

The Deltic Mangrove Landscape of the Sundarban is Fading Away: Sustainable Conservation Strategies

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ABSTRACT

The coastline of India has many instances of geological heritage, including coastal cliffs with geological formations and characteristics. The Indian Delta coastline stretches 7500 km and is characterised by varied landscapes, including sandy beaches, muddy shores, mangroves, and tidal networks (SAC, 2003). The Sundarbans and its mangrove forest are one of the major deltaic features, covering areas in India and Bangladesh. The region is a highly dynamic deltaic landscape shaped as the Ganga, Brahmaputra, and Meghna rivers converge in a very deeply sedimented, erosive, ever-changing natural landscape. It includes the largest continuous mangrove forest in the world and is a UNESCO World Heritage Site (since 1987) because of its high biodiversity and ecological importance.

On a geological time scale, the Sundarban landscape comprises Pleistocene terraces that were developed throughout glaciation periods when the sea level was 100 to 150 m below the current levels. In the Holocene, the sea levels rose due to glacial melting, and this created an inundation of the region. The rivers, Ganges-Brahmaputra-Meghna (GBM), also help in deltaic growth to a tune of about 15 km annually. In the last 5,000 years, as a result of sea-level stabilisation, the accumulation of sediments was possible, resulting in elevated older deltaic plains. In the present day, the most stable terrains (1-3 m above sea level) are the Older Deltaic Plain and Older Flood Plain, which are composed of mature mangrove forests with little human development. In the Younger Deltaic Plain, continued deposition is ongoing, and there has been more recent colonisation by mangroves, though this is also tidally affected. The Younger Coastal Plain is composed of eroded sands and salt flats at its outskirts, which were formed by waves. It is mostly identified by the existence of the Active Flood Plain, the overall part of an elaborate system of tidal canals and sandflats which are daily submerged and keep the largest mangrove ecosystem on earth. Scattered off-shore landmasses take the form of temporary sediment deposits, and interconnected waterways (rivers, estuaries, creeks) could penetrate all these units and be viewed as biological corridors. Surprisingly, one of the most important anthropogenic unclassified terrains is poldered cropland, embankments, and reclaimed terrains, indicating the alteration of land forms by human beings, especially when they are concentrated in the old plains. The Sundarban deltaic landscape includes landforms such as island sandbars (forested in the case of Sundarban), tidal sandbars, mstafidu, levees, tidal deltas, and more.

Previously titled as a UNESCO World Heritage Site, the geological history of the Sundarban landscape formed over the domination of the rivers, then modified by tidal forces and is currently being affected by the anthropogenic climate forcing. The region is facing sea level rise rates as much as double the global rate (~3–8 mm/yr in some locations), and some islands have already sunk underwater. The rare Mangrove Forest landscape has also started to deteriorate under climate change and rising sea level, and hence has been declining since 2006.29 km² (in 2017) to 1930.41 km² (in 2024), which shows the coastal regions are exposed to tsunamis and cyclones.

Our observations indicate that many of these highly diverse locations of geoheritage interest lack protection. To date, no effective management plans have been established under the national policy guidelines to address the anticipated effects of present and future climate change and variability, whether regionally or nationally, on the geoheritage interest of the Sundarban deltaic landscape. These climatic variations include the rise in sea level and the increased frequency of coastal storms and wave activity. Disturbed weathering and erosion cycles due to higher temperatures and a probable decline in precipitation or more variation in rain. Increased insights into the connections between geological, geomorphological, natural, and cultural heritage could lead to a greater appreciation of the landscape and geoheritage at the Sundarban deltaic landscape. To save these mangrove forest it should be considered as geoheritage sites as no other places have this kind of forest.

