



Assessment of Coastal Wetland Resources of Central West Coast, India, using LANDSAT Data

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ABSTRACT

The part of central west coast (Maharashtra and Goa) of India has been classified and quantified for coastal wetlands using LANDSAT data of 1985-86. The classification accuracy of the maps and area estimates achieved was 84% at 90% confidence level and the planimetric accuracy at 1:2,50,000 scale was 0.3 mm. The total coastal wetland areas in Maharashtra and Goa, have been estimated to be 1567 and 115 km², respectively. The estuarine and backwater regions contribute 44.6% of the wetland, followed by open mudflats (32%), mangroves (8.8%) and beach/spit (7.8%). Mangroves comprised of 17 species and are dominated by *Rhizophora mucronata*, *Avicennia officinalis*, *A. marina*, *Sonneratiu alba*, *Excoecaria agallocha* and *Acanthus ilicifolius*. The sand-dune flora comprised of 63 species while rocky intertidal regions harboured > 100 species of marine algae. Erosional changes have been noticed to be predominant along the Maharashtra coast while progradation of beaches is noticed in Goa.

Introduction

Coastal wetlands include littoral zones, brackish water and estuarine regions, lagoons and coral reefs, and constitute (Anon, 1991) ~ 70% of total wetlands of the country. These habitats in the world being great ecological and economic significance, global efforts are being made to manage these resources on a sustainable basis. Management of natural habitats primarily requires authentic data related to location, types, extent, composition of biota, utilization,

sedimentation, progradation etc. This kind of information on the coastal wetlands of India is either patchy or inadequate. Remote sensing data substantiated with ground truths, are being effectively used for exploration and management of earth resources. Recently the Ministry of Environment and Forestry, launched (Anon, 1992) a countrywide mission to study coastal environment with satellite data. The present study forms a part of Remote Sensing Application Mission and describes coastal wetlands along the central west coast (CWC) of India.

Study Area

Goa and Maharashtra coast extends north-south between 14° 49' - 20° N latitude and 72° 49' - 77° 41' E longitude (Fig. 1). The total length of the coast under study is about 840 km of which 720 km belongs to the state of Maharashtra. The segmented coast has 7 major estuaries in Goa, while 15 rivers, 5 major creeks and 30 backwater regions occur (Jagtap, 1985. Ahmad, 1972, Jagtap *et al.*, 1994) in Maharashtra. Soil is lateritic in the south and red, loamy and alluvial towards north. The climate is warm (atmospheric temperature 20-35°C) and humid (humidity 60-90%). The average annual rainfall reaches upto 3000 mm.

Materials and Methods

In the present study LANDSAT of path 147 and rows 46, 47 and 48 acquired on November and path 148 and rows 46 and 47 acquired on January, 1986 and October 1986 has been used. Topographical maps (scale 1:250,000) have been used as auxiliary data. Image interpretation key as discussed by Anon (1992) have been used for the interpretation of various coastal wetland related parameters. Interpreted results have been substantiated with adequate ground truth data and Survey of India topographical maps. Various

categories under wetlands have been delineated from imageries on to the trace paper, using light table and hand lens, and interpretation keys. Categories of size less than 2 x 2 mm have been not considered for mapping. Interpreted details have been transferred on to the base maps and area for each wetland category have been measured with digital planimeter and dot grid (least count 0.0625 cm²).

Classification accuracy (Arnoff, 1982) has been tested on a sample basis, assuming a binomial distribution for the probability of success and failure of sample tests. Final maps have been prepared with hybrid system using various legends (Fig. 2). Control accuracies of the maps have been assessed as described by Patel *et al.* (1988).

Results and Discussion

Coastal wetlands of India, excluding estuarine and creek water regions are estimated to be ~ 63630 km² (Anon 1992). Maharashtra and Goa states cover about 2.6% (1683 km²), including estuarine and creek waters. Estuaries contribute the maximum wetland followed by mudflats, mangroves and beach regions (Table 1). Estuaries along the central west coast being microtidal drowned valleys (Ahmad, 1972) are

Table 1: Extent (km²) of coastal wetlands under various categories from Goa and Maharashtra.

<i>Category</i>	<i>Maharashtra</i>	<i>Goa</i>
Estuarine	738.13	13.15
Mud flat	471.44	67.31
Beach/spit	119.65	11.75
Shoals	1.20	ND
Mangroves	146.40	2.0
Marsh	12.10	ND
Mudflat with vegetation	8.20	ND
Lagoon	8.60	ND
Dunes	42.40	21.30
Salt pans	19.50	ND

ND- Not Detectable

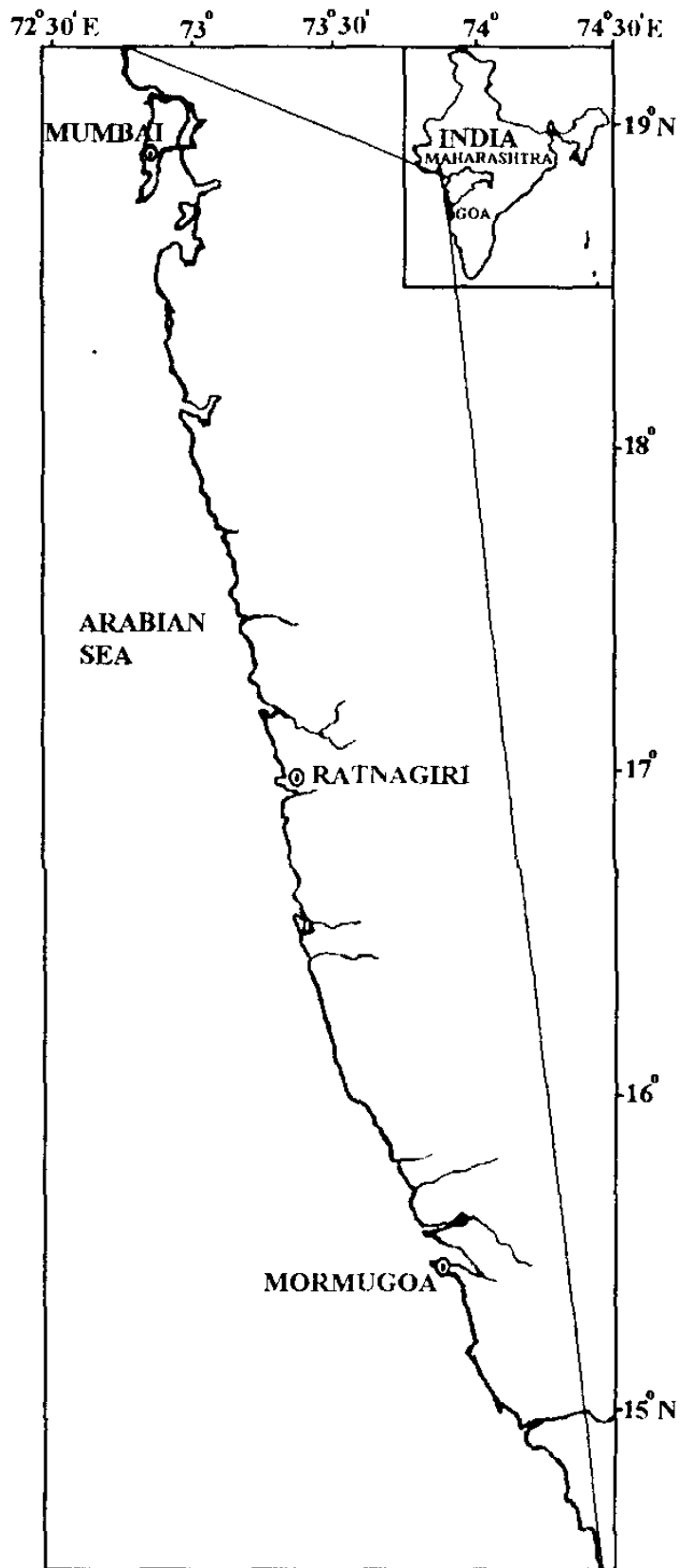


Fig. 1. Geographical location of Study site

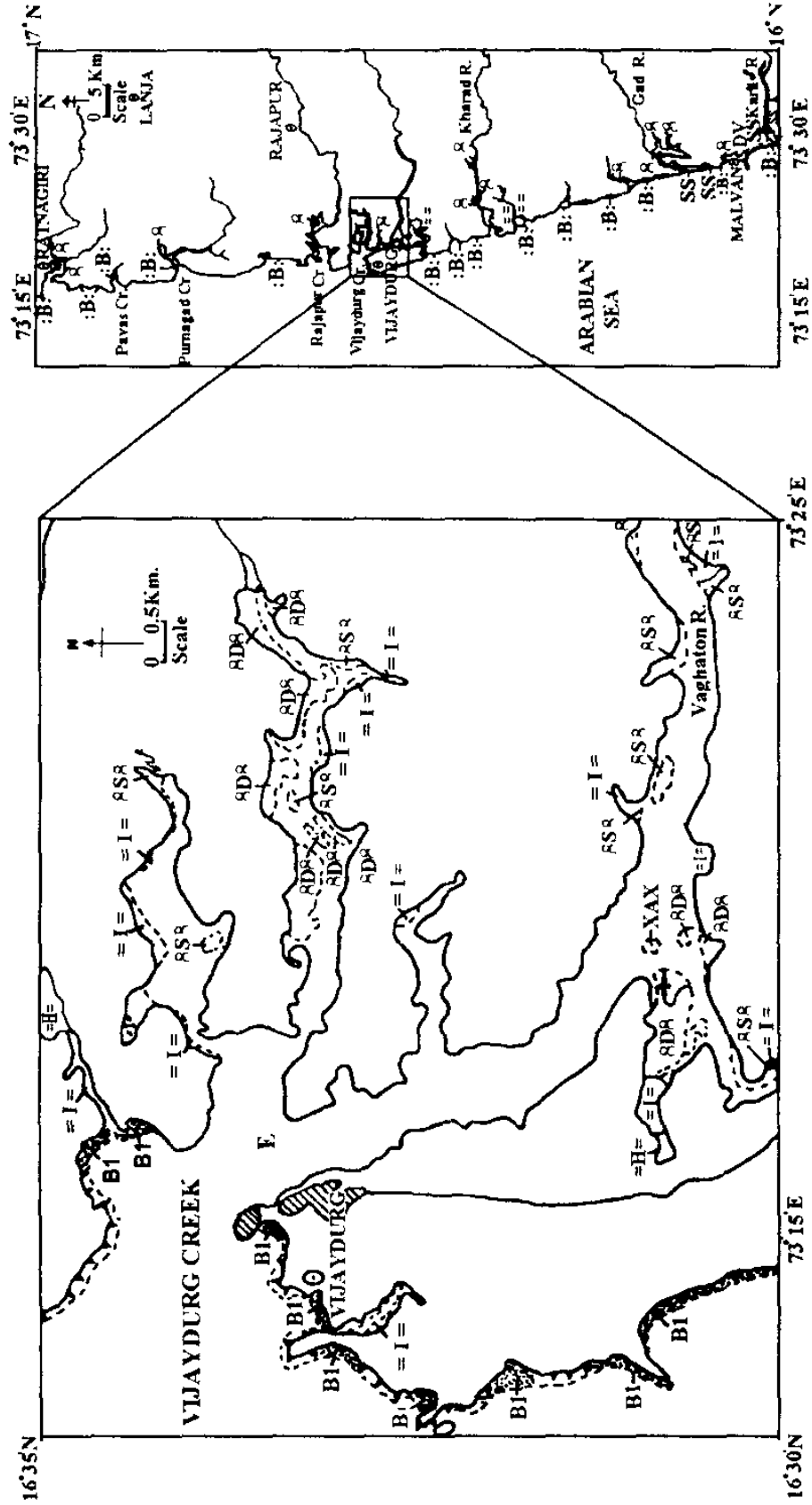







Fig. 2. The sample of Final maps for the various Wetland categories

Legend:

Non-Vegetated Wetland	Mudflat	
	High-tide mudflat	H-
	Inter-tide mudflat	!
	Beach	B
	Beach (Quartz sand)	B 1
	Sand spit	SS
	Rock> coast	
Vegetated Wetland	Mangroves	
	Mangrove (Danse)	
	Mangrove (Spare)	
Water bodies	Estuary	E
	Creek	C
Shoreland	Relict Alluvium	XAX
	Dune vegetation	DV
Other features	High waterline	
	Low waterline	
	Habitation	
	Roads	

dominated by the tidal influence. The intertidal mudflats of recent alluvial soils are mostly narrow. The estuaries and creeks are though mostly bordered by fringing mangroves, occasionally large sized patches have been also observed. The lunging nature of mangroves and narrow belts of mudflats are attributed to the rising topography of the coast.

Almost 80% of the mangrove area in Goa is located in the estuarine complex of Mandovi-Zuari and Cumbarjua canal. Better mangrove formations in the Maharashtra are located in the Thane Panvel, Karanja and Dharmatar creek complex in the Raigarh and Thane districts. Mangrove covers are estimated to be 146 km² in Maharashtra and 2 km² in Goa. The exclusive mangrove flora comprised of 17 and 15 species

along the Maharashtra and Goa coasts respectively. Species like *Acanthus ilicifolius*, *Avicennia marina*, *A. alba*, *A. officinalis*, *Excoecaria agallocha*, *Rhizophora mucronata* and *Sonneratia alba* are the most dominant. The northernmost coast of Maharashtra (Mumbai) though showing large mangrove regions (26.97 km²), is mostly degraded and mainly represented by stunted *Avicennia marina* and *Acanthus ilicifolius*. However, upstream regions of Thane and Uthas creek were observed to have luxuriant growth of *Sonneratia apetala*, *A. marina*, *A. alba* and *A. officinalis*. Similarly along the Manori and Malad creeks in Mumbai, *A. marina* is quite dense rather (Jagtap et al. 1994). Studies have reported 210 km and 20 km of the mangrove cover from the Maharashtra and Goa respectively! with the help of aerial photographs.

(scale 1:25,000). The lower estimates of the same during present investigation could be attributed partly to the reclamation and but mainly to the limitation (mangrove areas < 0.25 km- could not be quantified due to poor resolution) of satellite data. Mangroves along the west coast, excluding few localities along the Maharashtra and Goa coasts have been categorized (Jagtap *et al.*, 1993) as degraded. About 44% of the mangrove regions along the west coast have been reclaimed during the last three decades, resulting in discontinuous distribution of a few species like *Kandelia candal*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Aegiceras corniculatum*, *Lumnitzera* sp. and *S. apetala*. Mangroves species like *Xylocarpus* reported (Blatter, 1905) earlier have been totally disappeared from the west coast. Similarly, paleobotanical evidences which indicated the existence of *Nypa fruticans* from the Maharashtra, has also been vanished.

Open mudflats in the intertidal regions support rich growth of algae belonging to the genera *Ulva*, *Enteromorpha* and *Chaetomorpha* and number of Cyanophycean members. Economically important algae like *Monostroma* sp., *Gracilaria verrucosa* thrive (Jagtap, 1985) well in the highly saline swamps towards mouth of the estuaries and backwaters. Among angiosperms the marshy regions of low salinity towards upstream regions of the estuaries found to be dominated by members of Cyperaceae. Patches of *Porteresia coarctata* commonly found in the marsh regions of medium salinity (18-30 ppt) along the estuaries. It has been observed (Jagtap, 1985, Untawale *et al.*, 1992) that, *Porteresia coarctata*, a gramineae member, a seagrass *Halophila beccarii* and mangrove species like *S. alba* and *Excoecaria agallocha*, act as pioneer species, during succession process. Spectral signature from the mudflat algae particularly *Enteromorpha*, *Chaetomorpha* as well as other marsh vegetation of obligate halophytes and grasses are likely to be accounted for mangroves. Many a times it leads to over estimation of the mangrove area in the absence of ground truth data. Rocky coast is more

prominent at Cabo-de-Rama, Donapaula, Anjuna and Baga in Goa. Stretches and cliffs of rocks could be observed at Redi, Malvan, Vijaydurg, Ratnagiri, Harihareswar, Alibag, Colaba and Arnala, along the Maharashtra coast. Rocks are generally (Ahmad, 1972) Deccan basalt in Maharashtra and quartzites, granite and other metamorphic rocks in Goa. The intertidal and rocky subtidal regions have been reported to harbour 100 species of marine algae, with an annual production (Jagtap unpublished) of about 3300 M. ton of dry weight. Mostly the seaweeds are abundant during November to March along the Indian coast. However, in India, no attempts have been made till date, to study marine algae using satellite data. In general, the seaweeds of India are dominated by phaeophyceae and rhodophyceae members, which are relatively small sized having poor reflectance due to less or lack of chlorophyll a and b, unlike other vegetation. The reflectance is further reduced because of rocky uneven substratum and scattering effect due to splashing of water in the seaweed zone. As a result, it is almost impossible to recognize the vegetation in the intertidal regions. However, monospecific stands of large sized floating seaweeds like *Sargassum* spp., in clear and shallow waters, could be quantified (Anon, 1992) with satellite data.

Beach vegetation was located to be prominent towards north of Chapora estuary in Goa, and near Nandgaon as well as Palghar in Maharashtra. The sand dune vegetation of creeping and dwarf natures was rather difficult to detect on satellite data of 1:250,000 scale, due to poor resolution. However, a number of species were observed to be common on the backshores, The plantation along beaches comprised of *Casurina equisetifolia* and *Cocus nucifera*. Sand dune flora of India comprised (Untawale and Nair 1974) of 63 species. However, *Ipomea pes-caprae*, *Spinifex squarrosus*, *S. littoreus*, *Vitex negundo*, *Launea pinnatifida*, *Anacardium occidentale*, *Pandanus* and *Opuntia* spp. dominate the vegetation. A few plants of branched palm *Hypnae indica* occurred in the backshore regions along, the Miramar beach at

Goa only. This particular species has very limited and restricted distribution along the coasts of Goa, Diu and Daman. It is fast disappearing from the country, and hence warrants for urgent protection.

The subsidence and recession of coastal wetlands, by natural or anthropogenic causes are of immediate concern. Shoreline is subjected to rapid changes due to any alterations, which could easily be monitored from the satellite data. Demarcation of shoreline, hence form an important parameter in the coastal zone management. Erosional changes were predominantly noticed on the southern bank of Thane creek, and along the banks of Panavel Dharamtar creek complex, mouth of Vashisthi river, west of Dapoli and north of Devgarh in the Maharashtra. However, along the Goa coast progradation was observed off Margao and Calangute.

Being of great aesthetic importance, productive and sensitive, demands a long term strategy for their sustainable utilization through conservation and protection. The maintenance of biodiversity forms a keystone of sustainable development and hence is emerged as one of the central tenets of the world conservation movement. Fresh water wetlands in the world have received (Gopal and Krishnamurthy. 1993) more attention from the management point of view. Management of coastal wetlands in India have initiated recently (Jagtap *et al.*, 1993, Ansari, '1987, IUCN, 1971. Jayawardene. 1987) under UNESCO's Integrated Management of Coastal System (COMAR).

Mangrove and brackish water habitats from Maharashtra and Goa are mainly utilized for fishing, paddy cultivation, pisciculture and salt pans. Large areas have been reclaimed (Jagtap *et al.*, 1993) mainly for urbanization and agricultural purposes, and are under constant human pressure, Economic and other kind of anthropogenic activities in the inland and intertidal zones, result in the deterioration of vegetative cover, which is of great significance in protecting the inland and coastal

environments. Beaches, bays and estuaries are very commonly subjected to erosion. In general, the coastal wetlands of these states have been paid very little attention from management point of view.

Mapping of coastal wetlands on 1:250,000 scale envisages a reconnaissance level with number of limitations and constraints. Wetlands could be described in a broader perspective. However, synoptivity is adequate in making a quick appraisal of the status of wetlands. Small patches (> 25 ha) of mangroves, salt pans or aquaculture ponds could not be delineated due to poor resolution.

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