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Coastal sand dune and its importance in near shore marine ecosystem

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The coastal region along with sandy dunes, have been used by man for different activities. The dunes have been utilized without understanding the dangerous effects, their disappearance can cause to the surrounding environment. Indiscriminate cutting of coastal vegetation and over–exploitation of beach sand for developmental works have resulted in erosion of vast coastal area. Sand dunes are very important systems which require careful planning and management.

The coastal vegetation is of specialized nature which grows under different conditions. It mainly consists of 4 different groups. (1) marine algae or seaweeds (2) Seagrasses (3) Mangroves and (4) Sand dune vegetation . Marine algae and seagrasses are purely aquatic communities, while the mangroves are partially aquatic plants which prefer intertidal areas having tidal influence. The sand dune vegetation is totally different plant community which grows on a sandy shore beyond the highest high tide level.

Beaches vary in shape, appearance, slope and their exposure to intertidal zones, the beach material is commonly called 'sand'. The colour of the beach sand varies from dark brown, grey, black, light brown, golden to silvery white on atolls and fringing coral reefs. The forces acting on beaches are the waves, tides, currents and winds. The moving water spreading along the beach carries with it a layer of sand, but the sand keeps returning along the shoreline if it is a stable beach. However, if the wave action becomes too intense, and if the beach is not stable it gets eroded, there by destructing the down stream aquatic communities. Fig. 1 shows the succession of coastal vegetation in Rameswaram island on Palk Bay.

Sources of sand, transport and deposition

Principal sources of near shore sediment for coastal areas are streams and rivers which transport sand directly to the ocean. Sand is also derived from gradual weathering of rock formations and cliffs exposed on the shore. Shell, coral and other

Fig. 1. Rameswaram island sand dune vegetation *Prosopis juliflora*, sea weeds and seagrass beds down stream

fragments provide sediment to some beaches as seen in the Sangumal area of the island (Fig. 2).

Rameswaram island has got sand dunes from Kundugal point to Arichumunai, near Adams Bridge,

Fig. 2. Dead and disintegrating coral and shells in Sangumal

which in turn has moving shoals. The region has mainly sand on top of sand stone. Drilling of the Adams Bridge southern side, showed 0- 5 m depth of sand followed by sand stone for a depth of 18m. Dune formation along the coast takes place as a result of movement of sand particles from the inter-tidal to the backshore region with the help of wind. The wind

velocity in this region varies from 9-22 km/hr. Beach sand is also moved on shore and offshore by the action of waves, tides and currents. High-energy storm waves erode sand from the beach. This sand is often deposited off shore as submerged sandbars. During periods of calm weather, low-energy waves move sand from offshore sources and deposit it back on the beach to form a berm parallel to the shoreline. The berm, or ridge of sand is formed on the upper part of the beach outside the reach of normal high tides by the swash of incoming waves. Storm waves can also deposit sand as berms at the peak of wave run-up and outside the reach of normal waves and tides.

Beach ridges consist of sand deposited by wave action. They can form as successive beach berms deposited on seaward- advancing shoreline. Grasses and other obstacles (e.g. debris) on the beach ridge trap sand blown up from the beach. The beach ridge is increased in width and height by accumulation of wind blown sand.

Dunes are composed of wind blown sand. Foredunes are deposited immediately behind sandy beaches. Strong onshore winds erode dry sand from the steepening face of the beach. This windblown sand is deposited towards the top of the beach and a foredune gradually forms.

Foredunes also form where vegetation and other obstacles on the upper part of the beach cause deposition of wind blown sand. During periods of shoreline advance, successive foredunes may develop to form a series of parallel dunes.

The inter-tidal beds are an important host to a number of benthic organisms. The fishermen of this region dig up the polychaete (Fig. 3) and mix it with the fine silt of the seagrass bed, makes small balls and use as fish bait. They collect a minimum of 1 kilogram of bait for a day of fishing. This is also used as a feed in marine culture tanks. The protection of this area depends on how well the upstream land is protected by the coastal sand dune vegetation. Propogation in dune plants is both by vegetative means and by seeds. Sprouting from the disintegrated shoots is common. The fruits and seeds of dune plants can remain viable in the high temperature sand as well when occasionally exposed to seawater. The entire inflorescence or the arrangement of fruits in

Fig. 3. Polychetae, dug for feed for fishes

Spinifix littoreus (Fig. 4) has been specially developed to favour their dispersal in a wide area.

The down stream of the intertidal beds extending

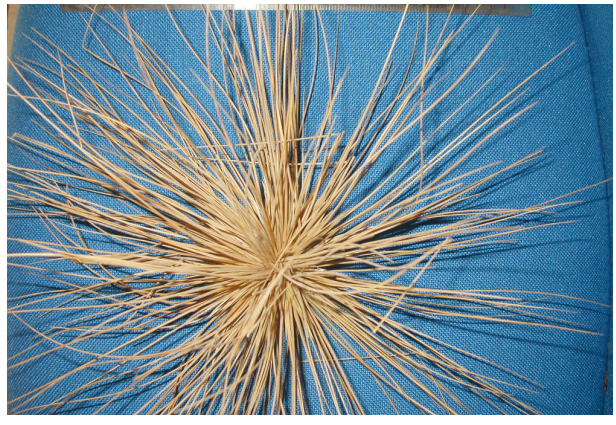

Fig. 4. *Spinifix littoreus* inflorescence

up to 5 – 9 m depth in Rameswaram island on Palk Bay and Pamban has seagrass beds which are highly dynamic and productive ecosystem, host to a number of marine organisms. The main land down stream of Mandapam and the islands are rich in the diversity of seagrasses.

Environmental factors

Climatological factors such as rainfall, air temperature, humidity and wind speed as well as edaphic factors like sand texture, pH, humus content, soil temperature and the ground moisture play an important role in the distribution and growth of dune vegetation. Atmospheric temperature in the dune regions directly affects the dune temperature. The barren dune temperature is usually more than that in

the vegetative area. The humus content and moisture minimize the temperature in the vegetative zone.

The rate of precipitation and the duration of rainfall are important factors for the dune community. These help in the germination of seeds, decomposition of organic matter, rapid growth of dune plants and create favorable condition in the dune region. The rainfall by itself binds the sand temporarily and generally the dune plants complete their life cycles during the monsoon and post monsoon seasons. Cyclonic or stormy conditions usually result in destruction of dunes by dispersing dune vegetation and by changing the configuration of dunes. Dunes without vegetation get easily eroded and cover the seagrass beds down stream during intense rainfall (Fig. 5). During summer the dunes are eroded by wind action, causing dust storm there by increasing the

Fig. 5. Eroding sand dune covering seagrass bed near Pamban Bridge - low tide

turbidity of near shore coastal waters.

Dune vegetation has a tendency to develop extensive rhizoidal root system which also helps in binding the sand. The shoot portion of the plants prevents or minimizes the movement of sand while fibrous rhizoidal roots of these plants perform important physiological and mechanical functions. To face extreme low water availability these plants have specialized inflorescence and seeds, as well as fleshy leaves.

Dominant dune vegetation in the region

The sand dune has been classified into pioneer zone, mid shore zone and back shore zone. The pioneer zone is closest to the sea and back zone is farthest. The pioneer zone in Thonithurai are covered by herbaceous crawling plant species with dominant flora of *Ipomea pes-caprae* (Fig. 6), *Cyperus arenarius* and *Spinifix littoreus*.

Fig. 6. *Ipomea pes-caprae* bed in Thonithurai

Large scale plantation of *Acacia planifrons, Prosopis juliflora, Casurina equisetifolia* on the sand dunes were introduced species 15-20 years before in Rameswaram and Mandapam. *Thespesia populnea, Azadiracta indica, Tamarindus indica* and *Prosorus indicus* were present earlier. Coconut and cashew plants are also now planted in the sand dunes.

Seagrass species of the region

The habitat complexity within seagrass meadows enhances the diversity and abundance of animals. The high primary productivity rates of seagrasses are closely linked to the high production rates of associated fisheries. These plants support numerous herbivore and detritivore based food chains. The seagrass species located in and around Rameswaram island and Mandapam are

Fig. 7. *Casurina equisetifolia* plantation in Dhanushkodi

Potamogetonaceae - *Cymodocea serrulata, Cymodocea rotundata* (Fig. 8)*, Syringodium isoetifolium* (Fig. 9), *Halodule uninervis* , *and Halodule pinifoli*a (Fig. 10).

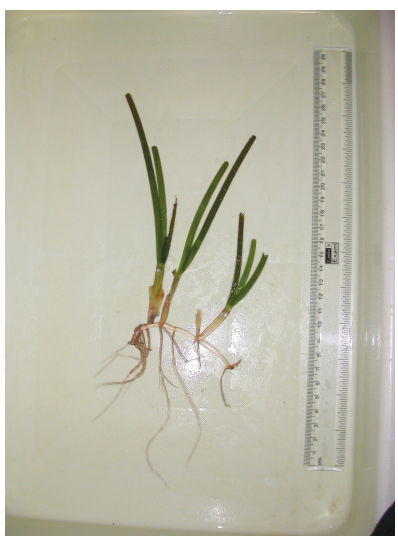

Fig. 8. *Cymodocea rotundata*

Fig. 9 *Syringodium isoetifolium* with flower

Hydrocharitacea- *Enhalus accoroides*, *Halophilla ovalis* (Fig. 11), *Halophilla beccarii*, *Halophilla decipiens* and *Thalassia hemprichii.*

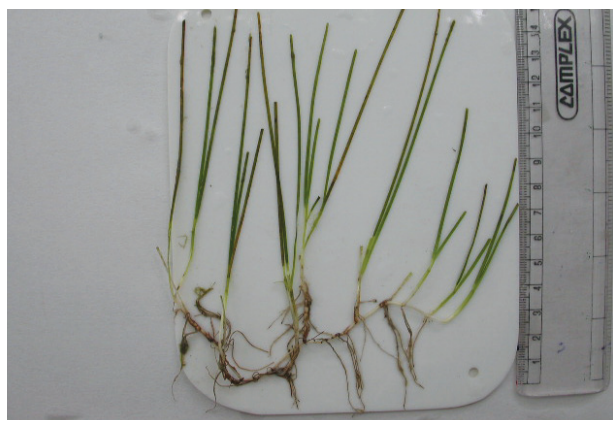

Fig.10 *Halodule pinifolia*

Fig. 11 *Halophila ovalis* with flower

Conclusion

Anthropogenic interference (e.g. agriculture, waste disposal, construction of buildings roads and ports, stone fencing etc) accelerates the loss of dunes and their habitats and interlinked marine ecosystem. Dune destruction or alteration leads to loss of natural landscape, dune dependent flora, fauna, microbes and social/cultural or traditional heritage of coastal dwellers. Systematic measures and stringent polices need to be enforced to prevent destruction and support stabilization of coastal dune habitats.