

## Habitat Diversity in Wet Coastal Ecosystem of Sindhudurg District of Maharashtra State in India

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### ABSTRACT

Wet coastal ecosystems are among the most productive and ecologically complex landscapes, characterized by strong environmental gradients and high habitat heterogeneity. The mangrove–estuarine systems of Sindhudurg District, located along the Konkan coast of Maharashtra, represent a mosaic of natural and anthropogenically modified habitats. The present study aims to document habitat diversity within this wet coastal ecosystem and to analyze its role in the distribution and ecological significance of mangrove associate plant species. Based on detailed field surveys, habitats were identified using geomorphological features, physicochemical properties of soil and water, microclimatic conditions, and degree of human disturbance. Sixteen distinct microhabitats were recognized and grouped into four major habitat clubs: mangrove land, encroached mangrove land, freshwater-dominated habitats, and associated coastal habitats. Results indicate that mangrove associate species show strong habitat specificity and are predominantly distributed in peripheral, transitional, and modified habitats rather than core mangrove zones. Anthropogenic activities such as bund construction, land reclamation, and altered hydrology have intensified habitat diversification, leading to the emergence of novel ecological niches. The study emphasizes that habitat-level diversity is crucial for understanding mangrove associate flora and highlights the need for habitat-based conservation strategies for sustainable management of wet coastal ecosystems.

**Keywords:** Wet coastal ecosystem, mangroves, habitat diversity, mangrove associates, Sindhudurg District, estuarine ecology

### INTRODUCTION

Mangroves are unique intertidal forest ecosystems occurring along tropical and subtropical coastlines, occupying the interface between terrestrial and marine environments. Ecologically, mangroves function as dynamic ecotones where freshwater, marine water, and terrestrial processes interact, resulting in high productivity and biodiversity (MacNae, 1968; Tomlinson, 1986). These ecosystems provide a wide range of ecosystem services, including shoreline stabilization, nutrient cycling, carbon sequestration, and habitat provision for numerous aquatic and terrestrial organisms (Kathiresan and Bingham, 2001; Alongi, 2014).

The term “mangrove” is commonly used to denote both the plant species with specialized adaptations to saline and tidal conditions and the ecosystem they form. To reduce ambiguity, MacNae (1968) proposed the term *mangal* for the community and *mangrove* for the constituent plant species. Mangrove flora is broadly categorized into true mangroves, which are restricted to intertidal habitats and exhibit distinct morphological and physiological adaptations, and mangrove associates, which occur within or around mangroves but are not confined exclusively to saline intertidal conditions (Tomlinson, 1986; Kathiresan, 2013).

Wet coastal ecosystems, particularly estuarine regions, exhibit significant habitat heterogeneity due to variations in salinity gradients, tidal inundation, sediment dynamics, freshwater inflow, and geomorphology. Human interventions such as bund construction, land reclamation, agriculture, and aquaculture further modify these natural gradients, leading to habitat fragmentation and creation of novel microhabitats (FAO, 2007; Duke et al., 2007).

Sindhudurg District, located along the southern Konkan coast of Maharashtra, supports fragmented mangrove patches associated with estuaries, creeks, and river mouths. Despite their ecological and socio-economic importance, mangroves in this region are under pressure from developmental activities. While several studies have documented mangrove species composition, habitat-level analysis with special reference to mangrove associate plant species remains limited. The present study addresses this gap by

analyzing habitat diversity in the wet coastal ecosystem of Sindhudurg District and evaluating its influence on mangrove associate flora.

## **MATERIALS AND METHODS**

### **Study Area**

The study was carried out in the wet coastal ecosystem of Sindhudurg District, Maharashtra, situated along the western coast of India. The region experiences a tropical monsoon climate with high rainfall during the southwest monsoon and distinct dry periods. Mangroves occur along estuaries and tidal creeks, often in fragmented and patchy forms due to extensive anthropogenic modifications.

### **Habitat Identification**

Field surveys were conducted covering mangrove stands and adjacent coastal landscapes. Habitats were identified based on:

- Geomorphology (elevation, slope, substrate type),
- Physicochemical properties of soil and water (salinity, waterlogging, texture),
- Microclimatic conditions (light intensity, humidity),
- Degree and type of anthropogenic disturbance.

Based on these parameters, sixteen distinct microhabitats were recognized, including under-canopy mangrove zones, open mangrove land, newly formed mangrove areas, mangrove borderlines, encroached paddy fields, scrub forest patches, stagnant water bodies, freshwater inputs, sandy beaches, rocky shores, and sand dunes.

## **RESULTS AND DISCUSSION**

### **Habitat Diversity in the Wet Coastal Ecosystem**

The wet coastal ecosystem of Sindhudurg District exhibited pronounced habitat heterogeneity resulting from the interaction of tidal processes, freshwater inflow, sediment dynamics, and anthropogenic disturbances. Sixteen microhabitats were identified, each characterized by distinct environmental conditions. Core mangrove habitats were saline and periodically waterlogged with high organic matter, whereas peripheral and encroached habitats showed modified salinity regimes, altered soil texture, and disrupted hydrology (Table no. 1).

Such heterogeneity confirms that mangrove–estuarine systems function as complex ecological mosaics rather than uniform vegetation units, as reported in other tropical coastal regions (Alongi, 2014; Duke et al., 2007).

### **Microhabitat Differentiation and Habitat Clubbing**

Mangrove land habitats supported true mangrove species adapted to frequent tidal inundation. Under-canopy zones showed sparse understory vegetation due to limited light availability, whereas open mangrove land and newly formed mangrove areas supported greater seedling recruitment and pioneer species.

Encroached mangrove land habitats exhibited high ecological disturbance and supported mixed assemblages of halophytes, semi-halophytes, and glycophytes. Scrub forest patches and stagnant water bodies represented transitional habitats resulting from altered hydrology and land use.

Freshwater-dominated habitats, including upstream riverbanks and freshwater paddy fields, showed reduced salinity stress and supported diverse herbaceous and shrubby mangrove associates. Associated coastal habitats such as sandy beaches and sand dunes provided additional ecological niches and functioned as bio-shields against coastal erosion.

### Distribution of Mangrove Associate Plant Species

Mangrove associate plant species were predominantly distributed in peripheral, transitional, and modified habitats rather than in core mangrove zones. Their occurrence was strongly influenced by microhabitat conditions, particularly salinity, soil moisture, and freshwater availability. Several species occurred across multiple habitat types, indicating ecological plasticity.

The observed overlap in distribution supports earlier views that classification of mangrove associates based solely on morphological or taxonomic criteria is inadequate. Habitat-based classification provides a more realistic framework for understanding mangrove associate flora (Mandal and Naskar, 2008; Kathiresan, 2013).

### Anthropogenic Influence on Habitat Structure

Bund construction, land reclamation, and conversion of mangrove land for agriculture have significantly altered the natural habitat structure in Sindhudurg. These activities disrupted tidal flow, created stagnant water zones, and modified sediment deposition patterns, resulting in habitat fragmentation.

While these disturbances have contributed to degradation of core mangrove habitats, they have also led to the formation of secondary habitats supporting mangrove associate species. However, such habitats may offer limited long-term ecological stability compared to intact mangrove ecosystems (FAO, 2007; Polidoro et al., 2010).

### Ecological and Conservation Implications

The study highlights that wet coastal ecosystems function as interconnected habitat networks. Mangrove associate habitats play critical roles as buffer zones, secondary shoreline stabilizers, and reservoirs of plant genetic diversity. Exclusion of these habitats from conservation planning may result in underestimation of ecosystem value and biodiversity loss.

### Conclusion

The wet coastal ecosystem of Sindhudurg District is characterized by high habitat diversity arising from both natural gradients and anthropogenic modifications. Mangrove associate plant species are closely linked to this habitat heterogeneity and are primarily distributed in transitional and modified habitats. Understanding habitat-level diversity is essential for accurate assessment of mangrove biodiversity and for developing effective conservation and management strategies. A habitat-based, landscape-level approach integrating mangroves with their associated ecosystems is recommended for sustainable coastal management.

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**Table 1: Habitat discrimination**

Sr. No.	Habitats	Type of encroachment	Geomorphology	Physicochemical properties	Microclimatic conditions	Frequency of occurrence
1.	Under canopy	1	Typical mangrove forests- either fringing or riverine	Saline, periodically waterlogged soil	Humid, shady climate	1

2.	Open mangrove land	1	Mangrove basin type habitat	Saline, periodically waterlogged soil	Humid with full light intensity	3
3.	Newly formed mangrove land	1	Newly formed elevated region	Saline conditions with regular inundations	Full light intensity, humid	3
4.	Mangrove borderline	2	Sloppy regions	Slightly saline soil with brackish water	Mostly shady humid places	2
5.	Vegetation along the bunds	4	Constructed bunds using gravel and stones, variable in dimensions	Saline soil with saline water	Full light intensity, soils remain dry during dry months	1
6.	Paddy fields in encroached mangrove land	3	Slightly elevated, texturally modified, cannot be submerged with direct salt water	Saline fields receiving estuarine water	Full light intensity with high soil temperature	3
7.	Stagnant water	4	Dredged area with stagnant water, depth variable not less than half meter	Highly saline water without direct connection with either fresh or estuarine water	Full light intensity, water with deteriorating material	4
8.	Plain encroached land	5	Elevated areas with modified water currents	Highly saline areas	Humid with full light intensity and high soil temperature	1
9.	Scrub forest patch	4	Elevated, with disturbed soil texture	Saline conditions with modified currents	Full sunlight, mostly humid	2
10.	Land with salt pans	5	Geo-morphologically modified, texturally disturbed, stagnancy of water during rainy season, salt extraction during summer	Highly saline with accumulation of salt	Full light intensity comparatively dry place with high soil temperature	4
11.	Upstream riverbank	2	Fringing patches	Slightly saline areas	Mostly shady	2
12.	Fresh water input	2	Slightly elevated regions, mostly fresh water and soil	Slightly saline areas with periodical or continuous supply of fresh water	Mostly shady humid places	2
13.	Fresh paddy fields along the mangroves	1	Slightly low level at some places, stagnant water can be observed periodically	Fresh soil with fresh water	Full light intensity with periodically humid	3
14.	Sandy beach	1	Dominated by loose sand,	Saline condition	Full light intensity with	2

			covered rarely by marine water		high soil temperature	
15.	Rocky beach	1	Rock dominated habitat covered rarely by marine water	Saline condition	Full light intensity with rare typical soil	3
16.	Sand dune and bars	1	Elevated sandy regions, mostly shifting in nature, few are recorded for number of years	Saline condition without covering water	Full light intensity, mostly dry soil	3

- Type of encroachment:
1. No observable threat
  2. Threat to vegetation only
  3. Threat to vegetation as well as soil
  4. Geomorphological changes/Changes in water current or depth
  5. Entirely disturbed area with land filling and dragging

Frequency of occurrence: 1. Common 2. Frequent 3. Occasional 4. Rare

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