case analysis. The time series water salinity data has been collected from the 13 river basins in the Sundarbans mangrove wetlands area based on potentiality of river basins and coastal ecosystems. All the 13 rivers show the water salinity increasing behaviour. The water salinity investigated results show that the salinity rate is much higher in southern and south western rivers; the rivers of the middle area are moderate level and the rivers of the northern portion carries low salinity than the rivers of middle area of the

Sundarbans. The river water salinity trends are showed that only one river has crossed the threshold line (43220 dS/m) in 2000, six rivers have crossed the threshold line in 2001; eight rivers have crossed threshold line in 2002 and eleventh rivers have crossed the threshold line in 2003. Therefore the results are showing that the river water salinity trends are gradually increasing and more rivers are affected by NaCl in the Sundarbans in Bangladesh.

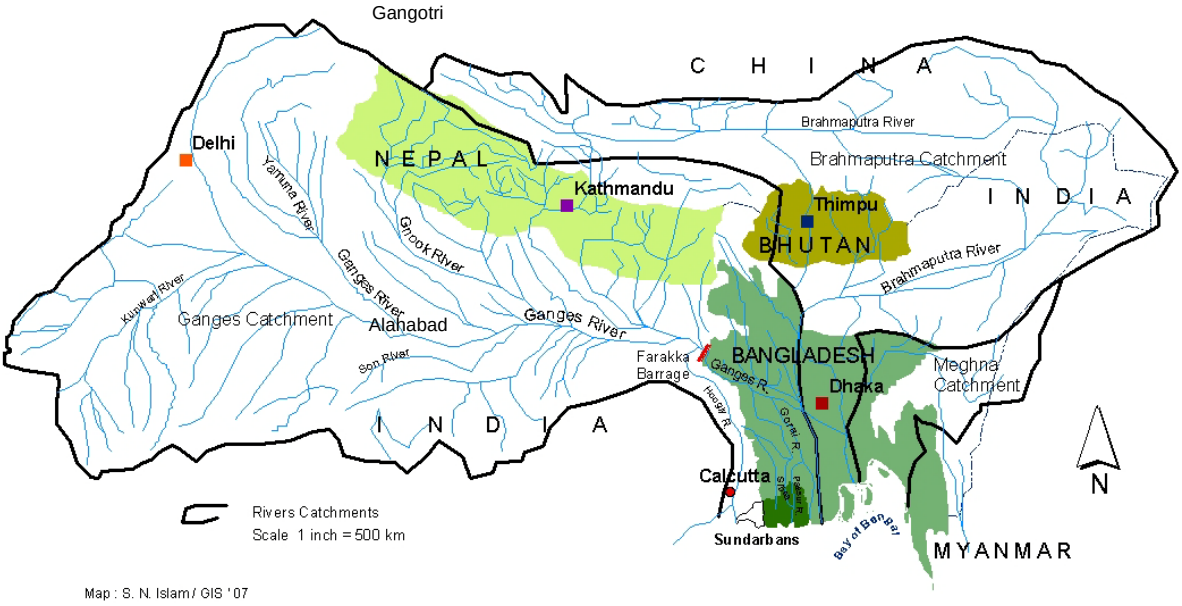

Fig. 1 The location of the of the Sundarbans mangrove wetlands in Bangladesh

The high salinity zone is located in the south-western corner of the Sundarbans, where the previous salinity values were 38,898 dS/m to 54,025 dS/m whereas the present values are 54,025 dS/m to 69,152 dS/m. The results of water salinity simulation in the Sundarbans rivers will support to make a plan by decision makers to protect the especial natural heritage site and mangrove wetlands ecosystems in the Sundarbans region in Bangladesh.

Water allocation in the Ganges basin

The Ganges River rises at the elevation of 7667 meters in Gangotri glacier of Kashi district of India on the southern slopes of the Himalayan range. The three major tributaries the Gandok, Ghagra and Kosi pass through the territory of Nepal. The Yamuna joins the Ganges below Alahabad after receiving the Chambal, Hindon, Sindh, Betwa and Ken. About 17 km down of Farakka Dam the Ganges enters in Bangladesh. The Gorai is the main tributary of Ganges which enters in the Sundarbans and supply upstream fresh water and joins Baleswar River (Fig. 1) in the downstream. The confluence receives the Meghna a few kilometers downstream before it merges into the Bay of Bengal. Constructing of the Barrage having a length is 2455 metrers which designed for maximum discharge of 75630 m3/sec. In 1972 the Government of Bangladesh took up the Ganges issue in earnest to the Government of India. The same year Indo-Bangladesh Joint River Commission (JRC) was constituted in 1972.

Reduced Ganges water and increased salinity

After the construction of the Farakka Barrage on the Ganges River in India and water withdrawal at Farakka Barrage point and different places for irrigation purposes in the lean season in down

stream, Bangladesh receives low quantity of water. There was a comparison of salinity intrusion in 1967-68 with the situation which occurred during 1976 and 1977 because the unimpaired dry season flows of these years were comparable. The water salinity approximations have been estimated on the Sundarbans wetlands before and after 1975. A comparative survey analysis was done in 2003 based on data of 1968, 1970 and 1976. The result shows that, the river water salinity has increased in 1976 in compare to the year of 1968. The amount of the Ganges river water flow in Bangladesh is influenced by the effect of the amount of water drawn at the Farakka Barrage by India. The Ganges flow in 1962 was 3700 m³/sec whereas it was 364 m³/sec in 2006 (Nishat, 2006) (Figure 2). As a result the high saline sea water has penetrated in the upstream and falling water the tables. The reduced water flow line and salinity increased line has crossed at the point A in 1975. The Figure 2 shows a strong correlation between Ganges water reduction and salinity intrusion in the Passur-Mongla point. Figure 2 also indicates that until 1974 the Ganges water flows did not reduced dramatically however, after 1975 there was drastic reduction in water flow with a corresponding increase in salinity. Point A shows the salinity increasing line after the Farakka Dam construction in 1975. At this point the Ganges water flows was almost 1200 m³/sec and salinity rate was 18000 dS/m. Point B is the highest considerable point of water intrusion at Passur-Mongla point. After this point the salinity increasing trend would be the harmful situation for ecosystems. This water level line can be introduced as optimum line and this point can be called optimum point of salinity intrusion. The Ganges water flow level C could be considered as the minimum level of water flows for the Mongla-Passur River point. Point C indicates 500 m³/sec water, this quantity of fresh water is necessary for the whole season to maintain the mangrove ecosystems. If 1200 m³/sec fresh water is available at the Hardinge point then the water salinity will reduce and it will come back before the Farakka Barrage situation. The figure 2 shows the salinity increasing behaviors and trends in the Sundarbans region.

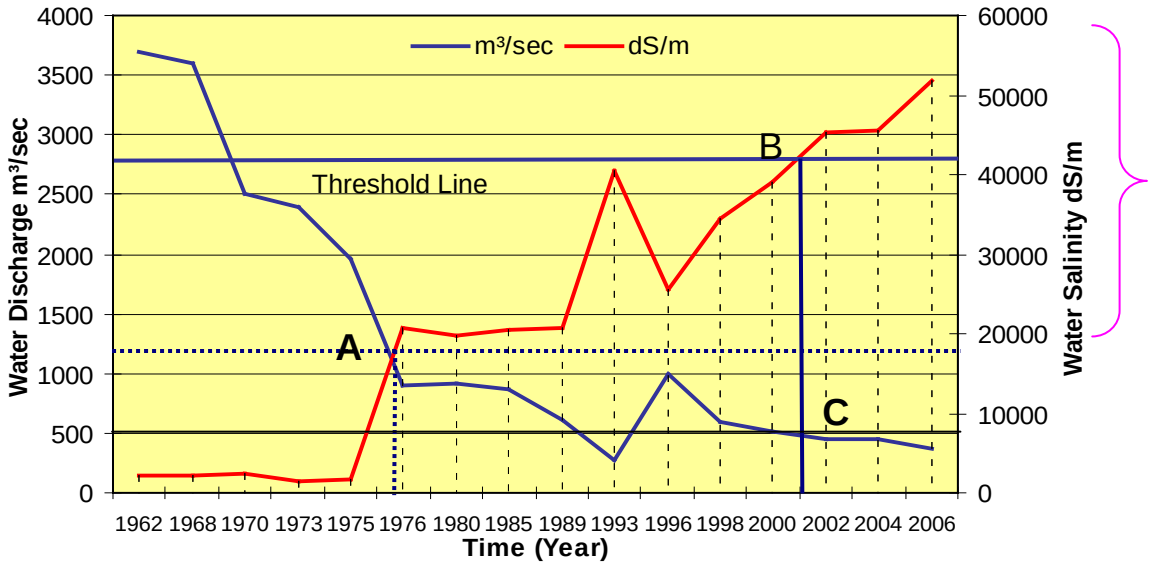

Figure 2 The Ganges water reduced and salinity increased at the Pasur-Mongla point

To compare the salinity increasing trends of three ecological zones, the present situation is much more harmful than 30 years before. Considering the value of water salinity, the eastern zone is still suitable condition for mangrove ecosystems; the middle area is rapidly turning from middle saline zone to high saline zone and the south western region which is carrying the highest rate of water salinity which would be more harmful for sensitive mangroves plants and animals in the Sundarbans.

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Salinity increased and degraded ecosystems in the Sundarbans

The reduction of Ganges fresh water in the upstream area is the main resean of salinity intrusion in the southwestern part of Bangladesh. Therefore the result of increase salinity and alkalinity has damaged vegetation, agricultural cropping systems and changing the cultural landscapes in the Sundarbans region. The impact of soil starts with the destruction of surface organic matter and of soil fertility for mangrove plants production. The changes alter basic soil characteristics related to aerations, temperature, moisture and the organisms that live in the soil. The core elements of ecosystem such as soil, water, vegetation and wildlife are strongly affected due to fresh water shortage and human influences. The study result of EGIS (Environmental Geographical Information Studies) shows that water quality has degraded in dry season February-June) in the Sundarbans rivers where 60% water is poor quality where EC dS/m is 5532 and 40% is good quality and the EC dS/m is 2766 (EGIS, 2000).

Loss of biodiversity and threats for coastal food security

The scarcity of the Ganges flow is a challenge for coastal food security and mangrove wetland ecosystems protection, further improvement of coastal saline environment. The research finding has asserted that India's diversion of water had resulted in a loss of rice output of 236,000 metric tons in 1976. Deforestation of mangroves due to shrimp farming, salt farming and agriculture adversely affects marine fishes production and leads to a loss of biodiversity and of livelihood to over 6 million people who depended on mangroves resources. A number of species like Javan rhinoceros (*Rhinoceros sondaicus*), water buffalo (*Bubalus bubalis*), swamp deer (*Cervus duvauceli*), Guar (*Bos gaurus*), hog deer (*Axix porcinus*) and marsh crocodile (*Crocodiles palustric*) became extinct during the last 100 years in the Sundarbans. Oil spills are another potential threat and could cause immense damage, especially to aquatic fauna and seabirds and also to the mangrove forest biodiversity. The yearly natural calamity, global warming and its impacts are new challenging threats for coastal food security and biodiversity. The siltation in the Sundarbans has increased and sediment trapping has been aided by pneumatophores and dense roots of mangroves. The dominate species of Sundari (*Heritiera fomes*) and Goran (*Cariops decandra*) are affected by top-dying disease. Almost 265 km² areas of Heritiera type forest are moderately and 210 km² areas are severely affected, which is one of the main threats for a sustainable mangrove wetland management and the protection of its ecosystems.

Conclusions

The Sundarbans mangrove wetland is situated in the Ganges Delta. The Ganges fresh water is playing an important role to protect the coastal wetland and its ecosystems. Water salinity increasing trends show the cyclic behaviour in the Sundarbans rivers due to shortage of the Ganges fresh water. Considering the salinity increase trends in the region the threshold values of water salinity for the Sundarbans case has been analyzed. The salinity threshold values have been crossed in most part of the Sundarbans region. It is indicating and forecasting the message that the upstream fresh water supply is necessary and emergency for the protection of the mangrove wetland ecosystems in the coastal region. It has been indicated that there is a strong relationship between fresh water supply and the quality of water in the region. Water quality and ecosystems management is more closely related. This is why the Ganges fresh water supply in the Ganges Delta in Bangladesh is necessary for the protection of coastal environment and mangrove wetlands ecosystems. The findings of this study would be a potential contribution to make comprehensive management plan for conservation and protection of mangrove wetland ecosystems in the Sundarbans region in the Ganges Delta in Bangladesh.