



Diversity of Coastal Sand Dune (CSD) Vegetation along the Coast of Maharashtra, India

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Abstract: The sand dunes vegetation in coastal regions of Maharashtra is important ecosystems because of their small size, the different species found in habitat, and the beautiful landscapes they create. The current study investigated the vegetative status of sand dunes on Sindhudurg and Raigad district, west coast of Maharashtra. A survey of sand dune flora along coastal sand dune areas was done from October to December 2020 and 55 species belonging to 46 genera and 26 families are identified from study sites. The families like Fabaceae, Rubiaceae, Poaceae, Asteraceae, Lamiaceae and Malvaceae are dominant in study areas which show halophytic and xerophytic nature. The heavy pressure of tourism and development in coastal area shows negative effects on sand dune vegetation are seen during study.

Keywords: Ecosystems, Coastal sand dunes, Maharashtra, Halophyte, Diversity

Coastal zones are the most productive and invaluable areas of coastal water and adjacent land forms and are the places of high priority interest of people, commerce, military and variety of industries. Coastal sand dune (CSD) serves as an ecological niche between terrestrial and marine life, and form important conservation sites. These are extensions of beach into the land and acts as a home for specialized plants and animals and protects the beaches from erosion, control the sea level rise and acts as filter for rainwater and groundwater (Heslenfeld et al 2008). Coastal sand dune flora protects the coastal environment by absorbing energy from wind, tide and wave action. These species played a crucial role in protecting the coast from erosion and flooding, sediments accumulation, sand binding and land building processes. India has an approx 7500 km coastline along the Arabian Sea on west and bay of Bengal on the east with 2.02 million Km² exclusive economic zone and 0.13 million Km² continental shelf with numerous types of plants, lagoons, beaches, estuaries and mangrove swamps. However, these habitats have been severely affected by natural and anthropogenic activities resulting in loss of habitat and dependent flora and fauna. Because it contains a dense population, the coast undergoes environmental modification and deterioration through reclamation, dredging, pollution, industry, and anthropogenic activities (Ingole 2005). Invasion of alien species in coastal sand dune vegetation also threatened the coastal environment (Gallego-Fernandez et al 2019).

The western coastal planes is of 720 Km lie in between

the Western Ghats and Arabian Sea and distributed into the coastal districts such as Mumbai, Thane, Mumbai suburbs, Palghar, Raigad, Ratnagiri and Sindhudurg. The Sahyadri mountain range and Western Ghats run parallel to the coast. The 17% of the total coast is sandy nature, 37% is rocky and 46% are mudflats. In 2004, 263 km. length of west coastline is affected by erosion, which about 40% of the Maharashtra coast (Lakshmi et al 2012). The CSD plants act as bio shield against coastal erosion and have many ecological importances. The objective of the current study was to understand the distribution of coastal sand dune plant and to identify the anthropogenic impacts on the CSD flora.

MATERIAL AND METHODS

Study area: Field visits were conducted at Shiroda (15°45'38.10"N 73°39'49.60"E), Malvan (16°03'00.73"N 73°28'07.93"E) and Achara (16°11'49.04"N 73°26'13.67"E) of Sindhudurg district and Kashid (18°27'24.21"N 72°53'54.68"E) and Revdanda (18°33'30.45"N 72°55'13.85"E) from Raigad districts (Fig. 1) during the winter season of month October and November 2020. Generally, the climate of study sites is humid and hot. In winter, the average temperature is in between 22-25°C with annual rainfall is 300 to 800 mm.

Sampling: Diversity of plant species were studied by random quadrat method. In each quadrat, sub quadrats of 10x10 m for trees, sub quadrats of 5x5 m for shrubs and 2.5x2.5 m for the herbs. Each quadrat was systematically surveyed by identifying and measuring all trees, shrubs and herbs.



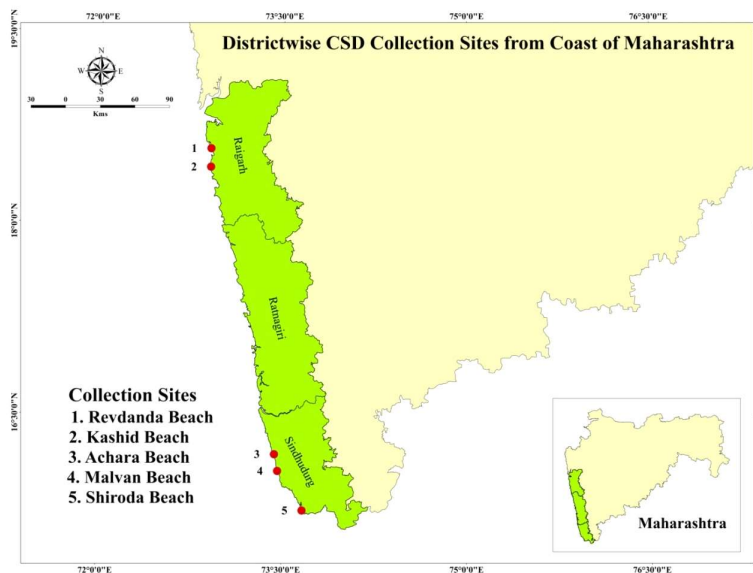


Fig. 1. Location map of the study area

Specimens of individual plant species were collected from each site and were identified using various regional flora and monographs (Cook 1967, Joshi 2011).

RESULTS AND DISCUSSION

The coastal ecosystem consist 338 species belonging to 69 families of which the west coast consists 267 species and east coast has 163 species indicating more diversity on west coast. Ramarajan and Murugesan (2014) reported 55 species and 26 families from Tamilnadu coast. Silambarasan and Senthilkumaar (2015) reported 39 species belonging to 33 genera and 28 families from Marakkanam Coast, Southeast coast of India. Jana (2016) reported the 82 coastal sand dune species from east Midnapore District, West Bengal, India. Arulmoorthy and Srinivasan (2017) reported 154 species belonging to 108 genera and 41 families from southeast coast of India. Qureshi and Rathod (2020) reported six new algal species from coastal areas of Karwar. During the present work 48 species recorded form different coastal sand dune ecosystems form the west coast of Maharashtra. *Brachiaria distachya*, *Casuarina equisetifolia*, *Ipomoea pes-caprae*, *Sesuvium portulacastrum* are the common species found along all the study areas whereas *Ammannia baccifera*, *Calophyllum inophyllum*, *Pedaliium murex* are less common and found on only one site. The Shiroda beach shows more diversity (46 species) than the other beaches and Malvan and Kashid beach is less diverse with 23 and 16 species respectively indicating the human intervention. Malvan and Kashid beach are popularly known tourist centres and the CSD plants largely affected by the tourists visiting these places.

The Revdanda and Kashid beach of Raigad district are popularly known tourist centers throughout Maharashtra. These beaches have direct connectivity through private vehicles and public transportation; hence the number of tourists visiting these sites is comparatively more. It was observed that, during the visits to the beaches the tourist pass across the sand dune vegetation and damaging the flora. In Kashid, Revdanda, Malvan and Shiroda, vehicles used for the exploration of beach, which caused more damage to CSD vegetation as compared to human trampling. The other harmful impacts of vehicles includes instability of substrate, disturbing and destruction of vegetation and killing and injuring coastal sand dune associated fauna (Kindermann and Gormally 2010). The tourist use to dump the domestic waste and plastic containers along the sides of beaches that also alters the dunes textures which ultimately leads in the disturbance of CSD flora. Similar observations were recorded for Malvan and Shiroda beach. Comparatively, Achara beach, which is longest but less affected (37 species) may be because of geographical situations, as it is located in the interior and the road and transportation facility is poor hence low trampling activity leads into less destruction of dune vegetation.

CONCLUSIONS

The current work indicates high number of coastal sand dune flora which strongly affected by tourism industry and other anthropogenic activities. The rate of developments through urbanization is high which in the study area leads into severe destruction of coastal sand dune vegetation. Hence, the effective management strategy for conservation of CSD



Table 1. Site wise distribution of CSD vegetation of the Maharashtra coast

Species name	Family	Locations				
		Sindhudurg			Raigad	
		Sd	Mn	Aa	Kd	Rd
<i>Aeluropus</i> spp.	Poaceae	+		+		+
<i>Ammannia baccifera</i> L.	Lythraceae	+				
<i>Anacardium occidentale</i> L.	Anacardiaceae	+	+	+		+
<i>Barringtonia acutangala</i> (L.) Gaertn.	Lecythidaceae	+		+		
<i>Borreria articularis</i> (L. f.) F.N. Will.	Rubiaceae	+		+		+
<i>Brachiaria distachya</i> (L.) Stapf.	Poaceae	+	+	+	+	+
<i>Caesalpinia cristata</i> Prowazek	Fabaceae	+		+		
<i>Calophyllum inophyllum</i> L.	Calophyllaceae			+		
<i>Calotropis gigantea</i> (L.) R. Br	Apocynaceae	+	+	+	+	+
<i>Senna tora</i> (L.) Roxb	Fabaceae	+	+	+	+	+
<i>Casuarina equisetifolia</i> Forst.	Casuarinaceae	+	+	+	+	+
<i>Chenopodium album</i> L.	Amaranthaceae	+				+
<i>Chromolaena odorata</i> (L.) R. King	Asteraceae	+		+		+
<i>Clerodendrum inerme</i> (L.) Gaertn	Lamiaceae	+	+	+		+
<i>Cocos nucifera</i> L.	Arecaceae	+	+	+	+	+
<i>Colocasia esculenta</i> (L.) Schott	Araceae	+	+			+
<i>Cyperus rotundus</i> L.	Cyperaceae	+	+	+	+	+
<i>Cyperus arenarius</i> Retz.	Cyperaceae	+		+		
<i>Dactyloctenium aegyptium</i> (L.) Willd.	Poaceae	+	+	+	+	+
<i>Hydrophylax maritime</i> L.f.	Rubiaceae	+				
<i>Indigofera</i> spp.	Fabaceae	+				
<i>Ipomoea pes-caprae</i> (L.) R. Br.	Convolvulaceae	+	+	+	+	+
<i>Ixora arborea</i> Roxb. Ex. Sm.	Rubiaceae	+		+		+
<i>Lantana camara</i> L.	Verbenaceae	+	+	+	+	+
<i>Launaea procumbens</i> (Roxb.) Ramayya & Rajgopal	Asteraceae	+		+		
<i>Launaea sarmentosa</i> (Willd.) Alston	Asteraceae	+		+		+
<i>Mollugo disticha</i> (L.) Ser	Molluginaceae	+				
<i>Morinda citrifolia</i> L.	Rubiaceae	+	+	+		
<i>Oldenlandia biflora</i> L.	Rubiaceae	+				+
<i>Opuntia</i> spp.	Cactaceae	+			+	+
<i>Pandanus fascicularis</i> Lam.	Pandanaceae	+		+		+
<i>Pedaliium murex</i> L.	Pedaliaceae					+
<i>Physalis minima</i> L.	Solanaceae	+	+	+		+
<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	+	+	+	+	+
<i>Premna obtusifolia</i> R.Br.	Lamiaceae	+				
<i>Rothia indica</i> (L.) Druce	Fabaceae	+	+	+		+
<i>Sesuvium portulacastrum</i> (L.) L.	Aizoaceae	+	+	+	+	+
<i>Sida cordifolia</i> L.	Malvaceae	+	+	+	+	+
<i>Spinifex littoreus</i> (Burm.f.) Merr.	Poaceae	+		+		
<i>Suaeda maritime</i> (L.) Dumort.	Amaranthaceae	+				
<i>Tephrosia pupurea</i> (L.) Person.	Fabaceae	+	+	+	+	+
<i>Terminalia catappa</i> L.	Combretaceae	+	+			
<i>Thespesia populnea</i> (L.) Soland. ex Correa	Malvaceae	+	+	+	+	+
<i>Tridax procumbens</i> L.	Asteraceae	+	+	+	+	+
<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	+		+		+
<i>Vitex negundo</i> L.	Lamiaceae	+		+		+
<i>Waltheria indica</i> L.	Malvaceae	+	+	+		+
<i>Ziziphus jujube</i> Miller	Rhamnaceae	+		+		+
Total	27	46	23	37	16	35

Sd-Shiroda, Mn-Malvan, Aa-Achara, Kd-Kashid, Rd-Revdanda



Table 2. Morphological observations of the study site beaches

Name of study sites	Length (M)*	Type of beach	Connectivity	Tourist attraction	Environmental Characteristics	Pollution	Beach services	Dune** type
Revdanda (Raigad)	4350	Rural-Urbanized	Private vehicle Public Transportation Easy Access by walking and bike	Beach camping Sun Bathing Fishing	Soft waves. Baby dune presence <i>Casurina</i> vegetation. Mangroves	Litter Domestic sewage Fishing waste	Restaurants Accommodation Parking space	Incipient dune
Kashid (Raigad)	3319	Rural-Tourism center	Private vehicle Easy Access by walking and bike	Beach camping Beach Sport Horse Ride	Strong waves. Signs of tourism disturbance. <i>Casurina</i> vegetation. Coconut farming alongside beach	Litter Domestic sewage by local restaurant. Plastic waste	Restaurants Accommodation Parking space Sport gear Lifeguard Changing rooms.	Incipient dune
Achara (Sindhudurg)	12880	Rural	Private vehicle Easy Access by walking and bike	Small scale Beach tourism	Soft waves. Sign of coastal erosion <i>Spinifex</i> vegetation.	Plastic waste	Small Restaurants Parking space	Incipient dune
Malvan (Sindhudurg) Commercially active beach	1506	Urban Tourism center	Private vehicle Public Transportation Easy Access by walking and bike	Tourist hotspot. Ferry service to Sindhudurg fort. Scuba diving. Snorkeling & Beach safari Beach Tourism.	Soft waves. Signs of tourism disturbance. Anthropogenic activities. Fishing disturbance. Less vegetation.	Litter, Domestic sewage and waste by local restaurant and residents Open sanitation on beach. Plastic waste	Restaurants & beach resorts. Parking space Accommodation Water sport gears Local guide Ferry services. Lifeguard	Incipient dune
Shiroda (Sindhudurg)	4464	Rural Tourism center	Private vehicle Easy Access by walking and bike	Beach camping Sun Bathing Foreign tourist attraction. Water sport.	Strong waves. Signs of tourism disturbance. <i>Casurina</i> & <i>Spinifex</i> vegetation. Anthropogenic activities. Large CSD area.	Litter Domestic sewage and waste by local restaurant and residents. Plastic waste	Restaurants & beach resorts. Bars Parking space Accommodation Water sport gears	Incipient dune & Foredune, blowouts

*Maharashtra Maritime Board, Government of Maharashtra Report, 2017

** Classification based on Short & Hasp (1982)

through strong implementation of laws, modification of coastal conservation policies and appropriate plantation program is the need of time. It is very important to conserve and protect the coastal sand dune vegetation for coastal protection and ecosystem management.

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