Ecoregion

Indus River Delta–Arabian Sea Mangroves

Area of the ecoregion
6020 km^2

Altitude
0 – 4 m

Annual rainfall
24 – 800 mm

Temperature
17° C – 37° C

Ecological Restoration Alliance

Overview

The **Indus River Delta–Arabian Sea Mangroves** are found along the arid and semi-arid coasts of Gujarat. These mangroves are nestled within the Gulf of Kutch and the Gulf of Khambhat forming stands along broad intertidal mudflats and salt marshes as well as estuarine-deltaic regions fed by a dense network of creeks. These forests are distinguished by low freshwater inputs and moisture due to low rainfall and long periods of drought and high salinity values. They have characteristic- monospecific stands of *Avicennia marina*, the most hardy true mangrove species. Despite the strong seasonality and limited resources, the ecoregion has a high diversity of microhabitats in the aquatic and intertidal ecosystems that these forests host, with a large number of phytoplankton, molluscs, crustaceans, and wetland birds adapted to the cycles of this low energy, arid coastal ecosystem. Much of the existing mangrove tracts are not protected and the coastline has been severely modified due to various industrial expansions (saltpans, cement, harbours) urbanisation and direct logging and grazing of mangrove communities.

Adjoining ecoregions

These mangrove communities border the coast of the Khathiar-Gir Dry Deciduous Forests and the Aravalli West Thorn Scrub Forests.

Mangroves along estuaries and marine fronts; Maharashtra

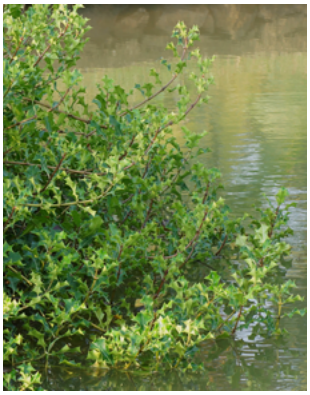
Geography

The Indus River Delta–Arabian Sea Mangroves cover an area of 6020 km^2 along the coast of Gujarat within India. These mangrove belts cover pockets of the coastline extending a length of 530 km primarily within the Gulf of Kutch and the Gulf of Khambhat. These arid and semi-arid coastal regions hold a high diversity of microhabitats including dense mangrove stands scattered across small deltaic-coastal islands, vast intertidal mudflats, salt marshes, sand dunes, and a dense vein of tidal creeks that feed these inland systems. These ecosystems are located primarily in the delta and estuarine regions of large river systems of the Gulf of Khambhat including the Purna, Tapti, Narmada, Mahi, Sabarmati and Shetrunji rivers and along the Gulf of Kutch these forests form on the seasonal salt marshes. Outside of India some broad tracts of this mangrove type are situated along the broad low delta of the Indus river. Coastal ecosystems of the region are primarily along sea level with a maximum elevation of 4 m asl.

Geology and Soil

This ecoregion is situated on new alluvial deposits and thus has no underlying geological baserock apart from layered, compressed, waterlogged sediments deposited over time through the pairing of river action and oceanic erosion-deposition cycles. The soils are largely homogenous through most of the coast and primarily consist of a fine silt-clay-loam. However there are small variations in soil consistency ranging from sandy clay, silt loam, sandy loam, to silted clay. Consequently, these variations can determine mangrove or coastal ecosystem composition and spatial distribution. Soil structures of intertidal mudflats are waterlogged over most of the year through tidal action and this results in various anaerobic processes. Soils have significantly high salinity (33% to 44%) due to the paucity of incoming freshwater from the arid and semiarid ecosystems of the Kutch. Soil temperatures also remain high throughout much of the year with an average of 28 . Soils are largely basic in nature and contain dissolved oxygen content varying between 3.42 ml l -1 to 5.85 ml l -1. Litterfall rates of 2.9 tonnes per hectare contribute a large proportion of nitrogen, potassium and phosphorus substrates and other organic matter. However only about 4% of nitrogen exists in an inorganic form.



Trees[left to right]: *Avicennia marina, Ceriops tagal, Sonneratia apetala, Acanthus ilicifolius*




Trees[left to right]: *Thespesia populnea, Salvadora persica, Derris trifoliata, Aeluropus lagopoides*

Climate

The mangroves of Gujarat are distinguished by growing in arid low rainfall ecosystems with extreme seasonal moisture and water availability determining and controlling biological activity across the entire ecosystem. Rainfall is extremely variable and sporadic and can range in annual precipitation from 24 mm to 800 mm with an average of 275 mm. A majority of the rainfall occurs in a short window of time during the southwest monsoon months of July and August. More than 8 months of the year comprise the annual drought period with summer extending from March to June and winter months between November to February. Temperatures range from a high of 37 to lows of 17 , milder in both extremes than the surrounding inland areas. Apart from being an arid to semi-arid coast, the northern extents of the Arabian Sea are a distinctly low energy coast with large tidal amplitudes due to the gradual slope of the continental shelf. The various coastal habitats are thus fed by strong diurnal tide with low wave action. Water depth varies between 0.3 m at low tide to above 3.8 m at high tide in some places. These tides feed the dense network of creeks as well as serve to bring food and sustenance to the semi-aquatic estuarine ecosystems. A distinguishing feature of the mangrove communities within this ecoregion is the lack of freshwater

Rippled mudflats and clumps of mangroves in the gulf of Kutch; Marine National park

influx into the biological system. Thus mangrove ecosystems of the Kutch are far more reliant on rainwater with important biological changes occurring during the monsoon months. This is equally true for the biotic life present beneath the soil and aquatic organisms.

Natural vegetation

Mangrove forests of Gujarat are dominated by monospecific stands of *Avicennia marina* that comprises more than 90% of the tree community. However, 11 true mangrove species are found within this ecoregion with different deltas having subsets of the regional pool. Some lianas and shrubs occur as mangrove associates but are found in drier, less tidal areas; their presence is variable but adds more structural and ecological complexity to this forest type. A mangrove-associate grass species endemic to this ecoregion is *Urochondra setulosa*. Mangrove forests are highly productive ecosystems with a tree density ranging between 300/ha to 900/ha within pockets of the Gulf of Khambhat. These mangrove trees are broad statured, predominantly evergreen and form a dense tract along estuaries, back waters, creeks, lagoons, marshes, swamps, and mudflats. Canopy height of these stands vary between 1.5 m and 9 m. The true mangrove plants and halophytes that thrive in this ecosystem

have several adaptations specific to tidal environments; such as being able to survive in oxygen-deprived soils, in high levels of salinity, and withstand strong wave action. Physical adaptations include stilt and knee roots that emerge above ground (up to 1 m) and aid in structural support against strong wave action and waterlogged conditions besides helping with aeration. Most mangrove species have subsurface root systems with dense interlocked networks on the upper surface of the soil. True mangrove species grow pneumatophores or upward-pointing roots that emerge above the surface for gaseous exchange. Mangrove plants actively maintain osmotic potentials between their tissues and the concentrated saline water, expelling excess salts through glands on the underside of the leaves.

Variation within ecoregion

Salinity, a crucial variable determining the zonation of mangrove types, may itself be a product of large-scale geographic, anthropogenic, and ecological processes. Salinity levels are greatly influenced by landscape-level processes, reducing with the volume of freshwater arriving at estuarine mouths. Consequently, within the Gulf the most hardy species capable of withstanding harsh droughts and high degrees of salinity is *Avicennia marina*; thus this species forms the monodominant stands within the Indus River Delta Arabian Sea Mangroves.

There are significant differences in floristic community and stand structure between the Gulf of Khambhat and the Gulf of Kutch. The Gulf of Kutch is far more arid and receives lower amounts of fresh water and moisture due to the lack of river systems. This is paired with the much higher salinity content which curtails the growth of more ecologically sensitive mangrove species such as *Sonneratia apetala* and *Bruguiera gymnorrhiza* which are absent in the northern regions. The Gulf of Kutch only has 7 true mangrove species of the total of 11. These mangroves are more sparsely populated and found in more sporadic clusters within the landscape.

Within all the mangrove communities, there are significant variations during the annual seasonal cycle. The monsoon months see a several-fold increase in productivity both within the mangrove trees as well as in the aquatic ecosystems with an increased concentration of nitrogen and phosphate. Apart from direct moisture, the rains increase the dissolved oxygen in the soil and creeks and see a dramatic increase in phytoplankton populations. The 103 species of phytoplankton found within this region

Characteristic native plant species

True Mangrove Species

True mangroves
Acanthus ilicifolius
Aegiceras corniculatum
Avicennia alba
Avicennia marina
Avicennia officinalis
Bruguiera cylindrica
Bruguiera gymnorrhiza
Ceriops tagal
Rhizophora apiculata
Rhizophora mucronata
Sonneratia apetala

Mangrove associates

Aeluropus lagopoides
Arthrocnemum indicum
Caesalpinia crista
Canavalia gladiata
Cressa cretica
Derris trifoliata
Ipomoea biloba
Porteresia coarctata
Salicornia brachiata
Salvadora persica
Sesuvium portulacastrum
Suaeda fruticosa
Thespesia populnea
Urochondra setulosa
Volkameria inermis

Plant seasonality

J	F	M	A	M	J	J	A	S	O	N	D
											
											
											

are a major driver of ecosystems and sustain more than 50 percent of the faunal assemblages and drive overall ecosystem health. A few examples of abundant species include *Hemidiscus hardmanianus, Coscinodiscus radiatus, Cerataulina bergonii, Spirulina sp, Bacillaria paradoxa, Bellerochea malleus, Odentella pulchella, Cerataulina bergonii,* and *Chaetoceros compressus*.

Lastly, there are gross differences in the habitat niches that different mangrove species occupy. *Avicennia marina* and *Avicennia officinalis* are coastal fringe species and also occur along the banks of large creeks with strong wave action. *Ceriops tagal* and *Bruguiera cylindrica* occur as a second tract of trees further inland from the coast and the large creek borders behind, and are protected by the frontal fringe of the Avicennia species. In contrast, *Sonneratia apetala* and *Rhizophora mucronata* are dispersed along sediment-rich intertidal mudflats along shallow small creeks and in depressions further inland. *Acanthus ilicifolius* and *Aegiceras corniculatum* are found on higher ground along the landward fringes of the intertidal area. Each of these floristic communities host different aquatic lifeforms and have different mangrove associated species leading to a high diversity of micro habitats and niches.

Plant seasonality

Flowering commences during the summer and pre-monsoon period, while fruiting begins after the monsoonal rains. There is significant variation in duration and timing between species. Furthermore, mangrove species are sensitive to microclimate and influenced by annual climatic variability.

Pollination and seed dispersal ecology

Most flowers of mangrove species have adapted to an explosive pollination method that allows flowers to interact and exchange pollen with insects and by wind. Insect pollination is mainly conducted by bees and wasps, including trigonid bees, besides other small insects. A majority of the true mangrove species are unisexual with separate male and female trees. There are twice as many male trees compared to female trees and 16 times as many male flowers, aiding in wind pollination when insect densities are scarce or absent. Wind pollination in mangrove trees functions as a fail-proof strategy when more targeted nectar-based pollination fails due to harsh and uncertain environmental conditions. This strategy is consolidated by most species having the capacity to self pollinate.

A distinctive adaptation of true mangrove species is vivipary (as in *Avicennia marina*, *Rhizophora apiculata, R. mucronata* and *Bruguiera gymnorrhiza*) and crypto-vivipary (*Ceriops tagal, Sonneratia apetala*) methods of seedling dispersal. In vivipary, the seeds germinate while still attached to the mother tree and fall to the ground as germinated shoots. About 16 percent of the fruits attain maturity in this method with seed predation accounting for a quarter of mature seed loss in the vivipary process. Seeds have no dormancy period and are primarily distributed by mechanical means such as tidal action or by simply falling and establishing themselves beneath the parent trees.

Animal life

This ecoregion is home to more than 300 species of gastropods, 200 species of molluscs, 2 species of bivalves, 27 species of prawns, 30 species of crabs, and 2 species of sea turtles including the olive ridley and green turtles both keystone species. Additionally, 94 species of water birds are found within this area including Lesser Flamingos, Demoiselle Cranes and Sarus Cranes.

Left to right: Lesser Flamingo, Sarus Crane

Left to right: Demoiselle Crane, Olive ridley

Conservation

The coast of the Indus River Delta–Arabian Sea Mangroves is a low energy coast and thus, is highly sensitive to minor environmental changes and human interference. A majority of this coastline has been faced with immense pressure and change due to expansion of industries like thermal power stations, fertiliser plants, cement manufacturing units, soda ash industries, ship breaking yards, ports and jetties. Additionally, a majority of the coastline and mudflats have been converted to salt pan industries. This is paired with the rapid urbanisation especially along the delta regions of the Narmada and Tapti river deltas, which places immense anthropogenic pressures on the coasts, including large-scale coastal erosion as well as pollution. Mangrove forests are also directly used for fuel and fodder, and for camel grazing. In recent times, the creation of offshore oil terminals has led to spills and destruction of vast tracts of mangrove and other intertidal ecosystems. All these factors are compounded by the low number of protected areas present for these mangrove communities and lenient coastal regulation.

Important Protected Areas in the Ecoregion

Marine National Park, Gulf of Kutch

Ecological Restoration Projects in the Ecoregion

We are currently not aware of any projects located in this ecoregion. Please mail us on hello@era-india.org if you know of any projects that could be listed here.

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[cover] Ecoregion Map: Madhavan A.P.
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[Pg 3] Avicennia marina; Peripitus
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[Pg 3] Sonneratia apetala; Dinesh Valke
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[Pg 9] Lesser Flamingo; Bendale kaustubh
[Pg 9] Sarus Crane: Charles J. Sharp
[Pg 9] Demoiselle Crane: Bernard Dupont
[Pg 9] Olive ridley: Murray Foubister

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One Earth Ecoregion Snapshot https://www.oneearth.org/ecoregions/godavari-krishna-mangroves/

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