
RECOMMENDATIONS

In this research work, it is observed that the mangrove ecosystem is stressed in the two islands under study, the Henry's island and the Patibania island, which are located in the south-western Sundarban region. The factors causing the stress can be broadly divided in three groups: climatic factors, hydrological factors and anthropogenic factors. Below, the ways these factors affect the mangrove ecosystem and possible approaches to cope with them are described.

From temporal analysis of climate data, it is observed that there is a strong decreasing trend in rainfall and a strong positive trend in temperature in the south-western Sundarban. This means that temperature will be higher in the future and rainfall will be lower. Also, from regression analysis, it is found that mangrove density decreases when rainfall decreases or temperature increases. This implies that the ongoing climate change will have a significant negative effect on the mangroves.

The hydrological factors negatively affecting the mangrove ecosystems are two: erosion and tidal drainage loss. The causes of erosion in this estuarine system are tidal currents and storm surges. Erosion degrades the mangrove ecology by removing the soil substrate supporting the mangroves. The affected regions witness strong tidal and wave action, which include sea beaches, tidal flats, etc. On the other hand, tidal drainage loss affects the inner regions of the islands. There, due to high level of siltation, the channels of the creeks get blocked, and the amount of tidal water reaching those areas falls. The mangrove ecosystem there suffers from the resulting shortage of water and related evaporative deposition of salt on the soil surface.

Anthropogenic influence has caused significant degradation and shrinkage of the mangrove ecosystem in the islands. Particularly, the ecosystem in the Henry's island is significantly affected by human activities. The Henry's island is relatively older than the Patibania island, and once had more extensive mangrove forests. However, aquacultural activities were set up in this island in the 80's, and those were expanded in the subsequent decades. The aquacultural facilities have replaced the mangrove forest that once stood in the central part of the island. The increasing demand of lodging space from tourists visiting the Henry's island have caused several multi-storied hotels to come up, which have also replaced the mangroves that were there once, and degrade and pollute the environment in other ways. The water requirement for all these activities is almost exclusively met from groundwater extraction, and it is observed that the rate of extraction of groundwater cannot be matched by natural replenishment, causing steep fall in the groundwater depth. The Patibania island is relatively less affected by human activity being a reserve forest. But it still is affected by illegal grazing by cattle coming from the villages

next to it.

The climatic and hydrological factors negatively affecting the mangrove ecology in the islands cannot be controlled. Climate change cannot be influenced in a localized initiative, and the hydrological factors are natural processes. However, strategies can be developed to mitigate their effects. Some of the avenues through which the climatic and hydrological factors affect the mangrove ecologies affect the mangroves are closely related. For example, the declining rainfall and tidal drainage loss both hinder mangrove growth and proliferation through decreasing water availability. Rising temperature increases evapotranspiration, further reducing available water. The decline in water availability in turn aids in the salinization of soil.

One approach on face of declining water budget and associated salinization is planting high salinity tolerant species of mangroves, which can better cope with the changing conditions. However, there is also another way. It is seen in the analyses that the spatial distribution of the mangroves is not uniform, and mangroves are more likely to grow well if they are next to a creek supplying water. Both of the islands already have some man-made creeks, and their banks are favorable mangrove habitats. So, to save the mangrove ecologies from the harms of climate change and tidal drainage loss, more creeks may be dug strategically and intelligently to supply water to the mangroves in the inland areas. Creeks blocked by siltation may be cleared so that they may again be avenues of water influx in the islands.

Certain mangrove species grow relatively better in areas with relatively high tidal energy. For example, halophytic grasses growing in salt marshes grow dense web of roots, which hinder erosion in the region covered by them. Certain bigger mangrove species also grow dense networks of subsurface and aerial roots, which absorb and decrease the wave energy, preventing erosion of the soil trapped in the network of their roots. These mangrove species can also be planted to guard against soil erosion. In fact, in the Henry's island, some plantations are already established on top of the sand dunes behind the sea beach, with the aim to hinder erosion and to absorb some of the destructive energy of storms. Of course, physical structures can also be built up to impede erosion.

Only the anthropogenic damages can be controlled by proper formulation and implementation of regulations. The aquacultural activities in the Henry's island should be regulated, and its further expansion in mangrove areas should be prohibited. In the tourism sector, the emphasis should be on sustainable tourism, and with this aim, ecotourism should be promoted keeping a close look on the balance between the environment and human activities. Surface storage

space for water should be developed, which would also aid in groundwater recharge. Project to maximize the utilization of surface water, which is stored in the developed spaces, should be undertaken with the goal to reduce consumption of groundwater. Further, groundwater extraction should be properly regulated to make it sustainable. In the Patibania island, proper monitoring procedures should be implemented to prevent illegal entry of cattle from adjacent villages.

Apart from guarding against further deterioration of the mangrove ecology, initiatives should be taken to restore the degraded mangroves. Different mangrove species propagate favorably in different geomorphic and environmental settings. For the restoration of mangroves, proper care should be taken that the appropriate species is planted in a degraded mangrove zone. In view of limited success in some of the similar past initiatives, studies should be undertaken to analyze the causes of failures, and also to identify the past successful strategies.

The ecosystem services from the mangroves provide the livelihood of the people in this region. It is in human interest that the mangroves are preserved. This fact should be explained to the local communities, and they should be involved in the conservation activities. The goal of the conservation initiatives should encompass both the preservation and restoration of mangrove ecologies as well as sustainable livelihoods of the local communities. This would significantly increase the likelihood of success of the conservation initiative.