UNDERSTANDING THE SOILS OF MANGROVE ECOSYSTEMS

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Mangroves are coastal ecosystems. Mangrove forests are typically found in the world's tropics and subtropics along the sheltered coastlines, lagoons, estuaries, deltas, and rivers. These forests are at their best when there are sizable expanses between low and high tide marks. The major vegetation of the ecosystem is made up of saltwater-tolerant trees and shrubs, which are dependent on the salinity, climate, and edaphic properties of the area. These forest types are mostly salt-tolerant evergreen forests that are known to be buried in tidal waters, which are saline (FAO, 2007).

When we talk about mangroves, we mean the trees and bushes found in a salty area or the ecosystem made up of species that can withstand salt. The saline environment has caused trees and shrubs to undergo adaptations such as development of aerial roots (Figure 1), salt excretion glands, and seed vivipary.

Globally, mangroves are found in 112 nations and span the continents of Africa, Asia, Oceania, North and Central America, and South America. Their total area is 17.07 million hectares (Aizpuru et al., 2000). According to FAO (2007), North and Central America, Africa, and Asia make up most of the region. On an area of 4 lakh hectares, India has barely 3% of the world's mangroves. West Bengal has the largest area in India with 2097 square kilometres, followed by Gujarat at 1103 square kilometres. The Andaman and Nicobar Islands span 604 square kilometres (Mandeep, 2017). The remaining three Indian states with sizable areas of mangrove swamp forests are Andhra Pradesh, Odisha, and Maharashtra, with corresponding areas of 352, 213 and 186 square kilometres.

Figure 1. Vegetation with aerial roots in the mangrove forests of Kerala (Source: https://www.wti.org.in/projects/kannur-kandal-project/)

CHARACTERISTICS OF MANGROVE SOILS

Physical Properties

Mangrove forests mostly have waterlogged soils. These soils, in general, found in the form of a soft liquid mass with poorly differentiated profile. These soils in general are smooth in the surface and gritty in the sub-surface. Stickiness class was slightly sticky and plasticity class was slightly plastic for a typical mangrove profile. Poor drainage limits the oxygen in these soils.

Clay illuviation is observed in the profiles of mangrove ecosystem. The particle size distribution of mangrove soils exhibit variation depending on the location of the soils. The soils are coarser at the upper levee and finer at the lower estuarine levee. The profile horizons also vary and it is a result of differences in topography, influences of vegetation, variation in the flow and direction of water courses. In India, primary mangrove forests of Sunderbans (Figure 2) recorded dominance of silty clay texture. The dominant fraction in the mangrove soils of Pichavaram, India was identified as sand (Nayar *et al.*, 2007). The bulk density of mangrove soils also increases with depth and it varied from 1.07 g cm^{-3} to 1.42 g cm^{-3} in the Sunderbans.

Figure 2. Sunderbans mangroves, Gosaba Block, South 24 Parganas, West Bengal, India (Source: NBSS Archives)

Chemical Properties

The pH of mangrove soils depends on the climate, vegetation or types of mangroves, period of inundation and wetting or drying, and the content of fibrous roots. In the humid tropics, mangrove soils were moderately acidic and it was more in semi-arid coastal mangrove soils. The pH remains near to neutral, which is the standard feature of mangrove soils not subject to any disturbance, which tend toward a pH balance promoted by oxidation-reduction reactions (Souza-Júnior *et al.,* 2008). These soils are saline and their salinity increases with the depth of soils. The electrical conductivity values ranged from 27.9 dS m^{-1} to 51.5 dS m^{-1} with a mean value of 39.79 dS m^{-1} in soils of mangrove forests of Egypt-African Red Sea coast (Afefe *et al.*, 2019). Soil salinity was <15 percent in the Sunderbans on the NE coast of Bay of Bengal (Das *et al.*, 2012).

Mangrove soils are rich in organic carbon. However, studies report a decrease in soil organic carbon content with depth. The higher surface soil organic carbon is due to the higher surface litter. Surface soil recorded 1.4 percent of organic carbon along with a reduction in organic carbon down the profile in the swamp soils of Palakkad, Kerala (Nair et al., 2012). Mangrove soils generally have a higher CEC, aluminium, sulphates, Fe, and exchangeable bases compared with non-mangrove soils.

The soil properties such as soil reaction, bulk density, electrical conductivity, CEC, organic carbon, nutrient concentration, and availability particularly of N, P, soil redox potential, and sulphide concentrations determine the nature of mangrove forests.

CONCLUSION

Soil and climatic conditions influence the species, composition, and structure of mangrove forests. The increase in sedimentation, its retention and stabilization of soils are supported by the mangroves. These help in the soil formation, shoreline stabilization and protection. Thus, protecting the mangrove ecosystem are essential to protect the soils from erosion as well as siltation. Mangroves need to be managed properly to maintain the ecological roles played by the unique ecosystem which is usually threatened due to the changes in land use and exploitation. Mangroves are highly efficient sinks of soil carbon and act as carbon scrubbers. Hence, efficient conservation of mangroves is essential in increasing carbon build up and thereby mitigating the climate change impacts.

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