International Journal of Forest, Animal and Fisheries Research (IJFAF)
ISSN: 2456-8791
[Vol-6, Issue-4, Jul-Aug, 2022]
Issue DOI: https://dx.doi.org/10.22161/ijfaf.6.4
Article DOI: https://dx.doi.org/10.22161/ijfaf.6.4.4

Mangrove ecology and species distribution along the Gorai Creek of Mumbai coast, Maharashtra, India

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Received: 31 Jul 2022; Received in revised form: 20 Aug 2022; Accepted: 25 Aug 2022; Available online: 31 Aug 2022

Abstract— *The extensive mangrove forest of Gorai Creek, Mumbai coast, has recently seen substantial deterioration. The results of a study on mangrove diversity conducted in Gorai Creek on the Mumbai coast from June 2017 to May 2018 are presented here. During the course of the study, twelve species of mangroves from five families and eight genera were identified in each of the three study locations along the creek. Avicennia marina accounted for 13.44% of the Gorai creek marshes, confirming its predominance. Sonneratia alba, Avicennia officinalis, Rhizophora apiculata, Bruguiera cylindrica, Kandelia candel, and Acanthus ilicifolius are among the mangrove species found in the estuarine embayment, with other species strewn around. A diverse range of species, including endangered migratory birds and herpetofauna, can be found in these mangrove environments. Mangroves have been observed to have narrowed in density with time, and it is critical to begin conservation efforts as speedily as humanly possible.*

Keywords— ***Avicennia marina, Gorai creek, Mangroves, Mumbai***

I. INTRODUCTION

Mangrove forests are tropical and subtropical trees, shrubs, and ferns that grow in the intertidal zones between land and sea (Clough, 2013; Tomlinson, 1986). Wetlands are among the most biologically diverse ecosystems, and their great carbon sequestering potential helps to mitigate the effects of rising atmospheric CO_2 (Jennerjahn and Venugopal, 2002). The name "Mangals" distinguishes the mangrove ecosystem from other plant types (Macnae, 1968). Because of its rich biodiversity and distinctive habitat, the mangrove ecosystem commands special attention among coastal habitats. Because of the successful interplay of land and water, this environment contains a varied faunal and floral variety (Murugan and Anandhi, 2017). The mangrove ecosystem plays an important role in pollutant trapping, coastal land stabilization through sediment filtering, and natural disaster protection (Elizabeth McLeod and Rodney V. Salm, 2006). Wetlands cover an area of about 1, 37,760 km^2 worldwide (Giri *et al*., 2011), with India accounting for about 3.5 % of that, or 4921 km^2 (Forest Survey of India, 2017). With an area of 304 km^2, the Indian state of Maharashtra contributes 6.2 % of the overall mangrove cover. Mangroves cover 66 km^2 along the Mumbai shoreline. The management of the rapidly dwindling mangrove ecosystem necessitates a thorough grasp of the ecosystem's compositional intricacy (Dislich and Pivello, 2002). Biodiversity inventories are essential before forest management activities to assess the nature and species distribution (Sagar *et al*., 2003).

Mangroves have indeed been devastated or altered by 50% in the last two decades, regardless of their importance (Padmakumar and Joseph, 2022). They are vital habitats for a variety of faunal species, providing shelter, food, and breeding chances (Mestre et al., 2007). Wetlands are home to more than 40% of bird varieties and around 12% of all other faunal species on the planet (Rajpar and Zakaria, 2010). Mangroves have long been established as playing an important role in estuary ecosystems, sustaining many of the other animals that depend heavily on the luscious wetlands for existence.

Many researchers have investigated the floristics of marshes along the Mumbai coast since 1905. However, the

exact mangrove species found along the Mumbai coast's Gorai Creek is unknown. As a result, the current research was carried out to better understand the complex nature and species richness of mangrove forests in the Gorai region, with the goal of protecting the shoreline.

II. MATERIALS AND METHOD

Study Area: With an average elevation of 10 to 15 meters, Mumbai is located between the latitudes of 18°96' N and 72°81' E. It is a seven-island city off India's west coast, in the 'Konkan' region. The research was carried out near Gorai Creek, which is about 10 ft above sea level and is between 19°14'12.69" N and 72°49'12.51" E. The stream extends inland for 12 km and is made up of mangrove mudflats and low-lying marsh. Gorai-Charkop is located on the creek's southern end, whereas Gorai settlement is located on the northern end. The area is heavily influenced by semi-diurnal tides that swamp the creek's lower reaches.

Data Collection: Field data collection was carried out between June 2017 and May 2018. The area was explored to learn more about the distribution of actual mangroves. The mangrove vegetation was identified and documented at 10 sites (Figure 1) along the Gorai Estuary. Regular surveys were conducted along the estuary's research sites to document the presence of mangroves. The mangroves were identified during their blossom and fruiting seasons, and images were captured using Nikon D300 digital single-lens reflex camera. Standard field guides such as Kathiresan and Ajmalkhan (2013) and Tomlinson (2013) were used to identify mangrove species Tomlinson (1986). Species nomenclature was mostly based on Tomlinson (1986), however, it was also confirmed using the International Plant Names Index (IPNI).

Fig. 1: Map showing study sites at Gorai Estuarine Area, Mumbai coastline

The following standard equations were used to compute biodiversity indexes such as diversity index, species richness index, and evenness index.

Shannon - Wiener diversity index (H') (Shannon - Wiener, 1949) was used to determine the diversity index.

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

Where,

Pi = S / N

S = number of individuals of one species

N = total number of all individuals in the sample

Ln = Natural logarithm

Margalef's species richness index (d) was used to calculate the species richness index (Margalef, 1958).

$$d = S - 1/LnN$$

Where,

S = total number of species

N = total number of individuals in the sample

Ln = Natural logarithm

Pielou's species evenness index (J') was used to analyze the evenness index (Pielou, 1966).

$$J' = \frac{H}{ln(S)}$$

Where,

H = Shannon -Wiener diversity index

S = total number of species in the sample

ln = Natural logarithm

III. RESULTS AND DISCUSSION

There were a total of 12 distinct mangrove species identified, divided into five families Acanthaceae (34.54%), Rhizophoraceae (34.85%), Myrsinaceae (3.12%), Euphorbiaceae (5.41%), and Lythraceae (15.62%). With three and five species, respectively, members of the Acanthaceae and Rhizophoraceae families were the most prevalent mangroves, followed by Lythraceae with two species. *Avicennia marina* and *Acanthus ilicifolius* were more widespread than other mangrove species among the 12 true mangrove species found along Gorai Creek. According to the IUCN Red List of Threatened Species, all of the species recorded were of Least Concern (LC) (IUCN, 2017). Table 1 shows the

dispersion of mangrove species across different research stations. *Avicennia officinalis*, a tough species with a wide range of adaptations, is the most important invader species of the mangrove environment, followed by the presence of *Rhizophora sps* (Arun and Shaji, 2013). Because the soil is saturated daily by sea water, mangrove variety along the coast is frequently associated with *Rhizophora sps* (Basha, 1992).

By producing a single annotated index of biological collections, the diversity index aims to evaluate an ecosystem's richness and make understanding, protection, and exploitation of living resources easier. In general, Shannon's index ranges from 1.5 to 3.5 for a well-diversified area, and it is regarded as 0 when there is no diversity (Margalef, 1972). When compared to the typical range, H′ = 1.5-3.5, the Shannon-Wiener diversity index was maximum at Site 3 (2.180) and least at Sites 4 and 9 having only a value of 1.680, showing substantial diversity in the mangroves (Shannon and Weiner, 1949). The results show that there is a huge diversity of species in the marsh. The highest value of Margalef's Species Richness was found at Site 4 (2.616), while the lowest was found at Site 3 (2.176). The Pielou's evenness index was highest at Site 1 (0.966) and lowest at Site 6 (0.917) (Table 2).

Shannon and Wiener index values, Margalef's species richness index, and Pielou's evenness index values reflect the average diversity and inequitable dispersion of mangrove species across the zone.

Along India's west coast, Maharashtra's coastline region is noted for its abundant mangrove variety. The composition of mangrove flora has been negatively changed as a result of increased anthropogenic activity, resulting in the deterioration of estuaries and wetlands (Dwivedi, 1973; Nammalwar, 2008). In contrast to previous records (Kantharaj *et al*., 2018), the current investigation found *Kandelia candel*, *Rhizophora mucronata*, and *Sonneratia alba*. Temperature, salinity, tidal pattern, and freshwater intake are all environmental characteristics that affect the distribution of mangrove species and are unique to each ecosystem (Duke *et al*., 1998). The concentration of nutrients, heavy metals, and Polycyclic Aromatic Hydrocarbons (PAHs) are constantly increasing in most creeks along the Mumbai coast due to sewage water inflow (Sukhdhane *et al*., 2015). In the mangrove habitats of Mumbai, Kantharajan *et al*., 2017 have found the presence of pollutants suggesting molluscan species such as *Neripteron violaceum* and members of the Ellobidae family (Cassidula and Melampus). Furthermore, due to the reduced influx of land runoff and salt generation in the upstream regions, salinity in Mumbai coast creeks remains >31 ppt all year (Kulkarni *et al*., 2010). Hypersaline conditions are favorable for the establishment of high salt-resistant species such as *A. marina*, which was found in abundance at the locations. *A. marina* was also found to be dominant in the mangrove forests of Thane Creek along the Mumbai coast, according to Shindikar *et al*., 2009. Along the Arabian Sea's bordering regions and India's northwestern coastline, *A. marina* comes to the fore. The presence of *A.marina* on the West Coast of India might be due to the high saline environment (Saenger *et al*., 2002; Sawale and Thivakaran, 2013).

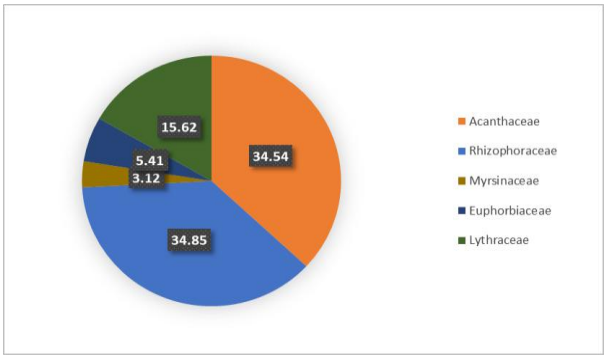

Fig. 2: representing the percentage of mangrove families in the study area.

IV. CONCLUSION

The amplitude and periodicity of tides, nutrients, monsoon seasons, and prevalent stresses all impact the structure of an estuarine system. Because the effect of these elements varies greatly across geographic locations, mangrove stands have a wide range of regional and local structural traits. As a result, knowing the local-level forest structure is critical for their management. Various human activities, such as dumping rubbish and disposing of sewage, as well as overexploitation for salt, fishing, navigation, and leisure activities, have put mangrove ecosystems along the Gorai creek in jeopardy. The species diversity and structural complexity still reveal the recovering character of the mangroves along the shore. In addition, low-saline-tolerant species such as *S. caseolaris* and *K. candel* could be endangered by the presence of high-saline conditions along the Gorai region. Though a high-saline environment is favorable for the sustainability of A. marina, monospecies dominance diminishes the ecological and economic services provided by mangroves. The lack of knowledge on the geographical distribution and habitat needs of mangrove species is the most significant hindrance to conservation efforts. As a result, the current study's findings give baseline data for effective mangrove protection and management throughout the Gorai region.

Table 1: showing the distribution and red list category of mangroves in Gorai Creek

Species name	Family	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Red List Category
Avicennia marina	Acanthaceae	+	-	+	+	-	+	-	+	-	+	LC ↓
Avicennia officinalis		-	+	-	+	+	-	+	-	-	+	LC ↓
Acanthus ilicifolius		+	-	+	-	+	+	+	+	+	-	LC?
Rhizophora apiculata	Rhizophoraceae	-	+	+	-	+	-	+	-	-	-	LC ↓
Bruguiera cylindrica		+	-	-	+	-	+	+	+	+	-	LC ↓
Kandelia candel		-	+	+	-	+	+	-	+	-	+	LC ↓
Rhizophora mucronata		-	-	+	+	+	-	+	-	-	-	LC ↓
Ceriops tagal		+	+	+	-	+	+	+	+	-	+	LC ↓
Aegiceras corniculatum	Myrsinaceae	-	-	+	-	-	+	-	+	+	-	LC ↓
Excoecaria agallocha	Euphorbiaceae	+	+	+	+	+	-	+	+	+	+	LC ↓
Sonneratia apetala	Lythraceae	-	+	-	+	-	+	+	+	+	+	LC ↓
Sonneratia alba		+	-	+	-	-	-	+	+	+	+	LC ↓

+ denotes occurrence

LC ↓—Least Concern with decreasing population trend.

LC?—Least Concern with unknown population trends.

Table 2 indicating the diversity, richness, and evenness of mangroves at the study sites

Biodiversity indices	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Diversity index (H)	1.730	1.770	2.180	1.680	1.790	1.780	2.040	2.060	1.680	1.850
Richness index (d)	2.378	2.510	2.176	2.616	2.463	2.451	2.364	2.286	2.525	2.518
Evenness index (J')	0.966	0.986	0.994	0.935	0.921	0.917	0.927	0.939	0.940	0.950

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